iNDUSTRIAL PLANTS

May 2014

ITALIAN ENGINEERING, CONTRACTING AND PLANT COMPONENTS SUPPLIERS

ANIMP



Spedizione in abbonamento postale - 45% - Art. 2 comma 20/B - Legge 662/96 - Milano

Special issue of "**IMPIANTISTICA ITALIANA**" Official magazine of **ANIMP** Italian Association of Industrial Plant Engineering

BOSCO italia

the factory of silence



Bosco Italia dal 1976 realizza sistemi per l'insonorizzazione ed il controllo del rumore per Impianti Oil & Gas, Produzione di Energia, Industria, Infrastrutture e Testing Room.
Tecnicità ed artigianalità, strumenti all'avanguardia per il rilievo, l'analisi previsionale e la progettazione, una officina interna altamente specializzata, severe procedure di controllo sulle materie prime e sul prodotto finito.
Tutto questo siamo Noi e tutto questo ha fatto di Noi una azienda leader e di riferimento nel settore del noise control in Italia e sui mercati internazionali.

Bosco Italia. La fabbrica del Silenzio.

Since 1976, Bosco Italia specializes in soundproofing and noise control systems for oil & gas, energy and industrial plants, large infrastructures, testing rooms.
Technology and craftsmanship, state-of-the-art tracing and detection instruments, anticipatory analysis, design and engineering, a highly specialized workshop, strict control procedures on feedstock and final products.
All this has made Bosco Italia a leading player in the field of noise control both in Italy and abroad.

Bosco Italia. The factory of Silence.

Bosco Italia S.p.A. - Sistemi Antirumore
Via Umbria, 16 - 10099 San Mauro T.se - Torino Italy - T. +39 011 223.68.38 - F. +39 011 223.68.63
noise@boscoitalia.it

REDAPPLE adv.it

"Nothing great
in the world
has been accomplished
without passion"

Georg Hegel

1954-2014

60 YEARS OF MANUFACTURING
EXPERIENCE, FOCUSED
ON SPECIAL ALLOYS...

... EVERY DAY WITH PASSION.

to be continued...

10 20 30 40 50 60 YEARS

STAINLESS STEELS	PRESSURE VESSELS	ISO 9001	PED 97/23/EC	PIPES 12 m	ASME U-STAMP
WELDED PIPES	NICKEL ALLOYS	AD 2000-WO	UNI EN ISO 3834-2	PIPES W.T. 60 mm	ISO 14001
FITTINGS	TITANIUM	AD 2000-HPO	NORSOK M-650	NUCLEAR APPROVAL	OHSAS 18001



OFFICINE ORSI S.p.A.
Villaggio Francolino
20080 CARPIANO [Milano] Italy
Phone + 39 02.98.50.95.1
Fax + 39 02.981.54.52
orsi@officineorsi.com

ORSI 60 1954-2014
SPECIAL PIPING SOLUTIONS

www.officineorsi.com

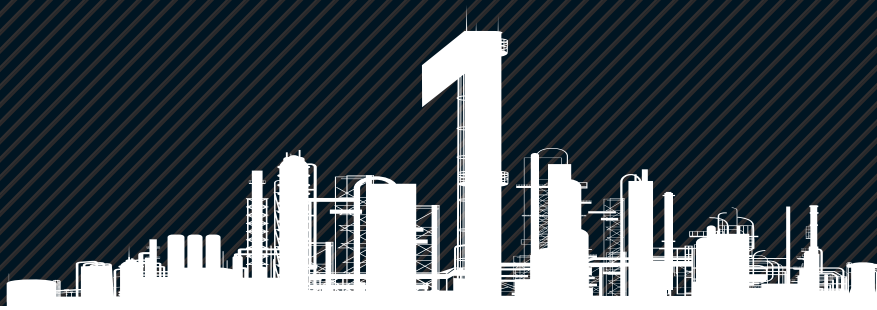
AVEVA™
CONTINUAL PROGRESSION

AVEVA
EVERYTHING3D™

E3D™

Plant Design for Lean Construction

AVEVA's vision for plant design is a new product called AVEVA Everything3D™ (AVEVA E3D™) that exploits technology innovations in mobile computing, cloud computing and laser scanning to enable Lean Construction in plant project execution.



SCAN THE QR CODE WITH YOUR MOBILE DEVICE TO SEE THE FUTURE OF PLANT DESIGN OR VISIT tinyurl.com/avevae3d

www.aveva.com/futureofplantdesign

LEVER

power solutions

since 1973

- Oil & Gas/Petrochemical
- Utilities & Power stations
- Transports
- Automation and industrial processes
- Telecommunications
- Information Technology







UPS - Uninterruptible power supply
Rectifier battery chargers
DC/AC inverter
Low-voltage distribution switchboards

Heavy duty technology made in italy for supply critical industrial applications



CUSTOMISED SOLUTIONS

Thanks to its experience and technical know-how, Lever offers customised solutions for the industrial markets. We analyse in detail the technical specifications provided by the customer, we agree upon the technical details, then we submit our offer:
- Technical and economical offer with or without prices; - Design upon request; - Drawing up of documentation upon request; - Expediting and testing; - Witness tests; - Commissioning supervision and start up.

LEVER S.r.l. - Viale del Lavoro, 17 - 37024 Arbizzano (Verona) ITALY
Telephone: +39 045 602.01.62 - Telefax: +39 045 602.01.47
info@lever.it · www.lever.it

Motors | Automation | Energy & Distribution | Coatings

The flameproof W22X.
Ultimate safety.
Ultimate efficiency.



Historically, hazardous area motors have been a compromise between safety and efficiency.

Not any more. Our new W22X flameproof motors are IEC compliant for use in hazardous areas. They're also the only flameproof motors rated IE3 for energy efficiency. So your customers get flameproof protection and money saving efficiency, too.

To learn more about our new W22X, the ultimate hazardous area motor,

visit www.weg-ie4.com/hazardous

Contents



View of the cogeneration plant designed and built by Foster Wheeler for Dow Chemical at Stade, Germany

9 **Editorial**
An Outlook for the Italian Engineering and Contracting Industry
N. Uccelletti
Animp President

10 Overcome Industrial Water Treatment Challenges
Federico Callero, Riccardo Martini
ABB, Italy
Mario Abela, Dario Giannobile
Isab Energy Services, Italy

20 Pd Based Membrane Reactors for Syngas and Chemicals Production
Gaetano Iaquaniello, Emma Palo
KT – Kinetics Technology SpA (Maire Tecnimont Group)
Annarita Salladini
Processi Innovativi Srl (Maire Tecnimont Group)

30 Shah Gas Development and Associated Railways Projects in Abu Dhabi, UAE
Stefano Grandino,
Branch Manager - Saipem Abu Dhabi and Project Director - Shah Gas Development
Luca Pretari
Operations Manager - Saipem Branch in Abu Dhabi
Alessandro Cursio
Project Manager - Shah Gas Plant and Sulfur Recovery Units
Roberto Lanni
Project Manager - Shah Product Pipelines Project
Giuseppe Iocco
Project Director – Etihad Railway Project, Stage 1

41 Energy Savings for Offshore Drilling Units Using LEDs
Kim Fumagalli
Nuova ASP

50 Installation of the MOSE Defense System in Venice
Rudy Corbetta,F rancesca Tablomi
Fagioli SpA

61 Enhancing Energy Efficiency of Gas Turbines
Thomas Helf, Carlo Coltri
Mann+Hummel Vokes Air

66 Substitute Natural Gas (SNG) Pilot Plant in China
Luigi Bressan, Fabio Ruggeri, Letizia Romano
Foster Wheeler

73 Air Cooled Condenser for a Geothermal Power Plant
Gabriele Miccichè, Marianna Caputo
Spig SpA

79 Neutralisation Package Unit in a Chemical Plant in Jordan
Alessandra Ranno
Costruzioni Elettrotecniche Cear srl

85 International Plant Achievements in the Energy Sector
Ansaldo Energia Press Office

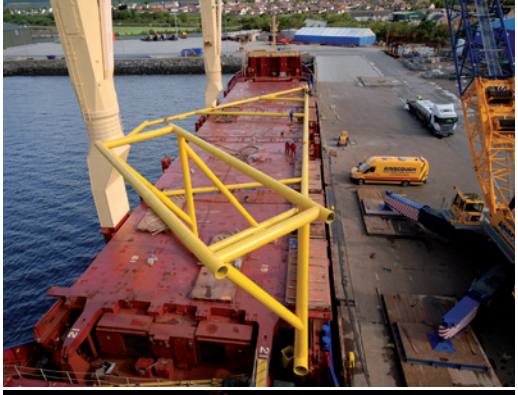
90 Centrifugal Pumps for an Offshore Platform
Cesare Nardini
Termomeccanica Pompe – TMP

95 Multi-Level, Integrated Fire and Gas Control System
Gianbattista Zago
Safco Engineering

98 Investing in TecÚology for Offshore Design
Eileen Tan
Intergraph

103 Intelligent Well Production
Daniela Bastico
Emerson Process Management Italia

106 Pumps for Offshore Energy Industry
Seepex





Deutsche Post DHL – The Mail & Logistics Group

MORE THAN MEETS THE EYE
PEACE OF MIND: PROVIDED BY DHL

We are proud of having supported customers with a **wide variety of project forwarding and out of gauge movements** across the globe and in our focus sectors; Mining, Oil & Gas, International Oil Companies, National Oil Companies, Power & Renewables and EPC.

We are proud of being able to offer **local projects expertise** in some 60 offices in 45 countries, in addition to our global network in over 220 countries.

We are also proud of our a market leading **Material Management System** (MMS) which helps our customers to keep track of purchase orders and inventory visibility, among many other things.

But most of all we are very proud of our z**ero-harm Health, Safety, Security and Environment (HSSE) and global zero-tolerance compliance culture** and strategy, led by below policies.



Understand the risk | **Clear Transportation Rules** | **Lifting Operations Right, Every Time.** | **Security - a structured system** | **Constant Communication**

If it can't be done strictly within our HSSE policy, we will not do it at all. That is our commitment today so we can be sure that we are still operating tomorrow. In return this is also your guarantee for long-term safety and reliability when working with your preferred partner - DHL Industrial EPC team.

To find out more about how we can support you, visit **www.dhl.com/industrialprojects**, email **projects@dhl.com** or connect with us on **www.linkedin.com/company/dhl-industrial-projects**.

EXCELLENCE. SIMPLY DELIVERED.

GENERAL CONTRACTOR

ABB
ALSTOM
APS ENGINEERING COMPANY ROMA
cefla impianti
Foster Wheeler
ROSETTI MARINO
eni
saipem
SIMECO ENGINEERS & CONTRACTORS
SP SUDPROGETTI
TECHINT Engineering & Construction
Tecnimont
KT Kinetics Technology
Technip

SOCI SOSTENITORI

ANSALDO ENERGIA
Ansaldo STS
auma Solutions for a world in motion
Autodesk
AVEVA CONTINUAL PROGRESSION
BONETTI Quality Valves & Level Gauges
EMERSON Process Management
Enel L'ENERGIA CHE TI ASCOLTA.
eni
FLOWSERVE Flow Control Division
IMESA ELECTRICAL ENGINEERING
indra VALVES & CONTROLS ITALY
I&SI Ingegneria & Software Industriale
INTERGRAPH
Nidec ASI S.p.A.
SISTEMI INDUSTRIALI Answer ABTICS Industrial Automation
PALL
PENTAIR
PEPPERL+FUCHS PROTECTING YOUR PROCESS
RIZZANI DE ECCHER
Schneider Electric
SIAD MACCHINE IMPIANTI
SIEMENS
STF S.p.A.
UNAOIL GROUP
24ORE SOFTWARE

COLLECTIVE MEMBERS

A.V.R. ASSOCIAZ. COSTR. VALVOLAME RUBINETT. – MILANO
AIDI ASSOCIAZIONE ITALIANA DOCENTI IMPIANTISTICA INDUSTRIALE – ROMA
ALBELISSA SRL – ROSTA (TO)
AMMONIA CASALE S.A. – LUGANO (CH)
ANIXTER ITALIA SRL – PESCHIERA BORROMEO (MI)
APRILE PROJECT SPA – ROMA
ARTES INGEGNERIA SPA – OLIVETO CITRA (SP)
ASCO FILTRI SRL – BINASCO (MI)
ASSOCIAZIONE COSTRUTTORI CALDARERIA-UCC – MILANO
ASSOPOMPE – MILANO
ATLAS COPCO ITALIA SPA – CINISELLO BALSAMO (MI)
ATV ADVANCED TECHNOLOGY VALVE SPA – COLICO (LC)
AUCOTEC SRL – MONZA
BAGGIO TRASPORTI SPA – MARGHERA (VE)
BAKER HUGHES – PROCESS AND PIPELINE SERVICES – Santa Teresa di Spoltore (PE)
BALCKE DUERR ITALIANA – ROMA
BASIS ENGINEERING SRL – MILANO
BCUBE SPA – CONIOLO (AL)
BENTELER DISTRIBUZIONE ITALIA – TREZZANO S/NAVIGLIO (MI)
BENTLEY SYSTEMS ITALIA SRL – ASSAGO (MI)
BIT SPA – CORDIGNANO (VI)
BM ELETTRONICA SPA – CIMEGO (TN)
BOFFETTI SPA – CALUSCO D'ADDA (BG)
BOLDROCCHI SRL – BIASSONO (MI)
BONATTI SPA – PARMA
BORRI SPA – SOCI DI BIBBIENA (AR)
BOSCH REXROTH SPA – CERNUSCO S/NAVIGLIO (MI)
BOSCO ITALIA SPA – S.MAURO TORINESE (TO)
BRUGG PIPE SYSTEMS SRL – PIACENZA
BSLE ITALIA SRL – GENOVA
BUHLMANN ROHR FITTINGS STAHLHANDEL GMBH – BERGAMO
BURCKHARDT COMPRESSION (ITALIA) SRL – COLOGNO MONZESE (MI)
CA.S.T.IM. 2000 SRL – ROMA
CADMATIC ITALY – ROMA
CAMFIL – CINISELLO BALSAMO (MI)
CAPITAL PROJECT LOGISTICS SRL – LIVORNO
CARLO GAVAZZI IMPIANTI SPA – MARCALLO C/CASONE (MI)
CARRARA SPA – ADRO (BS)
CCI ITALY – MILANO
CCM SPA – AMELIA (TR)
CEAR SRL COSTRUZIONI ELETTROTECNICHE – GESSATE (MI)
CEG SRL ELETTRONICA INDUSTRIALE – BIBBIENA STAZIONE (AR)
CESTARO ROSSI & C. SPA - BARI
CEVA LOGISTICS - ASSAGO (MI)
CINETIC SORTING SPA – LONATE POZZOLO (VA)
COMOTTO STEFANO SRL – GENOVA
COMPUTER LINE ASSOCIATES SRL – PIACENZA
CONTROLCAVI INDUSTRIA SRL – BERNATE TICINO (MI)
CONTROL SERVICE – SANNAZZARO DE' BORGUNDI (PV)
CORTEM SPA – MILANO
CORVALLIS PROCESS & SOLUTION – PADOVA
CS IMPIANTI SRL – SAN GIULIANO MILANESE (MI)
CTG ITALCEMENTI GROUP SPA – BERGAMO
CUDA SERVIZI TECNICI IMPIANTI – CSTI – NOVARA
D'AMORE E LUNARDI – SERRAVALLE SCRIVIA (AL)
DE PRETTO INDUSTRIE SRL – SCHIO (VI)
DELTA ENGINEERING SRL – DALMINE (BG)
DELTA-TI IMPIANTI SPA – RIVOLI (TO)
DEMONT SRL (REGGIANE DESALINATION PLANTS) – REGGIO EMILIA
DEUGRO ITALIA SRL – MILANO
DHL GLOBAL FORWARDING ITALY SPA – LISCATE (MI)
DRESSER ITALIA SRL – CASAVATORE (NA)
DRESSER RAND ITALIA SRL – VIGNATE (MI)
ECISGROUP SPA – MUGGIO' (MB)
EMERSON PROCESS MANAGEMENT VIRGO VALVES SRL – MILANO
ENERECO SPA – FANO (PU)
ENERGY INTERNATIONAL LOGISTICS SRL – SAN GIULIANO MILANESE (MI)
ENGITEC TECHNOLOGIES SPA – NOVATE MILANESE (MI)
ERREVI SYSTEM SRL – REGGIO EMILIA
ESAIN SRL – GENOVA
EUROTECNICA CONTRACTORS & ENGINEERS SPA – MILANO
EUSEBI IMPIANTI SRL – ANCONA
EXPERTISE SRL – VADO LIGURE (SV)
F.H.BERTLING LOGISTICS – SESTO SAN GIOVANNI (MI)
FABBRICA ITALIANA POMPE SRL – SESTO SAN GIOVANNI (MI)
FAGIOLI SPA – OPERA (MI)
FERRARI SRL – RAVENNA
FERRETTI HOLDING SPA – DALMINE (BG)
FILTREX SRL – MILANO
FINANCO SRL – GUBBIO (PG)
FINDER POMPE SPA – MERATE (LC)
FLEXIDER SRL – TORINO
FLOWSERVE Pump Division-WORTHINGTON – DESIO (MB)
FORES ENGINEERING SRL – FORLI'
FRAG SRL – MILANO
FRANCO TOSI MECCANICA SPA – LEGNANO (MI)
FRIULANA FLANGE SRL – BUJA (UD)
FUMAGALLI VALVES SPA – TREZZANO S/NAVIGLIO (MI)
GE OIL & GAS NUOVO PIGNONE – FIRENZE
GEA HEAT EXCHANGERS SRL – MONVALLE (VA)
GEA PROCESS ENGINEERING SPA – SEGRATE (MI)
GEA REFRIGERATION ITALY SPA – CASTEL MAGGIORE (BO)
GEODIS WILSON ITALIA SPA – GENOVA
GI.EFFE.M. SNC – LANDINARA (RO)
GREENE, TWEED & CO.ITALIA – MILANO
GRUPPOMEGA SPA – PRIOLO GARGALLO (SR)
HARPACEAS SRL – MILANO
HONEYWELL SRL – MONZA
HYDAC SPA – AGRATE BRIANZA (MB)
HYDROSERVICE SPA – MILANO
I.N.T. SRL – CASTELVERDE (CR)
IDI SPA – MILANO
IDROSAPIENS SRL – LEINI' (TO)
IGNAZIO MESSINA & C. SPA – GENOVA
IGS ITALIA SRL – GROSSETO
IMPRESIT METALLURGICA – TORINO
INGENIOTEC STUDIO DI INGEGNERIA ZILIO – CASSOLA (VI)
INPROTEC INDUSTRIAL PROCESS TECHNOLOGIES SPA – CINISELLO BALSAMO (MI)
INSIRIO SPA – ROMA
INTERAPP ITALIANA SRL – PERO (MI)
INTERMARE SPA – GENOVA
INTERTECNO SPA – MILANO
INVENSYS SYSTEMS ITALIA SPA – SESTO SAN GIOVANNI (MI)
IREM SPA – SIRACUSA
ISCOTRANS SPA – GENOVA
ISG SPA (IMPIANTI SISTEMA GEL) – MILANO
ISOLFIN SPA – RAVENNA
ISS INTERNATIONAL SPA – ROMA
ISS PALUMBO SRL – LIVORNO
ITAL BROKERS SPA – GENOVA
ITALIAN ENGINEERS SRL – ROMA
ITEX SRL QUALITY SERVICES – SAN DONATO MILANESE (MI)
JACOBS ITALIA SPA – COLOGNO MONZESE (MI)
JAS Jet Air Service SPA – GENOVA
JOHN CRANE ITALIA SPA – MUGGIO' (MB)
KENT SERVICE SRL – MILANO

COLLECTIVE MEMBERS

KM ENGINEERING SRL – MILANO
KROHNE ITALIA SRL – MILANO
LEVER SRL – NEGRAR (VR)
LLOYD'S REGISTER EMEA – VIMODRONE (MI)
LPL ITALIA SRL – GENOVA
M.E.G.A. SPA – SCANZOROSCIATE (BG)
M.S.T. MANUTENZIONE&SERVIZI TECNICI SRL – ROMA
MACCHI – ADIVISION OF SOFINTER SPA – GALLARATE (VA)
MAMMOET ITALY SRL – MILANO
MARELLI MOTORI SPA – ARZIGNANO (VI)
MARIMED SRL – NAPOLI
MAUS ITALIA F.AGOSTINO & C. SAS – BAGNOLO CREMASCO (CR)
MAZZERI SRL – MILANO
MECAIR SRL – NOVA MILANESE (MI)
MEMIT FORNITURE INDUSTRIALI – SENAGO (MI)
MESIT SRL – MILANO
METALLURGICA BRESCIANA SPA – DELLO (BS)
METANO IMPIANTI SRL – MILANO
MISTRAL INTERNATIONAL SAS – GENOVA
MONT-ELE SRL – GIUSSANO (MB)
MOVENDO LOGISTICS SPA – STEZZANO (BG)
NET ENGINEERING SRL – ROMA
NEUMAN & ESSER ITALIA SRL – MILANO
NOOTER/ERIKSEN SRL – CARDANO AL CAMPO (VA)
NUOVA ASP SRL – PANTIGLIATE (MI)
OFFICINE TECNICHE DE PASQUALE SRL – CARUGATE (MI)
OLPIDŰRR SPA – NOVEGRO DI SEGRATE (MI)
ONE TEAM SRL – MILANO
PANALPINA TRASPORTI MONDIALI SPA – GENOVA
PANTALONE SRL – CHIETI
PLANTEC – MILANO
PARCOL SPA – CANEGRATE (MI)
PENSOTTI FABBRICA CALDAIE LEGNANO SPA – LEGNANO (MI)
PEYRANI SPA – LEINI' (TO)
PEYRANI SUD SPA – TARANTO
PHOENIX CONTACT SPA – CUSANO MILANINO (MI)
PIETRO FIORENTINI SPA – MILANO
PIGOZZI IMPIANTISTICA – REVERE (MN)
POLARIS SRL – GENOVA
POMPE GARBARINO SPA – ACQUI TERME (AL)
PRISMA IMPIANTI SPA – BASALUZZO (AL)
PRIVATE ENGINEERING COMPANY ITALIA SRL (PEC) – ROSIGNANO SOLVAY (LI)
PRODUCE INTERNATIONAL SRL – MUGGIO' (MB)
QUOSIT SISTEMI PER L'AUTOMAZIONE – BARI
R.STAHL SRL – PESCHIERA BORROMEO (MI)
R.T.I. SRL – RODANO MILLEPINI (MI)
RACCORTUBI SPA – MARCALLO CON CASONE (MI)
RAMCUBE – MILANO
RBR VALVOLE SPA – POGLIANO MILANESE (MI)
REMOSA GROUP – CAGLIARI
REPCo SPA – MILANO
RIGHINI F.LLI SRL – RAVENNA
RINA SERVICE SPA – GENOVA
RIVA E MARIANI GROUP SPA – MILANO
ROCKWELL AUTOMATION SRL – MILANO
ROTORK CONTROLS ITALIA SRL – ASSAGO (MI)
S.E.I. - Strumentazione Elettrotecnica Industriale – CUSAGO (MI)
SAET SPA – SELVAZZANO DENTRO (PD)
SAFCO ENGINEERING SRL – PIOLTELLO (MI)
SAGA ITALIA SPA – MILANO
SAIMA AVANDERO SPA – LIMITO DI PIOLTELLO (MI)
SANCO SPA – GALLIATE (NO)
SAVING SHIPPING & FORWARDING SRL – OPERA (MI)
SAVINO BARBERA SNC – TORINO
SCHIAVETTI TEKNO SRL – STAZZANO (AL)
SCT SRL – GENOVA
SDV ITALIA SPA – PANTIGLIATE (MI)
SEEPEX Italia – MILANO
SESPI SRL – MILANO
SICC SPA – ROVIGO
SICES SPA – LONATE CEPPINO (VA)
SIEMENS SPA – MILANO
SIIRTEC NIGI SPA – MILANO
SIM SPA – PRIOLO G. (SR)
SIMA & TECTUBI SPA – PODENZANO (PC)
SINTECNICA SRL – CECINA (LI)
SISCO MANAGEMENT & SYSTEMS SRL – CASALMAGGIORE (CR)
SITIE IMPIANTI INDUSTRIALI SPA – CASSANA (FE)
SKEM@ SRL – BRINDISI
SKF INDUSTRIE – AIRASCA (TO)
SMIM IMPIANTI SPA – GENOVA
SMS INNSE SPA – SAN DONATO MILANESE (MI)
SPEDIZIONI TRASPORTI PASQUINELLI ENNIO SPA – JESI (AN)
SPIG SPA – ARONA (NO)
SPINA GROUP – CIVESIO DI SAN GIULIANO MILANESE (MI)
SRA INTRUMENTS SPA – CERNUSCO S/NAVIGLIO (MI)
STC SPA – FORLI' (FC)
STCR SRL – GENOVA
T.A.L. TUBI ACCIAIO LOMBARDA SPA – FIORENZUOLA D'ARDA (PC)
TALENTA MART SRL – MILANO
TECHFEM SRL – FANO (PU)
TECHNIP ITALY DIREZIONE LAVORI SPA (TPIDL) – ROMA
TECHNOR ITALSMEA SPA – GESSATE (MI)
TECNIPLANT SPA – SESTO SAN GIOVANNI (MI)
TECNOCONSULT ENGINEERING CONSTRUCTION SRL – FANO (PU)
TECNOMEC ENGINEERING SRL – ALTAMURA (BA)
TENARISDALMINE/TENARIS PROCESS AND POWER PLANTS SERVICES – SABBIO BERGAMASCO (BG)
TERMOKIMIK CORPORATION – MILANO
THERMOENGINEERING SRL – MILANO
TM.P. SPA TERMOMECCANICA POMPE – LA SPEZIA
TOZZI SUD SPA – MEZZANO (RA)
TRATOS CAVI SPA – PIEVE SANTO STEFANO (AR)
TRICAD SERVICE ITALIA – MILANO
TUXOR SPA – TORINO
UAMI/ANIMA – MILANO
UNITERM SRL – COLOGNO MONZESE (MI)
UTIP SRL – MELILLI (SR)
VALSAR SRL – CESANO BOSCONE (MI)
VERGAENGINEERING SPA – MILANO
VIGO e COVA SAS – MILANO
VOITH TURBO – REGGIO EMILIA
VOKES AIR SRL – SEGRATE (MI)
WATER GEN POWER SRL – GENOVA
WATLOW ITALY SRL – CORSICO (MI)
WEG ITALIA SRL – CINISELLO BALSAMO (MI)
WEIDMULLER SRL – CINISELLO BALSAMO (MI)
WEIR GABBIONETA SRL – SESTO SAN GIOVANNI (MI)
WEIR MINERALS ITALY – CERNUSCO S/NAVIGLIO (MI)
WTS WALTER TOSTO SPA – CHIETI SCALO
XYLEM SRL – S.AMBROGIO DI TORINO (TO)
ZENATEK SPA – GENOVA

NATIONAL BOARD

2013 ÷ 2015

Updated on May 2014

President

Nello Uccelletti*
President
TECHNIP ITALY

Honorary President

Riccardo Bechis*
President
SUDPROGETTI

Vice Presidents

Augusto Di Giulio*
Professor of General Plants Service
POLITECNICO DI MILANO

Marco Moresco*
C.E.O. Managing Director
FOSTER WHEELER ITALIANA

Marco Pepori*
Director Business Development
FLOWSERVE-WORTHINGTON

Tesoriere

Pierino Gauna*
ANIMP

Advisors

Enrico Bonatti
Presidente
TECHINT

Daslav Brkic*
Senior Vice President, Business and Technology Development
SAIPEM

Marco Deserti
Executive Vice President, Operations and Strategic Development
UNAOIL

Enrico Di Maria
C.E.O.
Divisione Process Automotion
ABB Spa

Gino Ferretti
Rettore
UNIVERSITA' DI PARMA

Maurizio Gatti*
Consultant

Claudio Andrea Gemme*
C.E.O.
NIDEC ASI

Paolo Ghirelli
President
BONATTI

Pietro Giribone
Professor of Mechanical Plant
UNIVERSITA' DI GENOVA

Alessandro Persona
Ordinario di Impianti Meccanici
UNIVERSITA' DI PADOVA

Alberto Ribolla*
Managing Director
SICES GROUP

Daniele Rossi
Managing Director
ROSETTI MARINO

Cesare Saccani
Professor of Mechanical Plant
UNIVERSITA' DI BOLOGNA

Luciano Santalucia
Managing Director
QUOSIT

Mario Saraceno
President
UAMI

Andrea Sianesi
Ordinario di Gestione dei sistemi logistici e produttivi
POLITECNICO DI MILANO

Michele Stangarone
General Manager Global Sales
Turbomachinery GE Oil & Gas
Nuovo Pignone

Massimo Tronci
President
AIDI

Giuseppe Zampini*
Managing Director
ANSALDO ENERGIA

Luca Zanotti
Managing Director
TENARIS

Collegio dei Revisori dei Conti

Antonio Marzola
ABB
(effettivo)

Massimo Massi
TECHNIP ITALY
(President)

Massimo Minciotti
NIDEC ASI
(supplente)

Domenico Orlando
SAIPEM
(effettivo)

Gionata Riccardi
SICES GROUP
(supplente)

Collegio dei Probiviri

Gianfranco Magnani
ROSETTI MARINO

Antonino Molinaro
TECHIMP ITALIA

Luigi Vincenti
ANIMP

Secretary General

Anna Valenti

**Executive Board ANIMP*

ANIMP Associazione Nazionale di Impiantistica Industriale

Via Tazzoli, 6
20154 Milano
Tel. 02 67100740
Fax 02 67071785
animp@animp.it

Section Representatives

Automation
Marco Manenti
Instrumentation e Control Discipline Manager
TECHINT

Components
Marco Pepori
Sales Director
FLOWSERVE WORTHINGTON

Construction
Mauro Mancini
Docente Dipartimento di Ingegneria Gestionale
Politecnico Milano

Energy
Rosa Domenichini
Techincal Director
FOSTER WHEELER ITALIANA

Multiphase Flow
Francesco Ferrini
Managing Director – Tec. Director
TECHFEM

Logistic
Raoul Cossutta
Executive manager P.R.&Mkt
APRILE PROJECT

Information Technology
Marco Papagna
Corporate I.T. manager
Sices Group

IPMA Italy
Roberto Mori
Chairman of council IPMA
Director of Special Projects - TENOVA

Manutenzione
Flavio Beretta
Senior Vice President
ABB Spa

Editorial

An Outlook for the Italian Engineering and Contracting Industry



Nello Uccelletti
Animp President

"*ndustrial Plants*", Animp's yearly publication for the international audience, aims at highlighting some significant recent achievements of the Italian engineering and contracting industry. As in previous years, also this number illustrates several significant projects, currently under execution or recently completed by our industry in international or domestic markets, with a special focus on main challenges of today: new markets, new technologies, complex project organization, challenging logistics, advanced systems, competitive supplies.

The Italian industrial plant supply-chain (world-class engineering and construction contracting as well as equipment supply) is today further broadening its horizons towards an ever more globalized and highly competitive market. Our companies are forced to be ever more flexible and ever more innovative, in order to apply successful execution models, mitigate the increasing project risks as well as generally to apply a number of very innovative solutions.

The prospects in our oil & gas sector point to continuing growth globally, despite the slow-down in the so called developed countries, and – more importantly – problems generated by the rapidly growing costs. Therefore, there has not been any change of pace in the global markets over the past twelve months. The most important geographic areas for our industry are once again the Middle East, North America and Asia, both for onshore and offshore businesses.

In offshore markets a renewed interest for investments in West Africa and a gradual interest in the East has been confirmed.

The volume of new investments, particularly in upstream, remains impressive and rising, even though the political uncertainty in some regions, the doubts about the long-term growth of some energy-consuming countries and the difficulty of closing the financing arrangements have caused delays, cancellations or major modifications of many large projects.

Indeed, many projects today are becoming more and more complex in terms of size, technological characteristics, extreme logistics and generally very challenging environments.

These projects require high technical and management skills in which many of our companies excel. This know-how can be an asset to compete against newer entrants from emerging markets, often less experienced and not as well organized. To remain successful in this market, our companies have therefore invested in complementary skills and job tools, but also in strategic alliances etc.

While we thank the Italian industry working in the oil & gas sector for their strong support to Animp, we confirm our commitment to provide a continuously improving range of services to all our affiliates and to represent the Italian supply-chain of the engineering and contracting industry in all global contexts.

Nello Uccelletti



Overcoming Industrial Water Treatment Challenges

Operation improvement and utility savings by mean of Advanced Process Control at an IGCC plant

Federico Callero, Riccardo Martini
ABB, Italy

Mario Abela, Dario Giannobile
Isab Energy Services, Italy



Local environmental regulations impose to industrial plant operators to treat process wastewater in order to comply with discharge limits. Most of the industrial plants and utilities have process units devoted to wastewater where those are treated by mean of physical or chemical methods. On the other side, industrial plant goal is to maximize productivity and optimize operation cost; hence, the concept of *Watergy* is becoming a fundamental for plant managers. This expression describes the envelope which includes water management and energy and is becoming more and more popular in the industrial market.

This paper will describe how advanced automation technologies support an IGCC (Integrated Gasification Combined Cycle) wastewater treatment plant to comply with regulation and, at the same time, to optimize operation and increase energy efficiency. In particular, authors will describe how, by mean of Model Predictive Control (MPC), an effective pH control was achieved in a wastewater stripping column minimizing the usage of steam for stripping operation. Herein a brief description of plant and process will be provided, highlighting operation and control challenges, followed by a brief description of project goals and technologies implemented to deal with the problems. Conclusions will show some results and achievements in term of process manageability and energy efficiency improvements.

Integrated Gasification Combined Cycle (IGCC)

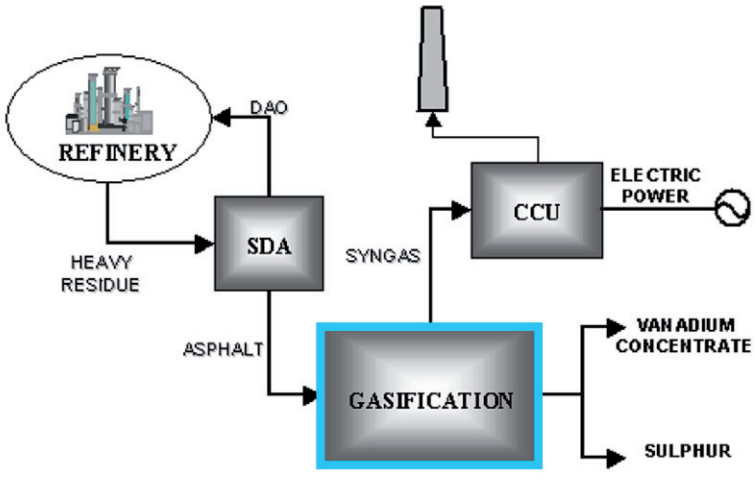
IGCC plants are among the most advanced and effective plants for power generation from refinery residuals, such as vacuum residue, heavy oil, petroleum coke and coal. The fossil fuel is converted by a partial oxidation process to produce synthesis gas (syngas), rich in CO and H_2; the syngas is then burned to generate electricity by combined cycle.

IGCC plants are among the most advanced and effective plants for power generation from refinery residuals, such as vacuum residue, heavy oil, petroleum coke and coal

The plant converts about 120 tons/h of heavy residual oil, provided by the nearby refinery, into more than 500 MW of electric power and can be divided in three main areas (**figure 1**):

- Solvent Deasphalting Unit (SDA) treats the heavy residues from the refinery: the deasphalted oil (DAO) is sent back to the refinery, while the asphalt is fed to the Gasification Unit;
- gasification transforms the asphalt into syngas; this section includes different units, encompassing units for sulphur, carbon, acid gas and heavy metal recovery, which are removed prior the combustion;
- Combined Cycle Unit (CCU) includes two trains for power generation, each of them with a gas turbine, a HRSG and a steam turbine.

Fig. 1 - IGCC plant scheme



Process water overall treatment

In the gasification section (**figure 2**), syngas is processed in different units before arriving to the CCU, in order to remove unwanted compounds or matters which are recoverable for further purposes. In these conditioning units large amount of utilities are used. Waste water treatments are necessary to process the water utilities before discharge in order to comply with local environmental regulations.

Waste water main source hence are represented by soot water coming from gasification unit.

Soot water from gasification unit first is sent to carbon recovery unit were the ashes and carbon content is abated; after this treatment, a crucial step is represented by the heavy metal recovery unit were all the pollutants are removed and stored as metal cake for disposal. Residual waste water purified from metals and solids is then sent to the wastewater pretreatment unit which represents the scope of this application.

In this unit water, coming from different processes, is treated with chemicals and stripped with steam. At the end, treated water is then sent to the secondary water treatment unit external to IGCC plant.

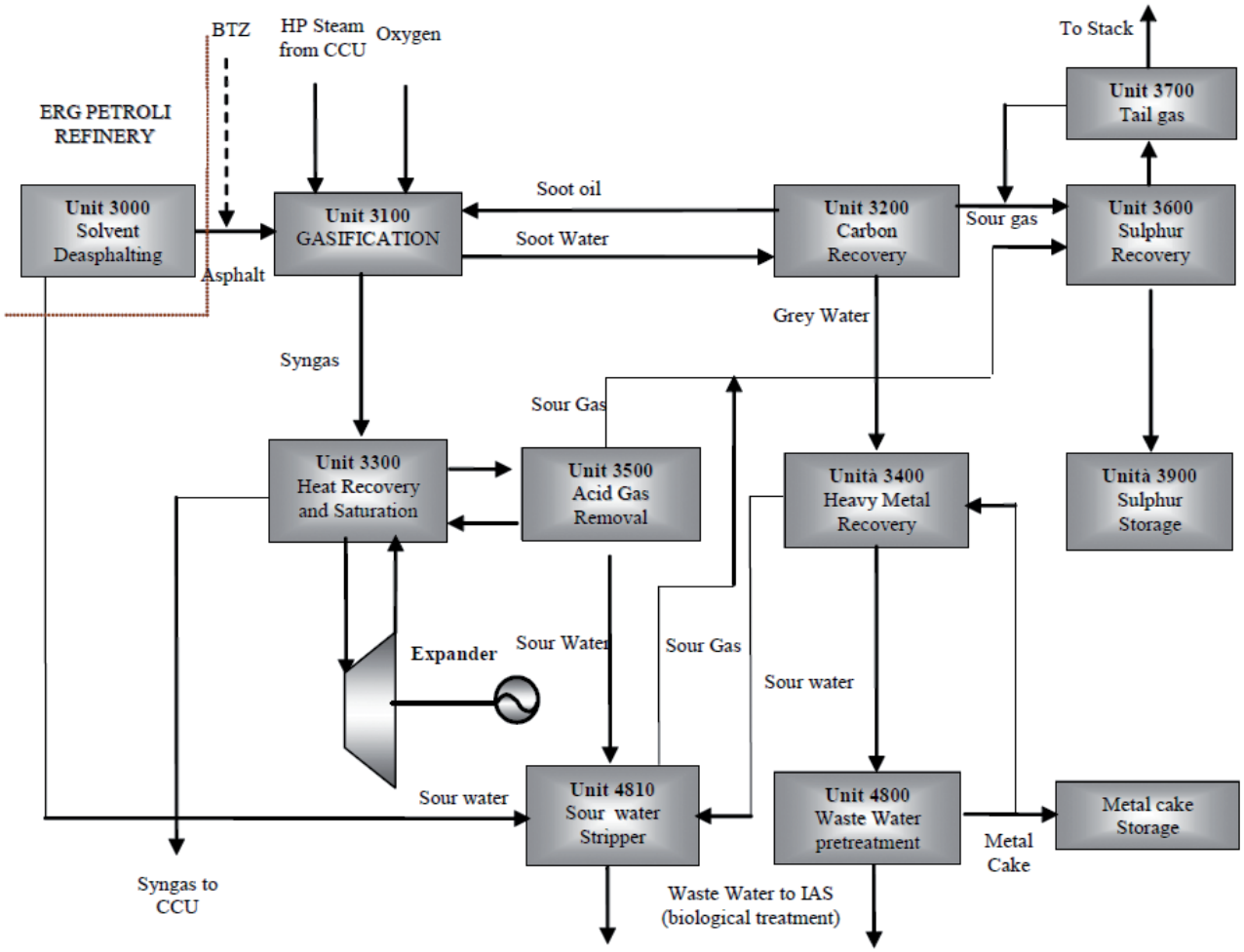
Secondary process is based on biological treatment by aeration in specific tanks; after the secondary treatment, water is partially recycled to process and partially discharged in the environment.

Wastewater pre-treatment unit

The unit consists mainly in a stripping column (**figure 3**) where the water is separated from ammonia by means of thermal separation. In order to perform an effective separation, the wastewater inlet stream is added with soda (NaOH) [1] whose quantity is regulated by a devoted pump. The stripper thermal balance is guaranteed by a pump around where the water exchanges heat with steam in a specific reboiler; steam coming from low pressure network is controlled and adjusted in ratio with the actual wastewater column inlet. The column top stream, rich in ammonia, is successively sent to other process units, while the bottom stream represents the pre-treated water which is sent to sour water treatment unit.

One of the major challenges in this process is related to the effective control of the stripping column, whose objective is to maintain the value of the pH and residual ammonia content of the outlet water within pre-determined ranges. Maintaining at

Fig. 2 - Gasification flow diagram



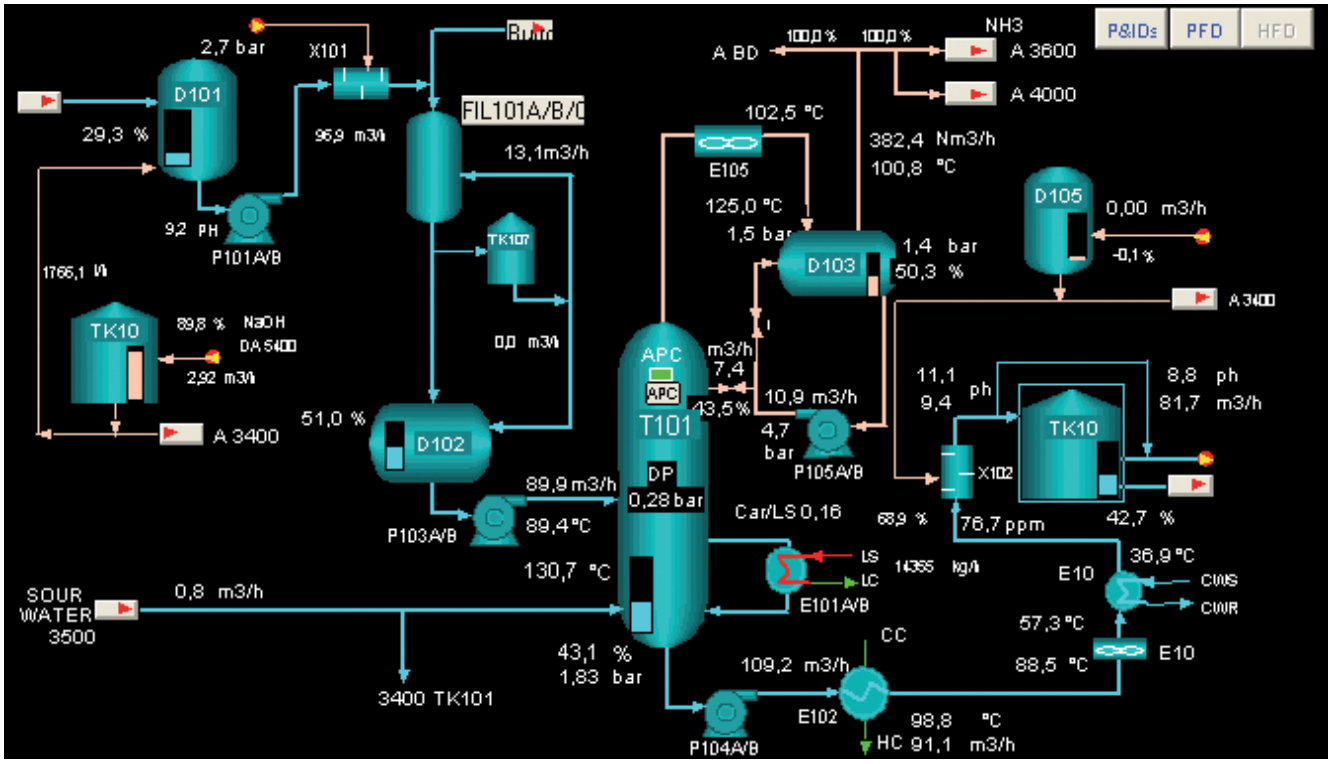


Fig. 3 - Stripping column of the wastewater treatment.

the correct level the pH of treated water is crucial for two main concurrent factors:

- prevent formation of carbonates, which can precipitate and lead to the need of unit maintenance due to clogging and fouling processes or even worse major failure in water pumps

$$2NaOH + CO_2 \rightarrow Na_2CO_3\downarrow + H_2O$$

guarantee an effective ammonia stripping

$$NH_4^+ (l) + OH^- (l) \rightarrow H_2O + NH_3 (g)$$

This process is controlled by two main operating parameters:

- the quantity of soda, that is introduced before the stripper;
- the steam / load ratio at the reboiler.

Both the steam / load ratio and the soda have a direct effect on process variables of the system (pH and residual ammonia content), which, furthermore, is characterized by a slow response dynamic.

The previously existing control strategy, based on DCS control scheme, showed poor control performance. In particular, the following issues emerged:

- the DCS configuration had the pH control in closed loop which cascaded to the soda trimming (before the stripper section);
- pH control used a sensors located upstream to the stripping column and close to soda injection but this measurement has a very low reliability / availability and is affected by periodic clogging, resulting in very rare and short operation in closed loop.

The control of the NH_3 residual content was assigned to a manual operator control; as a consequence the pH measurement showed excessive swings, together with an excessive usage of low pressure (LP) steam.

Current challenges in process control lead to the decision to engineer and install an advanced controller based on MPC. Before entering in the details of project development, in the next section are recalled some features of MPC technology.

MPC background

After careful evaluation of the process configuration and its specific control challenges, it was decided to implement a Multivariable Process Control (MPC) application covering this process area.

The multivariable controller used to implement this application is Optimize^{IT} Predict & Control (P&C), based on state space technology. This technology provides several advantages over ordinary MPC technology. Among them, state space technology allows efficient handling rejection of unmeasured disturbances, especially when available upstream measurements (faster) can be used to anticipate future changes in downstream measurements (slower).

Multivariable control first came into common use in

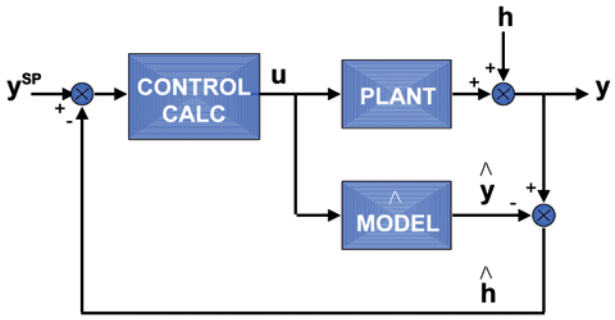


Fig. 4 - Standard MPC structure

the 1980's when several independent sources all began converging on a basic architecture. The key to this architecture is the use of an internal linear dynamic model in the controller calculation. The algorithm computes an estimate of process disturbances acting on the process variables being controlled. The disturbance estimate, the process variable setpoints and feedforward signal levels become inputs to the controller calculation. With these inputs and the process model, the controller is able to calculate the required values for the independent, manipulated variables. This structure is illustrated in **figure 4**.

In the controller error minimization calculation, the model helps predict future values of the process variables. This led to the names Internal Model Control (IMC) and Model Predictive Control (MPC). The MPC algorithms became the first large-scale deployment of computer based multivariable process controllers (also called Advanced Process Control or APC). To make the calculations efficient and convenient, the algorithms use discrete impulse response models. These models can predict the values of future process outputs through the discrete convolution equation. The equation is fairly simple to program and lends itself to incorporation in the optimization algorithms needed to calculate the values of future manipulated variables, while minimizing process variable deviations.

MPC algorithms have become the dominant method for dealing with interactive process control problem and have proven to be very flexible in expanding to large systems and in handling complicated constraint scenarios

MPC algorithms have become the dominant method for dealing with interactive process control problem and have proven to be very flexible in expanding to large systems and in handling complicated constraint scenarios. An enhancement that first appeared in the early 1990's posed the controller optimization problem as a multi-objective optimization, where each stage of the optimization problem added a new constraint while adhering to the optimal solution for previously solved higher ranked constraints. This innovation made tuning the controllers with varying sets of active constraints much easier.

Space state tecÚology

For a long time the control literature has described modern control algorithms based on a flexible type of multivariable model. The model was based on linear differential equations that mapped the relationships between process inputs and process outputs through use of intermediate variables, called the *state vector*. This type of model was called a state space model. MPC algorithms came along after state space models were introduced, but did not use this type of model.

State space models became linked to optimal control theory for aerospace applications and did not include many of the practical control objectives that were part of the design basis of MPC. The result was that state space models were ignored for a long time by the process industries, but recent enhancements in new algorithms have changed that.

The equations that represent a discrete-time state space model are presented in the equation:

$$x(k+1) = Ax(k) + Bu[u(k) + w(k)] + Bt\ d(k)$$
$$z(k) = Cx(k)$$
$$y(k) = Cx(k) + v(k)$$

where:

- x is the state vector
- u is the process input or control effort vector
- d is a vector of measured disturbance variables, also known as feedforwards
- w, v are noise vectors
- z is the vector of process variables
- y is the vector of process variables with measurement noise
- Ax, Bu, Bd and C are process matrices
- k is the time in number of sampling intervals

In this case, the MPC controller (**figure 5**) uses an explicit estimation of state vector X to compute the future moves on manipulated variables.

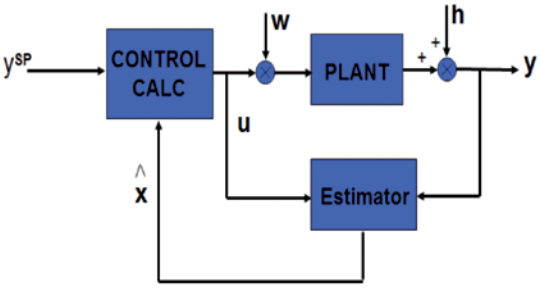


Fig. 5 - State Space MPC

MPC at the water pre-treatment unit

The MPC solution implemented in the water pretreatment unit has been seamlessly integrated in the existing automation hardware configuration, as presented in **figure 6**. The application is based on dynamical process models taking into account the relation between controlled variables (CV), manipulated variables (MV) and disturbances (FF). Those relations have been extrapolated by observing the historical process data gathered from plant DCS as well as by mean of data collection campaign coupled with devoted step test when possible. Step test were performed in strict cooperation with plant operation and always keeping into account process stability and targets. Evaluation of relations between controlled variables, manipulated variables and disturbances gave the possibility to deploy models representing the core of MPC.

The solution applied is the ABB Optimize^{IT} Predict & Control (P&C), a software package for multivariable control based on state-space modeling technology. The tool communicates with the existing plant control system, the ABB Melody DCS, through the use of an OPC connection thanks to the existing OPC Server DA.

The project represents a second step of APC systems implementation strategy related to the entire IGCC plant.

The first step featured APC solutions in some of the key process units, such as SDA Unit, AGR Unit and Gasifier Units [3].

A third step was executed in 2012, covering an MPC acting as global IGCC coordinator to control power export control and also a controller dedicated to gasifiers water management.

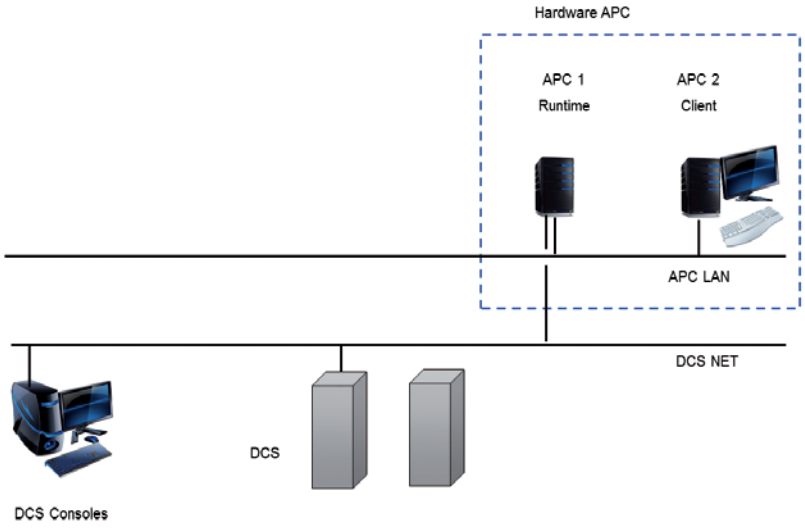


Fig. 6 - HW architecture

Advanced controller configuration and operation

The APC technology was essential to achieve an effective pH control in the wastewater stripping column, so to simultaneously comply with regulation, optimize operation and increase energy efficiency. In details, the purpose of the APC application is to automatically moving the manipulated variables (i.e. soda and steam / load ratio) in order to:

- keep the pH near the required setpoint, avoiding the precipitation of carbonates that may affect the overall process also due to the deterioration of equipment and maximizing the efficiency of the stripping column;
- keep top stripping column pressure below a minimum value in order to ensure stable operation;
- keep the value of the residual ammonia below a maximum, minimizing the need of the low pressure (LP) steam for stripping;
- keep the pH for the upstream measurement in range when this measurement is available. When this variable is active, the controller uses it as an additional feed forward in its state space model to predict future changes in the downstream pH following changes in the upstream pH.

Below the configuration of the controller is reported, covering the main controlled variables (CV) and control mode, manipulated variables (MV) and type target where applicable (**table 1**).

In order to preserve safe operation and stable and process conditions, at the controller configuration

Variable Description	Type
Controlled variables	
Residual ammonia from stripping column	max limit
Downstream pH (downstream of stripping column)	setpoint with band
Top column pressure	min limit
Upstream pH measurement	min/max (when available)
Manipulated variables	
Soda al 10% inlet	
Ratio steam/load at stripping column	minimize

Table 1 – Controller configuration

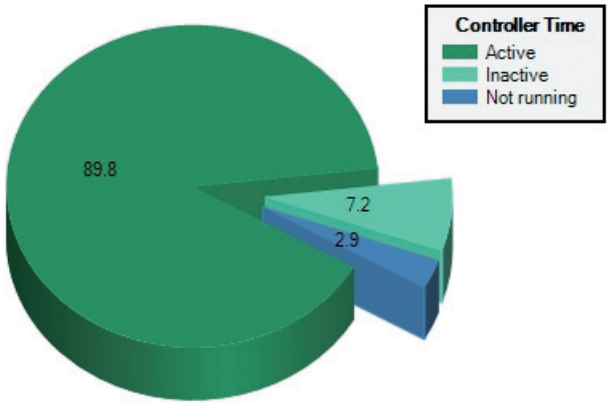


Fig. 7 - MPC controller service factor

stage, a number of settings and limits have been implemented on both DCS and P&C controller side.

Results

Advanced controller is in operation since late 2010 and has led to significant benefits both on process operability and economic returns (**figure 7**):

SF= MPC Operation Time / Total time, Oct. 2012 [4]

The chart of **figure 8** shows the pH control results over a one week period with indication of the limits. pH control with APC showed a reduction in variable standard deviation of about 45 % compared to the case with normal DCS control.

The implementation of APC allowed the plant to operate with lower steam usage. As plant operators gained confidence on the controller, additional space was given to the steam ratio setpoint, allowing a progressive reduction of the specific steam usage.

The following trend (**figure 9**) shows the specific steam usage over about one year, with an overall reduction of about 15%. This resulted in large steam savings, whose potential value can be estimated in the range of 300 keuro/year.

Further to this, the customer experienced additional benefits in terms of reduction of operator's activities and daily tasks, which resulted in additional time that could dedicated to other tasks.

Conclusions

In conclusion, final results prove that APC is a valuable technology supporting plant owner and managers in the implementation of *Watergy* concept [5]: this term is becoming more and more important for industries having to deal at the same time with crucial factors like environmental and operation

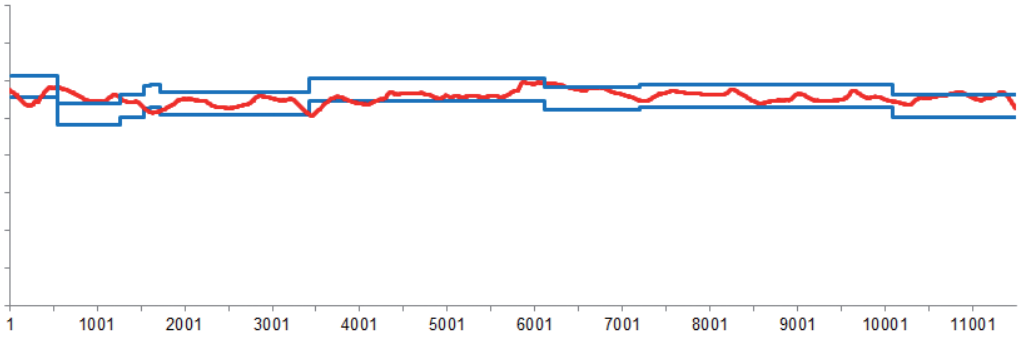


Fig. 8 - Results from pH control over a 1 week period (band = 0.3)

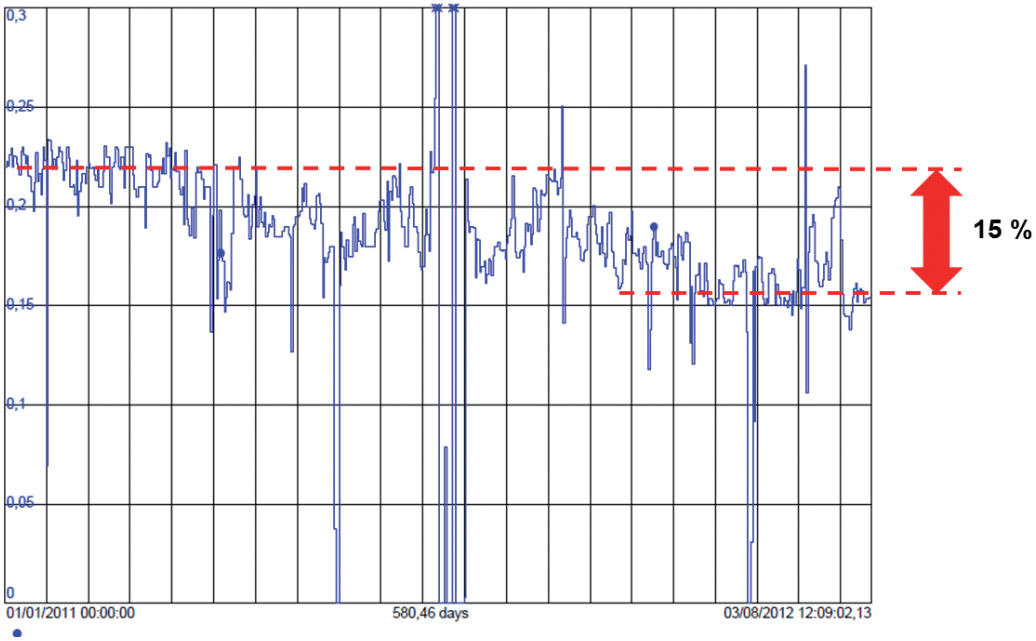


Fig. 9 - Specific steam usage unit since MPC activation

sustainability as well as process and energy efficiency. In fact it is now possible, by mean of APC solutions, to include in a single envelope, factors traditionally perceived as antithetic.

APC led to a significant increase in treatment performance allowing a better pH control at stripping column for ammonia removal; at the same time, it was possible to achieve significant savings in steam consumption and tangible economic benefits. This second successful step of APC implementation at an IGCC plant paved the way to further application for the completion of plant unit optimization.

The positive results achieved were due to a tight cooperation between the APC vendor and the customer. This resulted in shorter project duration and also allowed in significant benefits in all the project phases.

References

[1] www.insightengineers.com/articles/SourWaterStripping.pdf

[2] Bonavita N., Martini R., Matsko T.: *Improvement in the Performance of Online Control Applications via Enhanced Modeling Techniques* - Proc. of ERTC Computing, Milan, Italy, 2003

[3] Abela M., Bonavita N., Martini R.; *Advanced Process Control at an Integrated Gasification Combined Cycle Plant* - ERTC Asset Maximization, Rome, Italy, 2007

[4] ARC Advisory Group/plant-performance-benchmarking/APC

[5] www.ase.org

[6] http://en.wikipedia.org/wiki/Integrated_gasification_combined_cycle

Acknowledgement: The authors would like to thank all the people contributing to the present paper, particularly to Irene Crocicchia and Fabio Podesta' for the support in the information gathering process and Nunzio Bonavita for sponsoring and encouraging the editing of this work.



Federico Callero

Federico is Advanced Service Hub for Europe for ABB Italy, he has a degree in Chemical Engineering from University of Genoa, IT. He joined ABB in 2007 as an advanced process control engineer in Italy. After covering different roles in O&G, Technology Management and Water Vertical Market, he is now responsible for driving delivery and implementation of Advanced Services, monitoring market requirements and support local sales teams for Mediterranean Region and Europe. Federico has experience in Process Control and Advanced Application development covering different process units and market sectors. He is author or co-author of 4 papers published on technical magazines or at international conferences.



Riccardo Martini

Riccardo is Advanced Process Control Operations Manager for ABB Italy, Oil Gas & Petrochemical Business Unit. He graduated in Electrical Engineering at Genoa University in 1994. Riccardo has over 15 years experience in Advanced Process Control and Process Optimization, covering a different process units and different markets, from Refining to Petrochem, from Gasification to Gasification to Power Generation. From November 2005 to December 2009 he acted as Product Manager for the ABB Multivariable Process Controller software Optimize IT Predict & Control . He is author or co-author of more than 10 papers published on technical magazines or presented at international conferences.



Mario Abela

Mario is responsible for Process Automation at ISAB Energy Services. The company operates in Priolo G. (Sicily) the Integrated Gasification Combined Cycle (IGCC).
Mario got his degree in Electronic Engineering from the Catania University in 1982. He has managed several projects in the field of Supervision, Control and Automation systems.
These include the realization of many Multivariable Predictive Controls (MPC) for the various units of the plant as the Solvent Deasphalting unit, the Hot Oil Furnace, the Gasification Reactors, the Acid Gas Removal unit, the Water Treatment system, the Combined Cycle Power Station.



Dario Giannobile

Dario is responsible for the performance control of Isab Energy IGCC plant (Italy). He graduated in Chemical Engineering at Palermo University in 1999. Dario has 13 years of experience in different fields. He started as Automation Engineer and after 3 years he was involved in the Process Control area of the IGCC (both process units and combined Cycle). From February 2007 he became Operation Manager for the GE Gasification units and the relevant process units such us Kellog Solvent Deasphalting, Lurgi Claus unit, UOP Hydrogen plant and so on. After 6 years of experience in the operation, from February 2013 until now he is involved in the Performance Control Area of IGCC.



GARBARINO

CENTRIFUGAL AND POSITIVE DISPLACEMENT PUMPS FOR MARINE, OFFSHORE, NAVAL AND INDUSTRIAL FIELDS



Member of CISQ Federation
RINA
ISO 9001:2008
Certified Quality System

ISO 9001

UKAS
ENVIRONMENTAL MANAGEMENT
001

ANSI • RAB
QMS
ACCREDITED

Ex

CE

www.pompegarbarino.com

Pompe Garbarino S.p.A. Via Marenco, 44 - 15011 Acqui Terme (AL) - Italy - Tel. +39 0144 388671 - info@pompegarbarino.it



Fig. 1 - Membrane reformer pilot plant

Pd Based Membrane Reactors for Hydrogen and Chemicals Production

KT – Kinetics Technology is now a well recognized leader in design and operation of pilot plants where membrane plays essential role for process intensification

Gaetano Iaquaniello, Emma Palo
KT – Kinetics Technology SpA (Maire Tecnimont Group)
Annarita Salladini
Processi Innovativi Srl (Maire Tecnimont Group)

Steam reforming for syngas production is one of the most attractive applications of Pd based membrane reactors. Indeed, the possibility to substantially lower the reaction temperature of about 350 °C with respect to traditional values ranging from 850-880 °C, could result in several benefits such as the use of less expensive materials for the fabrication of the catalytic tubes, an overall process efficiency increase, a saving of combustion fuel.

Nevertheless, despite the very huge amount of scientific work on lab scale available in the literature on this process, a lack of information is observed on pilot or higher scale, being the scale up of the technology and the long term stability of such materials two of the main challenges to be addressed for an actual assessment of the technology on industrial level.

KT – Kinetics Technology experience in membrane reactors for pure hydrogen production started almost ten years ago in the framework of the Italian Research Project FISR "Pure hydrogen from natural gas to total conversion obtained integrating chemical reaction and membrane separation", the which main question, up to that moment still unsolved, was: *is it possible to obtain pure hydrogen by membrane separation on semi industrial scale?*

KT accepted the challenge and that vision became a reality in 2009 when the facility in Chieti Scalo was started up, with a capacity of 20 Nm^3/h of pure hydrogen, representing one of the only two applications available worldwide with this size. From that date, while the plant was collecting more than 2000 hours of operation, KT was gaining more and more knowledge in membrane technology and development of novel process schemes, based on membranes for hydrogen separation.

Moving from these first significant steps in pure hydrogen production, KT looked at alternative markets for membrane reactors application, gaining also experience in synthetic fuels and chemicals production, thus becoming a well recognized leader at European level in design and operation of pilot plants where membrane plays essential role for process intensification.

Pure hydrogen production

The plant has been designed according to an open architecture based on two stages of reaction and membrane separation whit the aim to enhance feed conversion at lower reaction temperature. Moving towards a non integrated approach, a more easy and flexible pilot plant operation and management, together with a thermal and fluidynamic optimization of reaction and separation environments, may be obtained with respect to the more traditional integration approach in which the membrane is put in direct contact with the catalyst in reaction environment [1]. **Figure 1** reports a bird eye view of the overall pilot unit covering an area of about 1000 m^2 fully equipped with utilities such as natural gas lines, demi water, cooling and fire water circuits, nitrogen storage, instrument air, steam production and chemical laboratory for gas sampling analysis.

The plant has been designed according to an open architecture based on two stages of reaction and membrane separation with the aim to enhance feed conversion at lower reaction temperature

The original scheme was based on two stages of low temperature steam reforming reaction and membrane separation. Each reformer stage consists essentially of two main sections: the radiant box, containing the reaction tube for an heated length of 3m (OD = 2-½") and the convection section, where heat is recovered from the hot flue gases for preheating and superheating feed and steam. One



Fig. 2 - Internal view or reformer chamber and reformer tube (left). Internal detail of structured foam catalyst mounted inside the reforming tube (right)

of the advantages of the low temperature architecture is to require for reforming tubes low cost stainless steel instead of traditional exotic and quite expensive material as HP 25/35 chromium/ nickel.

To intensificate heat and material transfer properties and improve fluidynamic regime, innovative structured catalyst on SiC foam were adopted instead of traditional pellets (**figure 2**). From catalytic point of view, taking into account the poor Ni activity at low temperatures, a noble metal based formulation has been selected. Reaction is carried out at 10barg and temperatures in the range of 500-650 °C while separation stage may work from 300 to 450 °C with sweep gas to increase efficiency in hydrogen separation.

The modular concept typical of an open architecture, allowed to test different Pd-based membranes thus enriching field of investigation. The three installed units (**figure 3**) developing a total area over 1 m^2, were fully characterized in terms of hydrogen permeance flow, selectivity as well as long time stability. The real industrial environment under which membranes stability was tested gives great relevance to this experience providing very significant experimental data and observations useful for a fully membrane integration into industrial level.

Detailed start up and shut down procedures were developed to ensure a trouble free operation especially for the most critical plant section represented by membrane separation stages. In this regard, heating and cooling cycles together with feed introduction procedure were carefully tuned on membrane requirements. Again, the advantages offered by a non integrated approach allows for a better management of both process and emergency shut down minimizing thermal and mechanical stresses and allowing also for short start up time: the latter may be performed within three hours while only half an hour is required for plant shut down. ESD sequences and main control loops are demanded to a dedicated PLC and DCS system (**figure 4**) which ensure to performer test under safety conditions.

Detailed start up and shut down procedures were developed to ensure a trouble free operation especially for the most critical plant section represented by membrane separation stages. In this regard heating and cooling cycles together with feed introduction procedure were carefully tuned on membrane requirements

Collected data confirmed that membrane integration with steam reforming reaction enables to obtain a considerable increase in feed conversion by overcoming thermodynamic constraints. Enhancement respect to equilibrium conversion up to ten point per cent were experimentally obtained by working with two reaction stages and an intermediate membrane separation step performing hydrogen recovery factor ranging from 25 to 35% (**figure 5**). By extending this concept at higher numbers of reaction and separation stages as well as at higher installed membrane area, that means higher hydrogen recovery factors, very high feed conversion may be obtained even working at lower temperature than traditional (860-880 °C). Four stages architecture for example working at

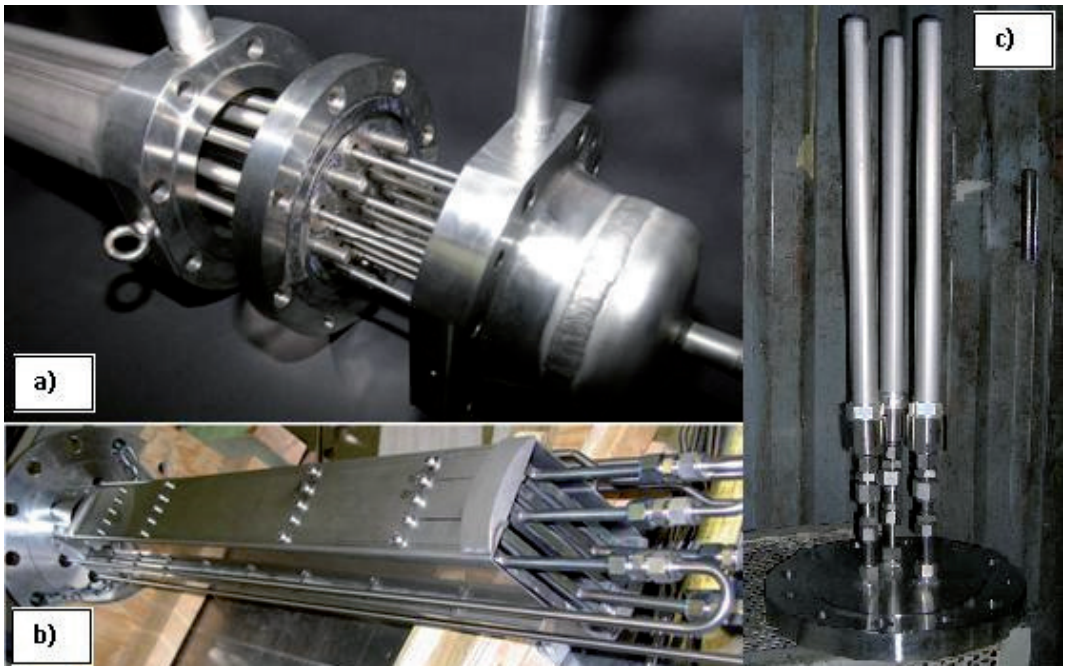


Fig. 3 - a) ECN membrane module: Pd selective layer having a thickness of 2.5 µm on tubular ceramic supports; b) MRT membrane module: PdAg selective layer having a thickness of 25 µm on flat metallic supports; c) NGK membrane module: PdAg selective layer having a thickness of 2.5 µm on tubular ceramic supports

reforming outlet temperature of 600 and 650 °C reaches a feed conversion of 72 and 90% respectively (**figure 6**). As already discussed, the application of membrane technology on industrial scale level, even before of an efficient performance, requires long term stability in order to assure a satisfactory level of plant reliability. In this sense very promising results were obtained from our experience: even working under a real environment characterized by frequent cycles of start up and shut down, quite stable performances were observed along the overall testing period.

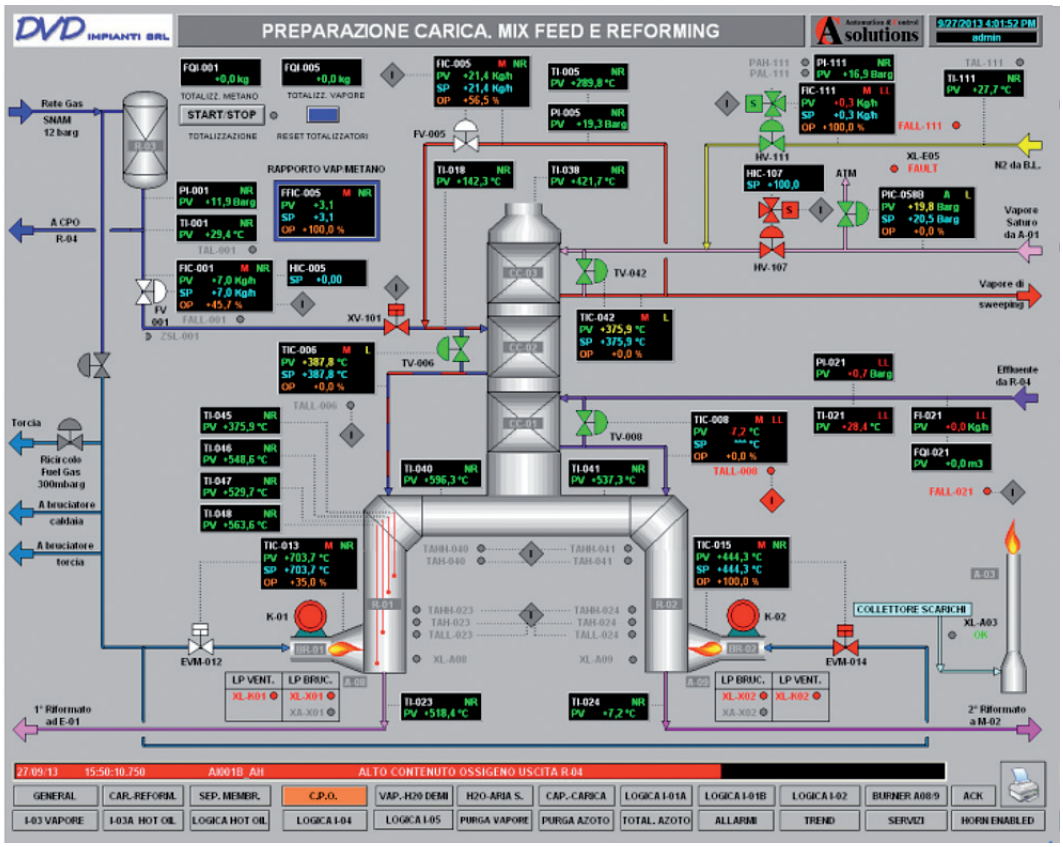
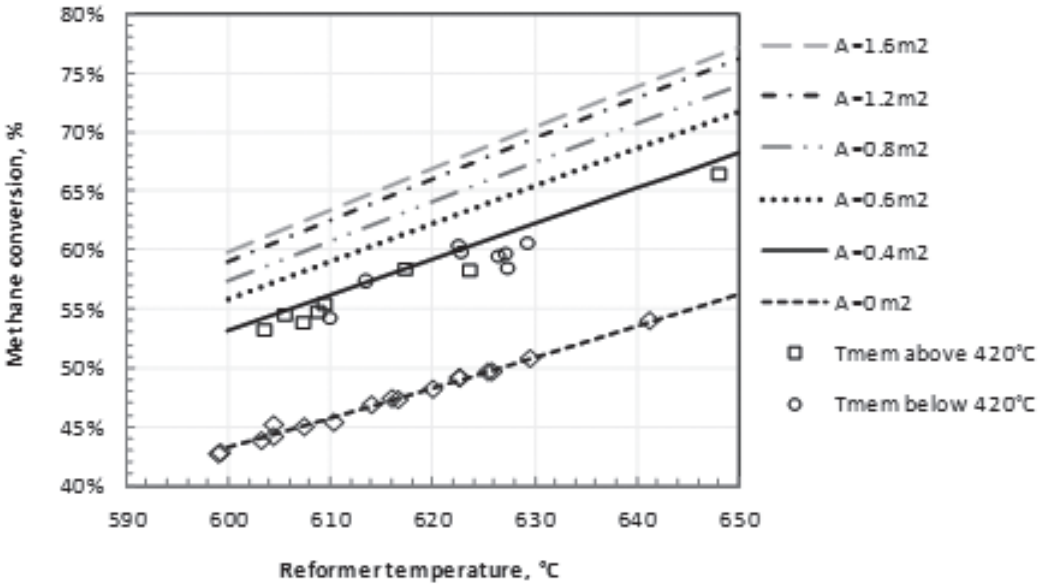


Fig. 4 - Membrane reformer DCS system: control display for reformer (up) and membrane section respectively (bottom)

Fig. 5 - Feed conversion as a function of reforming reaction temperature and membrane area



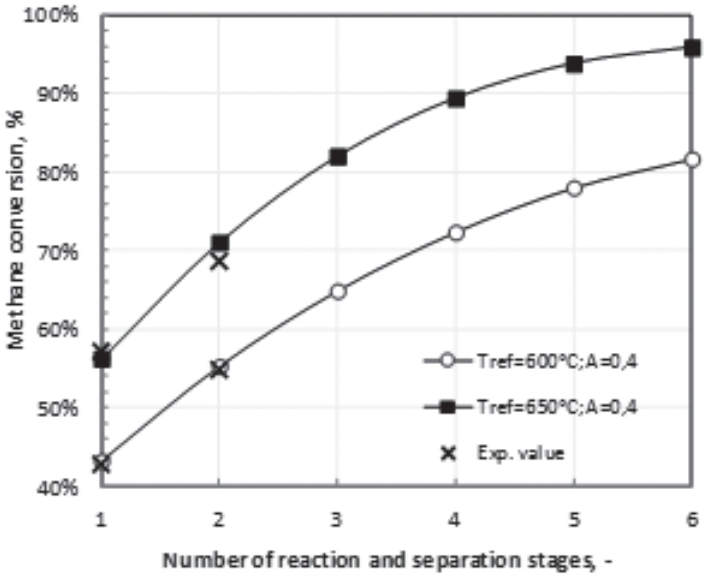
Alternative applications

Gas–To–Liquids Processes

The main challenge of monetizing gas resources is logistical. Natural gas reserves close to markets are usually transported via pipeline. Where this is not feasible, the gas can be transported with alternative methods, such as compressed natural gas (CNG), liquefied natural gas (LNG) and gas-to-liquids (GTL) which all address this challenge by densifying gas and reducing transportation costs.

Natural gas to liquid technologies have been studied for several decades, but were considered economically unfavorable due to the high natural gas costs. However, recent prospects for shale gas production as well as an escalation in oil price have held to a high spread between oil and gas prices, thus improving economics for GTL and making it the most promising alternative for adding value to natural gas assets in particular in North America [2, 3].

Fig. 6 - Feed conversions as a function of reforming reaction temperature and number of reaction/separation stages



The GTL process has three main steps:

- feedstock preparation and syngas production;
- Fisher Tropsch synthesis;
- product upgrading.

Syngas production typically involves steam reforming or autothermal reforming reaction with pure oxygen from ASU; product upgrading typically involves hydrocracking processes of syncrude. The core of the technology is represented by FT synthesis which requires an H_2/CO ratio of about 2.0.

The first step, synthesis gas production, is the most expensive of the three processes, accounting for up to 50% of the Capex. However, feed consumption is responsible for up to more than 80% of all operating costs and more than 60% of the cost of production. Therefore, there is a significant incentive for developing new technologies to decrease the capital and operating cost of syngas production unit. Furthermore, since developing and constructing a large scale GTL plant is very capital intensive and takes years, with significant market timing and hence economic risks involved, the possibility to think to modular design of smaller scale GTL plants is opening up opportunities to reduce risks and on the same time for the use of natural gas in both offshore and remote on-shore locations [4].

This challenge has been addressed by KT over the past years in the framework of the R&D European project “Innovative Catalytic Technologies & Materials for Next Gas to Liquid Processes”, NEXT-GTL, ended in October 2013. The development of novel process schemes for the production of syngas at lower temperature than the traditional ones, without affecting natural gas conversion and saving

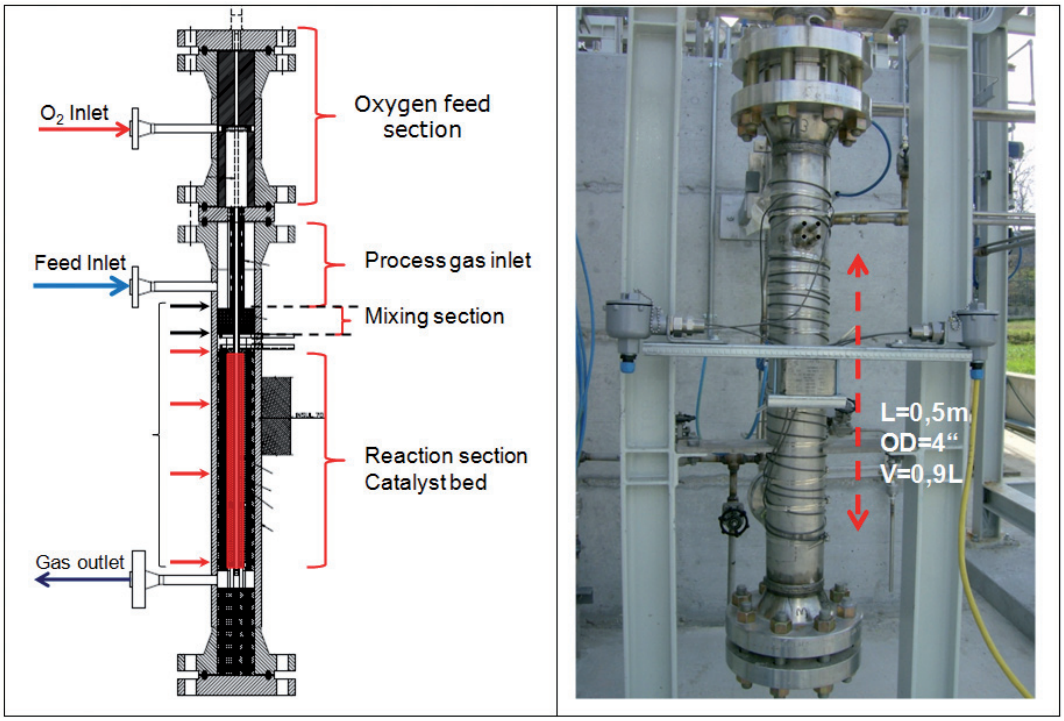


Fig. 7 - CPO reactor schematic configuration and onsite installed view

on the same time in terms of feed consumption and plant complexity, was the main aim of the project to better assess the potentiality of distributed GTL plants.

The use of membrane reactors coupled with novel routes for syngas production such as Catalytic Partial Oxidation (CPO) [5] were the bases for the developed novel process scheme [6, 7]. The experimental assessment was performed by KT in the facility at Chieti Scalo, where a CPO reactor was installed downstream the first membrane separation module and fed, after pure oxygen addition, with the retentate from the steam reformer operating at low temperature, thus acting as a sort of prereformer.

The core of the activity was the design and construction of CPO reactor, reported in **figure 7** in a schematic configuration as well as the onsite installed view.

Here the main challenge was represented by the design and operation of CPO in a safe manner, ensuring a proper mixing between the hydrocarbon feedstock and the oxygen, thus avoiding the risk to ignite the hot mixture (Maximum temperature = 300 °C) outside the catalytic bed but just in front of it. The proper flow distribution was performed through a non-catalytic SiC foam 20 ppi, into which three tubes were inserted for oxygen supply.

An axial multipoint thermocouple provided the temperature profile along the catalytic bed and along the static mixer. Furthermore, the external metal temperature is monitored by a continuous spiral thermocouple in order to assure safety operation and prevent hot spot due to leaks in the internal insulation layer. To further reduce thermal loss, reactor is also externally insulated with high density ceramic fiber (120 mm). Two couples of electrical cartridge heaters are installed at the inlet of catalysts bed and switched on only during heating cycle to adjust the inlet gas temperature if needed.

Reactor was properly designed to accommodate catalyst both in the form of pellets and monoliths.

The operation of the reactor was performed in a standalone configuration and integrated one in the overall process scheme. In particular, in the first option the CPO reactor was fed with a dedicated natural gas stream. The comparison between the two options was carried out in order to evaluate the potentiality of the overall novel process scheme to contribute to a reduction in oxygen feed consumption (**figure 8**). Experimental test showed that for a total feed conversion of 40% for example, the integrated architecture allows to reduce oxygen consumption over 50% with a consequent reduction in process economics.

The experimental assessment was performed by KT in the facility at Chieti Scalo, where a CPO reactor was installed downstream the first membrane separation module and fed, after pure oxygen addition, with the retentate from the steam reformer operating at low temperature, thus acting as a sort of prereformer

Chemical building blocks production

Olefinic compounds (alkenes) are so widely used in a number of chemical industries to be named "chemical building blocks". To name a few, for the production of petrochemical products, such as synthetic rubbers, plastics, motor fuel blending additives. Among the olefins, propylene is the world's second largest petrochemical commodity,

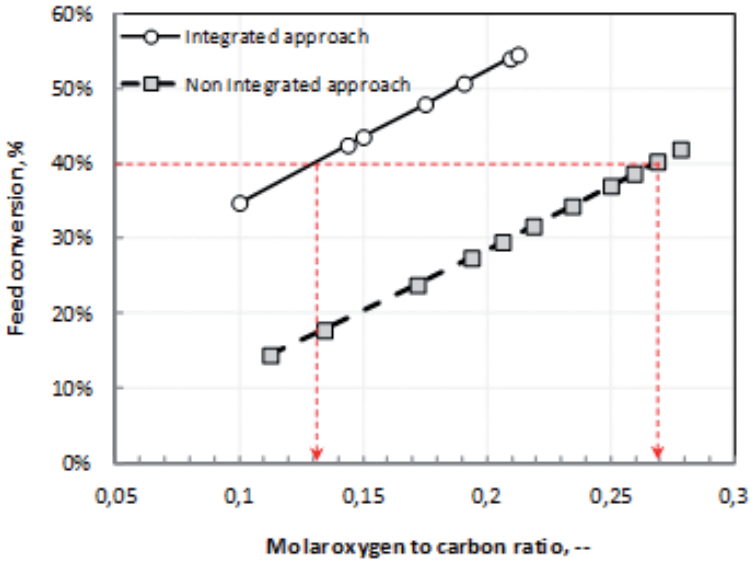


Fig. 8 - Feed conversions against oxygen to carbon ratio. Comparison between standalone and integrated configuration

being the precursor of polypropylene, which is used in such everyday products as packaging materials and outdoor clothing.

At present time, steam cracking with feedstocks as naphtha and ethane and fluid catalytic cracking (FCC) with feedstock as gas oil and residue represent the main technologies for the production of propylene, which in this case is obtained as by-product of ethylene production. Steam crackers and FCC cover respectively for 55 and 30% of the total demand of propylene. The remaining 15% is ensured by the following "on purpose" technologies, which are optimized to produce propylene as main product:

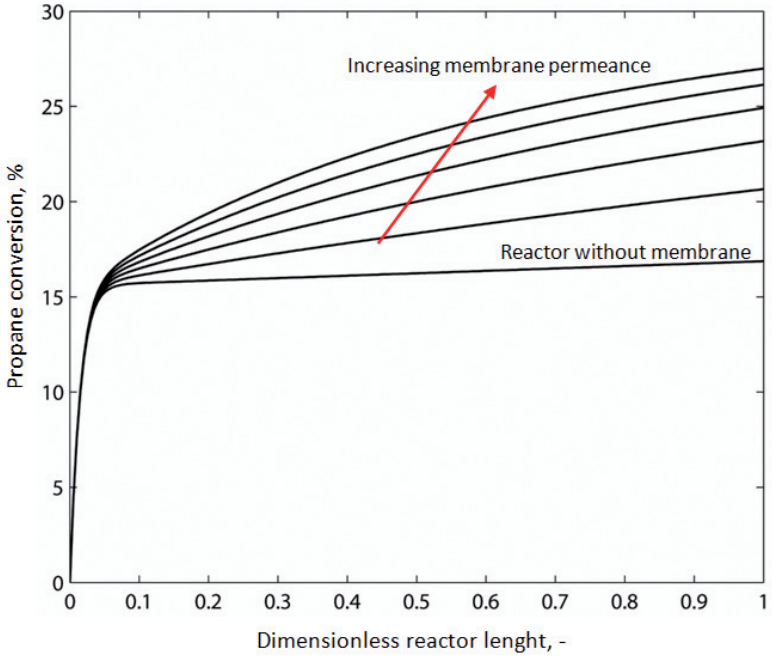
- Propane DeHydrogenation (PDH);
- Olefins Conversion Technology (OCT) or metathesis reactions;
- Methanol to propylene or olefins (MTP/MTO).

Among the olefins, propylene is the world's second largest petrochemical commodity, being the precursor of polypropylene, which is used in such everyday products as packaging materials and outdoor clothing

However over the last years, the shale gas advent in the USA is pushing towards a change in the worldwide economy. Shale gas recovery by horizontal drilling and the use of fracking technology has resulted in the US having an abundance of natural gas. Once natural gas is available, it is fractioned to separate ethane from the rest of the natural gas; the separated ethane is then fed into the pipeline. The consequent change of feedstock will greatly affect the product distribution in the effluent of a liquid cracker. The amount of propylene produced in an ethane-consuming steam cracker is about 10 times less than what is produced when consuming naphtha-range material. Therefore, the shift towards shale gas would result in constrained propylene supply for petrochemical consumption and a potential price increase.

On the other hand, according to market analysis experts, the global demand for propylene is expected to increase between 3% and 6% over the next three years. Given the trend discussed above, the alternative of on purpose technologies and their intensification are becoming increasingly well positioned to meet the growing demand for propylene. Among these technologies, selective PDH is believed to have a great potential as a propene booster in the future.

Fig. 9 - Propane conversion to propylene in a membrane integrated reactor as a function of membrane permeance



The thermodynamic constraints of the reaction limit alkane conversion, hence the necessity to operate at high temperature in order to reach a sustainable reactant conversion. In spite of the huge efforts into the direction to increase process selectivity, avoiding in particular coke formation, the severe operating conditions still lead to coke deposition on the catalyst, thus to its deactivation. This is the reason why in the commercialized process a periodic regeneration of the catalyst is required. Accordingly, the complexity of the overall plant limits the potential for this technology of scale down to 1/5 of the original capacity. The possibility to strongly decrease the amount of carbonaceous compound deposited on the catalyst is linked to the possibility to attain sustainable propane conversion at temperature lower than 550 °C, overcoming the thermodynamic limitations, hence the use of membrane reactors (**figure 9**).

A patent application was filed by KT in 2011 where the membrane reactors are still arranged in a non integrated approach [8]. The great importance and potentiality of this novel approach is linked to the

enormous amount of products that could be produced by propylene.

A ten years long history still going on

The very successful results obtained up to now confirmed that KT is looking in the right direction. Still main challenges, such as membrane costs, stability and scale up of membrane manufacturing should be addressed to make the definite assessment of the technology, but the scientific network of research institutes created all over these years, to which KT belongs, will contribute to make also this vision a reality.

References

[1] Barba D., F. Giacobbe F., De Cesaris A., Farace A., Iaquaniello G., Pipino A.: *Membrane Reforming in Converting Natural Gas to Hydrogen (Part one)* - Journal of Hydrogen Energy 33 (2008) 3700-3709

[2] Salehi E., Nel W., Save S.: *Viability of GTL for the North America Gas Market* - Hydrocarbon Processing, 92 (2013) 41-48

[3] Baliban R.C., Elia J.A., Floudas C.A.: *Novel Natural Gas to Liquids Processes: Process Synthesis and Global Optimization Strategies* - AIChE Journal 59 (2013) 505-531

[4] Roberts K.: *Modular Design of Smaller-scale GTL Plants* - Petroleum Technology Quaterly 18 (2013) 101-103

[5] Iaquaniello G., Antonetti E., Cucchiella B., Palo E., Salladini A., Guarinoni A., Lainati A., Basini L.: *Natural Gas Catalytic Partial Oxidation: a Way to Syngas and Bulk Chemicals Production (Chapter 12-Natural Gas)* - Extraction to End Use. Edited by Sreenath Borra Gupta, ISBN 978-953-51-0820-7

[6] Capoferri D., Cucchiella B., Mangiapane A., Abate S., Centi G.: *Catalytic Partial Oxidation and Membrane Separation to Optimize the Conversion of Natural Gas to Syngas and Hydrogen* - ChemSusChem (2011) 1787-1795

[7] Salladini A., Palo E., De Falco M., Iaquaniello G.: *Process Intensification in Membrane Assisted Steam Reforming At Semi Industrial Scale* - WHTC2013, Shanghai (China), 25-28, September 2013

[8] Palo E., Iaquaniello G.: *Method for Olefins Production* – EP Application, n. 11160218.1, 29 March 2011



Gaetano Iaquaniello

Gaetano was born in Rome in 1952. He holds a Graduate Degree cum laude in Chemical Engineering from the University of Rome (1975), is “docteur” at the U.E.R des Sciences-Université de Limoges (1984) and has a M.Sc. in Management from the London Business School/University of London (1997).

He has published several papers, in particularly on syngas/hydrogen production and operation, more recently he has published two books on membrane reactors for processing industry and on CO_2 re-use. He is also authors of several patents and patent application.

After is military service as Lieutenant in the Army Engineer Corp (1976), and a period at the “Fondation de l’Eau“ at the University of Limoges with a grant (1975-1978), his started his professional career in Italconsult SpA at beginning of 1979 and joined Kinetic Technology International (KTI) in 1980, where he held various positions: from Process Engineer to Process Manager, from Process and Engineering Manager to Vice president of Technology and Business Development of the Company which today is KT – Kinetic Technology SpA. During this period he was assigned in KTI Corp –USA, 1981-1982, and Technip Canada, 2002.

Since beginning 2011, he has also been VP corporate Technology of the Maire Tecnimont Innovation Center BV in the Netherlands and from mid of 2011 is also CEO of Processi Innovativi Srl, a small company of MT Group, focused on process development. From 2009 he has been coordinator of Italian Society of Chemical Engineers (ADICH) for Central Italy and member of the National Board.

From October 2011 he is Associated Professor of “Analysis Simulation and Strategy of process engineering” at the Campus Bio-medico - Chemical Engineering Department for Sustainable Development.



Emma Palo

Emma, Master Degree cum laude (2003) and Ph.D. (2007) in Chemical Engineering at the University of Salerno, is currently Technology Project Coordinator in KT – Kinetics Technology SpA, Italy.
She is involved in the project management of Research and Development activities, mainly at European level. The research field is mainly focused on hydrogen production from hydrocarbons and renewable sources, hydrogen purification, olefins production, heterogeneous catalysis in energy and environmental fields. She is coauthor of a number of publications, research reports, international conference presentations and patent applications.



Annarita Salladini

Annarita is a chemical engineer currently working for Processi Innovativi, a process and engineering company owned by KT-Kinetics Technology SpA. She received her M.Sc. in Chemical engineering on 2004 and her Ph.D. on “Innovative Chemical and Biotechnological Processes“ on 2009, both from the University of L’Aquila.
She joined Processi Innovativi on 2009 and she was involved in R&D project in the field of hydrogen production and purification, renewable and energy saving technologies. She co-authored a number of scientific papers, chapters on international books and conference presentations.



ONE RELIABLE SOLUTION FOR ALL

YOUR SHIPPING DEMANDS



PROJECT LOGISTICS DEPARTMENT: VIA VIGENTINA 2 - 20090 OPERA (MI) - ITALY
TEL: +39 02 576901 INFO.PROJECTLOGISTICSANDFREIGHTFORWARDING@FAGIOLI.COM

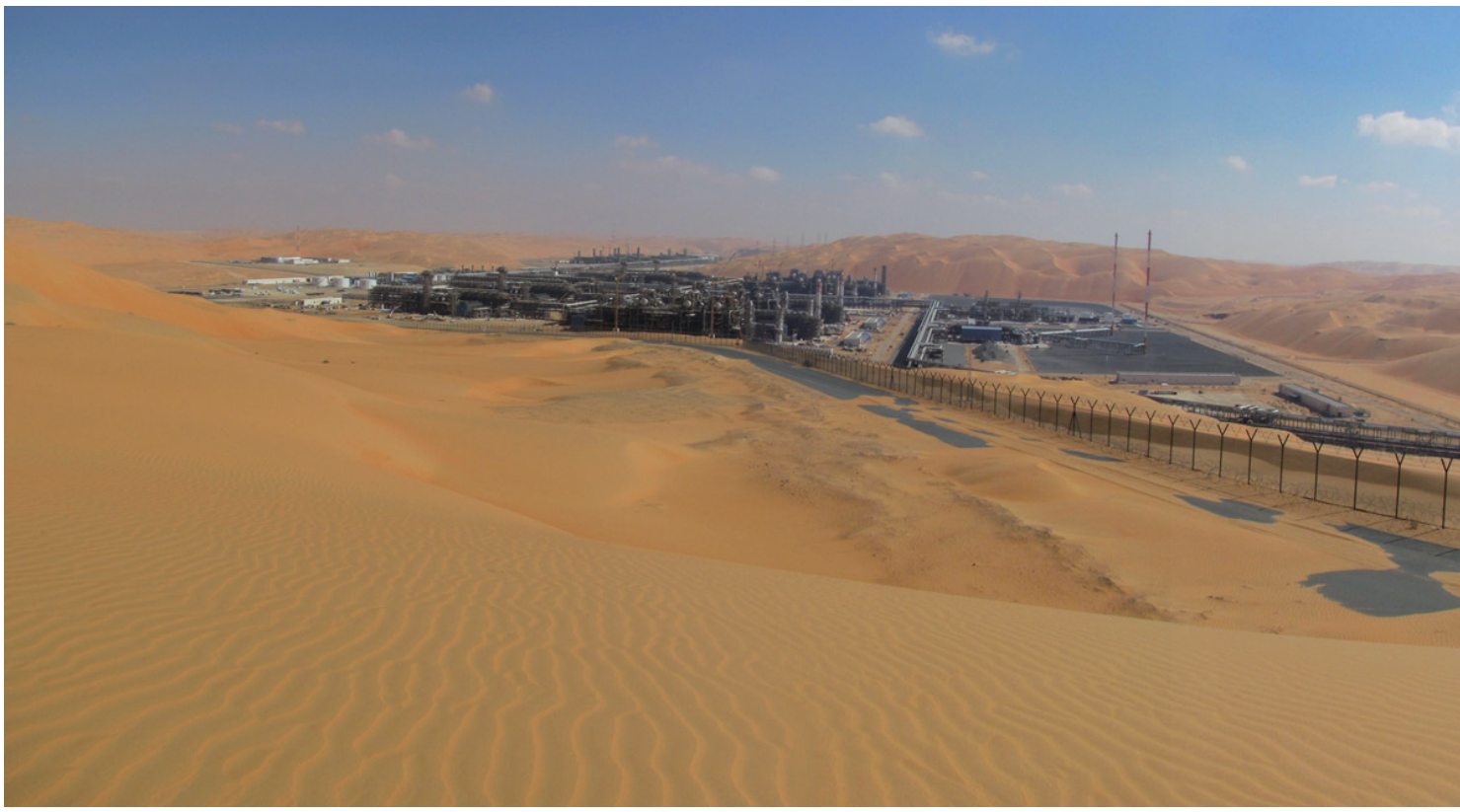
FAGIOLI HEADQUARTERS: VIA FERRARIS 13 - 42049 - S.ILARIO D'ENZA (RE) - ITALY
TEL: +39 0522 6751 INFO@FAGIOLI.COM

WWW.FAGIOLI.COM









Shah Gas Development and Associated Railways Projects in Abu Dhabi (UAE)

Saipem is managing four onshore contracts worth approximately US$ 5 billion

Stefano Grandino
Branch Manager, Saipem Abu Dhabi and Project Director, Shah Gas Development
Luca Pretari
Operations Manager, Saipem Branch in Abu Dhabi
Alessandro Cursio
Project Manager, Shah Gas Plant and Sulfur Recovery Units
Roberto Lanni
Project Manager, Shah Product Pipelines Project
Giuseppe Iocco
Project Director, Etihad Railway Project, Stage 1



Shah Plant Panoramic from West area

Following a 40 years long history of successful operations in GCC countries and particularly in Abu Dhabi, since 2010 Saipem has managed four onshore contracts in Abu Dhabi worth approximately US$5 billion, related to the Shah Gas Development Program (SGD Program).

The program's goal is to produce and treat 1 billion cubic feet of sour gas a day from the Shah Arab gas reservoir, separating the sulfur from the natural gas.

The Abu Dhabi Gas Development Company Ltd. had divided the overall SGD Program into 11 EPC Packages. Saipem had been awarded the following three, all on a EPC LSTK basis:

- EPC Package 2: Shah Process Plant;
- EPC Package 3: Shah Sulfur Recovery Units;
- EPC Package 5: Shah Product Pipelines.

Following the successful award and the initial execution of these contracts, at the end of 2011 Etihad Rail Company PJSC awarded a further contract for the design and construction of the 264 km long railway line connecting Shah to Ruwais via Habshan. This railway will service both the Habshan and Shah sour gas fields. It will allow the transportation of granulated sulphur from these fields to the port of Ruwais. This last package was awarded to a JV led by Saipem, which comprises Maire Tecnimont and Dodsal.

At the time of writing, this mammoth project execution is proceeding "full steam ahead", in a complex terrain and very exacting climatic condition, naturally with different details on the various packages the project completion is expected for the fourth quarter of 2014. Most importantly, we are pleased to see that – so far – the project has reached 90 million LTI man-hours free.

In general the development of the project faced several challenges during its stages, starting from the engineering phase to the procurement, transportation of equipment and execution phases.

Since the beginning of the mobilization at site in March 2011 Saipem has deployed its best know-how acquired from its vast experience, in order to set up the advance camp and its office in an area reachable only through a gatch road with no other facilities close to it. The closest small town was at 130 km away from the site. Later on, together with its subcontractors Saipem built a telecommunications facility by installing a fibre optic cable and by setting temporary camps for around 30 thousand people. Also power was finally connected to the camp with main electrical grid. Following the initial mobilization the structural material started to be delivered to the site in June. The huge quantities of material and equipment to be installed, the very challenging construction schedule and commissioning

Saipem has been awarded three EPC packages of the Shah Gas Development Program and later the design and construction of the 246 km railway from Etihad Rail PJSC



Fig. 1 - Unit 751- Structure A

have been always the driver of the project. Ever since the beginning of the engineering phase, operation and construction resources have been working hand in hand with the engineering and the procurement team.

The whole development of the project has passed through critical moments due to the high quantities of information to be managed during the engineering and procurement of materials. The 34,000 isometric to be issued from the project was a first challenge to feed the prefabrication on site A lot of effort was required to set up the 3D model to extract weekly 1000 isometrics in order to maintain the planned progress. Thereafter the prefabrication was organized in order to produce around 1,5 million dia inch achieving the peak of 5000 dia inch a day.

The start of the civil works during the summer period provided an additional challenge to the already huge quantities of concrete to be cast and



Fig. 2 - Unit 721 - HP absorber

forced most of the work to be performed during the night, when temperatures were in line with the project specification requirement (during the day the temperatures at site reached 50-55 °C).

Meanwhile, the project was also overcoming the day-by-day issues related to the environment and the hot season, particularly trying to keep the progress in line with the project requirements. At the head office the procurement activities were finalized with emphasis on delivering all material and equipment in time for the requested sequence of construction. In particular, the “Structure A” (**figure 1**) of the sulfur unit required the installation of the equipment by layers, so steel structure and equipment had to arrive at the site absolutely all at the right time.

Therefore, the procurement team had to work on the best deliveries and on the most economical market conditions to ensure the optimal procurement of the material to meet the project requirements. This was possible while working in close cooperation with the project team and using all Saipem experiences and capabilities, resources and departments involved.

> The project, now in the last phase, has successfully solved all the challenges due to its large size, hot seasons and remote location

The most critical equipment were fabricated in Italy: for example the 4 HP absorber (**figure 2**) of 1400 tons and 45 m in height transported from Italy to the site with a dedicated cargo and with a huge effort to ensure the viability locally in UAE. The delivery on the site of these giant pieces of equipment was completed within two months after the arrival in UAE by using a special transport configuration and a good number of trailers to cross the high sand dunes in the Liwa oasis.

Today, the project is in its last phase. Pre-commissioning and commissioning activities are the last challenges of this giant project. Saipem and its subcontractors are proudly aware that they are bringing to the end one of the most important projects ever carried out in the UAE. We are grateful for the excellent contribution of all our subcontractors - Descon, Dodsal, Target and Butec, just to mention a few.

This article contains more detailed descriptions of individual contracts.

EPC Package 2: Shah Process Plant
EPC Package 3: Shah Sulfur Recovery Units

The Shah Process Plant and its associated Sulfur Recovery Units is a grass-root facility within the SGD Program. The plant is located in the Shah Field approximately 200 km southwest of Abu Dhabi. There are no existing processing facilities at the site of the Shah Gas Plant location.

The complex is among the largest gas treatment plants in the world, and sets a benchmark for its distinctive features, in particular:

- a high sour content and associated sulfur production, with an inlet feed of acid gas with high H2S percentage. This makes safety a fundamental pre-requisite for the whole plant design: especially for the inlet and gas sweetening facilities (the location of which is labeled "Red Zone" in the Project terminology) processing approximately 1000 MMSCFD of sour gas at 70 bars;
- the sulfur recovery trains have a total production capacity of 10,000 tons/day of liquid sulfur;
- large plant area for 5 × 3 km, located within 3 low-lying areas roots facilities, including a sour/ high pressure gas restricted zone – Red Zone.
  - associated erection quantities:
  - civil concrete quantities: approx. 171,000 m^3
  - steel structures: approx. 80,000 tons
  - piping: approx. 40,000 tons
  - equipment: approx. 73,000 tons, of which 28,000 tons of heavy lifting equipment, requiring special transportation and methods of construction
  - approx. 5,400 km of electrical and instrumentation cable;
- large amount of interaction: the Shah Gas Plant and Sulfur Recovery Units are 2 EPC packages of the Shah Gas Development Program, entailing 8 EPC Packages for a total number of 6 EPC Contractors.

A number of factors increased the degree of complexity in executing the projects. The remote desert location presented a number of logistical challenges, as did efforts to obtain the necessary permits from local authorities. Equally, Saipem environmental commitment to minimize its footprint in large scale operations in the area (there were more than 25,000 workers at the peak level), was no mean feat. Several actions were brought in to successfully tackle the various challenges, faced specifically.

Saipem has minimized its environmental footprint, even with 25.000 workers on site at the project peak

Project Management

The creation of a project directorate, to ensure alignment on all project decisions, with one dedicated senior manager per area: head office management; UAE operations; project controls; QHSE; technical management, procurement and manufacturing management; and, management of contracts and subcontracts.

Three main operations centers, individual focal points for activities at each specific phase of the project were identified:

- Corporate Headquarters in San Donato (Milan), Italy, leading the design and procurement activities;
- Chennai, India operating center for the execution of detail design and "production" engineering;
- in UAE, Abu Dhabi Branch and construction site operations centers for construction, commissioning & start up activities, including coordination of transportation and delivery operations and local procurement of material.

Engineering

Process and engineering design activities have been carried out by a task force organization in Corporate Headquarters.

The center of engineering activities moved to Saipem engineering operations offices in Chennai, India, immediately after a 30% 3D model review. This included the relocation of technical management and discipline leads.

The bulk of the "production" engineering (such as laying foundations, piping isometric production, E&I cable material take offs and interaction with the UAE construction site) was carried out in Chennai.

There was a large presence of technical management

and field engineering engaged at the construction site, ensuring direct communication with vendors and construction subcontractors on all construction-related issues.

Procurement

Procurement and execution of purchase orders were directed by the Corporate Headquarters.

Saipem UAE operations were heavily involved in the local procurement and supply of materials and were able to intervene directly when there were delays from vendors, particularly regarding steel structures. Transportation management was also handled by UAE operations.

To cope with possible market congestion and the related logistical constraints in delivering materials , an early procurement strategy was also introduced.

In compliance with various owner specifications, a proactive approach to material standardization was taken across the different EPC packages, in close collaboration with other EPC contractors.

Subcontracting

Saipem employed a multidiscipline subcontracting approach with civil, mechanical, and E&I activities falling under the same subcontract.

The main construction subcontract was finalized during the tendering phase while the other main construction subcontracts (e.g. for buildings) were awarded during the projects execution, in close coordination with the UAE Operations units.

Transportation subcontracts were split among different parties, as appropriate: foreign-country road transportation, airfreight and sea transportation.

The balance of subcontracts was awarded and managed by the UAE Operations center and site offices.

Fig. 3 – Solvent regenerator colum



Construction

Immediately after being awarded the contract, Saipem Abu Dhabi branch was upgraded to become the strategic UAE operations center.

Saipem subcontracted and began works on the temporary camp and office facilities soon after being awarded the project, which allowed works to be completed within approximately 6-7 months.

The main construction subcontractor was involved in the design activities since the outset, working with the Headquarters Design task force for an early assessment of all related issues. “Adaptive” constructability analysis was used: most of the sulfur recovery units heavy lifting equipment is installed on a 4-storey steel structure (Structure A). The initial plan was to add layers as the equipment arrived, although this plan was later adjusted.

For the first time in an oil and gas project in the UAE Saipem made use of a pre-cast structure to build part of the electrical substations.

Moreover, some examples of Saipem employed cutting edge technology include:

- STS (Spools Tracking system): it allows tracking and monitoring of piping spools (around 90,000 piping spools). The process employs bar codes tags, palmtop decoders and an electronic data base;
- PTS (Pipe tracking System): it allows the full history of spool welding to be recorded;
- Electronic tablets for quantity surveyors and supervisors: they allow measurement of construction progress, downloading and uploading data from the main database, and provide a visualization of construction drawings.
  PAUT (Phased Array Ultrasonic Test): a Non Destructive Test (NDT) alternative to RX testing for detection and interpretation of welding defects. The main advantages compared to traditional RX technology are:
  - the absence of Ionizing radiations, thus providing a radiation-free working environment;
  - accuracy in the identification and measurement of welding defects.

Particular care was taken to ensure that all

workers were aware of, and protected from, all construction-related hazards. In line with Saipem HSE commitment and in accordance with the LiHS (Leaders in Health and Safety) corporate program, introduced as the Shah project began, Saipem sought to promote the HSE culture at all levels of the workforce, from senior management all the way along the chain to subcontractors. The following specific initiatives were particularly noteworthy:

A permanent training center was established near the site offices, as well as an external training ground, which carried out training drills for working at height, rigging, lifting and fire training, all of which have translated into more than 1.4 million man-hours of training.

Working at height: incidents in previous projects led to the decision to hire a dedicated subcontractor, with the aim of ensuring no incidents in the Shah Project. The subcontractor was responsible for ensuring all workers received adequate training for their work, be it working at height or in confined spaces. The initiative was a success: no working-at-height incidents occurred during more than 100 million man-hours.

Assessment and training for all operators: specialist simulators were provided to assess the skills of operators of heavy machinery, scoring performance according to the competency level shown. Equally, detailed plans were made for when sour gas will be introduced in the plant. Finally, close attention was paid to monitor the number of operators and workers allowed in the plant during operations, as well as to ensure adequate protection and evacuation training were provided.

Commissioning and Start Up

Commissioning activities are ongoing and are fully integrated with the construction activities. Saipem stringent approach enabled commissioning activities to be carried out without waiting for the mechanical completion of the facilities, with evident benefits to the schedule.

Saipems's integrated approach allows to start commissioning without to start waiting for the mechanical completion

This achievement was made possible by involving the commissioning team from the design phase, with direct participation in the basic process and design activities.

The next challenge for the commissioning team will be the plant startup at partial capacity, with particular attention to potential leakages and flare emissions as some construction activities are being completed.

Such challenge will be managed through a careful identification of the concerned SIMOPS (simultaneous operations), an assessment of the associated risks and the development of suitable mitigation meaures.

EPC Package 5: Shah Product Pipelines

The Shah Product Pipelines Project is located in a very remote area – dubbed the 'Empty Quarter'. It is a part of the SGD Program, and consists of three pipelines running in parallel– one 36" pipeline (**figure 4**) of around 127 km in length, and two 16" pipelines, each of 66 km - built to transport respectively from the Shah Process Plant the Sales Gas in the existing networks. In addition, 6 Scraper Launchers with 6 Mainline Block Valves has been constructed and 400 km of FOC (Fiber Optic Cable) has been laid.

In choosing the sites and putting up temporary construction facilities, local environmental conditions have been given great consideration throughout. Careful attention has also been paid to waste management, storage of fuel and other hydrocarbons, and dust control. Finally, vehicles have been closely monitored in order to limit access for non-authorized off-road excursions in case of emergency.

Local environmental conditions have been considered in choosing the sites for temporary construction facilities

Fig. 4 - 36" Lean Sales Gas Pipeline



A camp, including a site clinic, was built at the heart of the pipeline corridor to facilitate the construction team's efforts. This was carried out in the face of a number of operational challenges, not least the fact that the site is extremely inaccessible for the delivery and transportation of materials. This made meeting the project schedule very challenging.

Particular efforts were made to preserve the construction materials and equipment against the extreme temperatures (> 50 °C) experienced during the summer months. Most significantly, management of heat stress for all workers on site was given the highest priority, with a dedicated training program and continuous monitoring of worker conditions.

The engagement with other key stakeholders (such as regulatory authorities, local government, and third-party owners) presented a further challenge in the construction of more than 300 crossings of existing facilities and networks.

Etihad Rail Project: Shah-Habshan-Ruwais Railway

The Etihad Rail Project (**figure 5**) will be a core part of the UAE Railway Network, which will link the principal centers of population and industry in the UAE, and form part of the planned Gulf Cooperation Council (GCC) Railway Network. It will run as part of the interoperability corridor linking the six countries of the GCC.

Saipem is developing the first stage of this network, a 264 km of freight railway lines between the new Gas facilities in the Abu Dhabi desert in Shah and Habshan, to the port facility of Ruwais, to transport the sufur extracted from the gas. All trains will depart from the operational freight maintenance depot in Mirfa, where the railway Operational Control Center will be located.

Etihad Rail's first trains will be carrying granulated sulfur for Abu Dhabi National Oil Co. The Railway is expected to haul about 7 million tons of granulated sulfur a year from the oil and gas fields at Shah and Habshan, for export from the port of Ruwais. This is the equivalent of two 11,000 tons trainloads per day. The train will be operated using seven SD70 ACS diesel locomotives, supplied by the US supplier EMD, and 240 covered hopper wagons, supplied by Chinese CSR. Operation of the Railway will be managed by a joint venture between Etihad Rail and DB Schenker Rail.

The line will also comprise 124 km of double track along the coastline, as part of the future development



Fig. 6 – Double track along the coastline

of the UAE passenger railway (**figura 6**).

The key data of the project include: 80 million m^3 earthworks, 9 huge crossings of existing utilities from the principal local stakeholders, 2 railway bridges crossing 2 important highways, 16 road-bridges across the railway, 37 road tunnels beneath the railway, 200 minor concrete structures, 400 km of track to be laid, 14 buildings to be constructed, along with other relevant infrastructure, full telecommunication and signaling systems to be configured, 2 yards dedicated to facilities for track laying, and 3 main facility camps for the project.

Construction activities have been performed across 5 simultaneously active work fronts. While the strict schedule which forced many activities to overlap, the challenging desert environment affected the progress of works, and necessitated contingency plans. In particular, very high temperatures and windblown sand affected construction as well as the future operation of the Railway. Sand drift represented a major threat to the railway and accompanying facilities, given that the ground

Saipem is developing a 264 km freight line to connect the gas facilities to the port of Ruwais

surface is covered by dry loose sands, and rainfall is rare. However, a system of ditches and dykes provided a solution, whereby an artificially stabilized dune prevents windblown sand from reaching the railway platform, protecting the rails.

The construction of a railway embankment was carried out using local sand and gatch. Specific trial embankments have been set up in two different

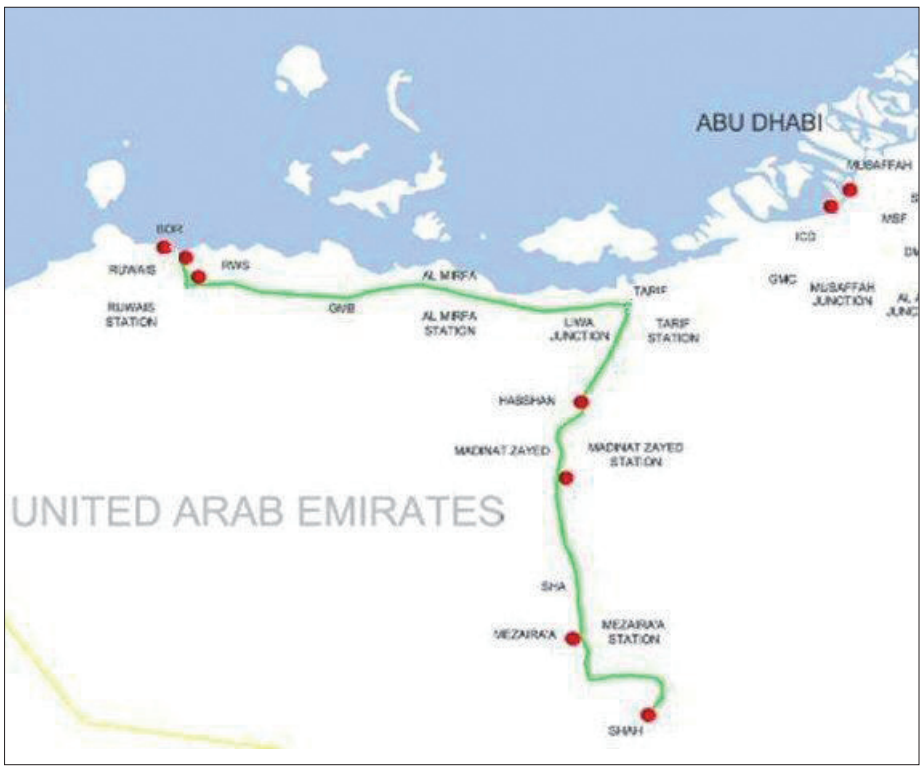


Fig. 5 - Shah Railway Route



Fig. 7 – Temporary view of the train at Mirfa

locations, one at Mirfa - alongside the coastal line - and one at Shah- within the desert area.
System equipment devices located along the track are fed by electrical power through buried cables and sub-stations, linked with the local electrical network. The depot buildings are powered in the same way.
The 25 m-long rails were manufactured in Italy, shipped to Abu Dhabi Port and then directly transported to the site. A dedicated yard with welding facilities saw the 25 m rails welded into 150 m-length rails. A temporary railhead has been created at Mirfa, near the center of the line, and connected to the main line with temporary track (**figura 7**).
Track construction was carried out by specialist railway equipment, carrying out various works on a daily basis. An important component of this activity is the material ballast- crushed rock extracted from quarries located in the north of the UAE, a great distance from the Project.
Section 1 of this project is currently being tested for commercial viability. It will be the first railway in the UAE, and Saipem is pioneering of this goal.



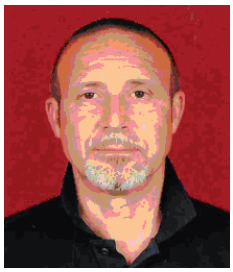
Stefano Grandino

With Saipem since 1997, Stefano Grandino has gained experience in the different projects made by Saipem in the world, particularly in Saudi Arabia, Nigeria, Oman, Australia and UAE, starting as site assistant for civil work in Saudi in 1997, being responsible as PM/PD and MD in Nigeria and then PD and Branch manager of different projects and areas. He is currently Project Director of the Shah Gas and Branch Manager of the Saipem Abu Dhabi Branch.



Alessandro Cursio

Alessandro Cursio is the Project Manager of the Shah Gas Plant and associated Sulphur Recovery Units Projects, respectively packages EPC 2, 3 of the Shah Gas Development Program for Al Hosn-Gas (ADNOC - Occidental Petroleum JV).
He consolidated a multi-year experience as Senior Proposal Manager for the management of EPC Bids on Lump Sum Turnkey and Reimbursable basis for projects in the upstream, refinery and gas monetization environment. He joined Saipem SpA in 2004 as Machinery Project Lead.



Roberto Lanni

Roberto Lanni has been working with Saipem for 32 years.
During his professional career he has covered various roles starting from Onshore Pipeline Engineer to Technical Manager until the current position of Project Manager operating in several countries such as Italy, Middle and Northern Europe, North Africa and the Middle East.



Luca Pretari

Luca Pretari joined Saipem in 1991 as project specialist engineer for packages systems. After 4 years he was transferred to the construction department where he had the opportunity to cover all the construction positions up to site manager in 2009. In 2009 he joined the Project Management and he is now covering the position of Operations Manager for the Saipem branch in Abu Dhabi.



Giuseppe Iocco

Giuseppe Iocco, graduated in management engineering at Politecnico di Milano, Italy, joined Saipem in 1994 as quality engineer and has developed most of his career in railway sector, with an huge experience in the High Speed Railway Project Milano-Bologna in Italy, where he was deputy project director. Since 2011 he has been in UAE leading as Project Director the Etihad Railway Project, the first railway infrastructure project in the country.



MEETING YOUR SAFETY NEEDS.

NUOVA ASP
make them safe

Via De Gasperi, 26
Pantigliate - MI - Italy
Tel. +39 02 90686013
www.nuovaasp.net

Energy Savings for Offshore Drilling Units Using LEDs

Nuova ASP technical illumination study for drilling infrastructures

Kim Fumagalli
R&D Manager, Nuova ASP

To better understand how it is possible to achieve energy savings it is important to firstly analyse different lighting sources. All lamps currently on the market can be placed, in accordance with the manner in which the light is generated, into two major categories:

- *incandescence*: composed of a tungsten filament which becomes incandescent and emits a certain amount of visible radiation (light) when an electric current runs through it;
- *electrical discharge in gases*: they emit light through a discharge generated inside a gas. In particular, among other categories, discharge light sources include traditional tubular fluorescent lamps (commonly, but erroneously, known as neon lamps) and compact lamps [1].

In addition to these two large categories of sources, the new LED light power sources (**figure 1**) have become more widespread in recent years.
LED uses the optical properties of semiconductor materials to produce photons from the recombination of electron-hole pairs. When subjected to a direct voltage, the electrons of the semiconductor's conduction band recombine with holes in the valence band, releasing enough energy to produce photons. Due to the thinness of the LED chip, a reasonable number of these photons leave the chip and are emitted as light [2].

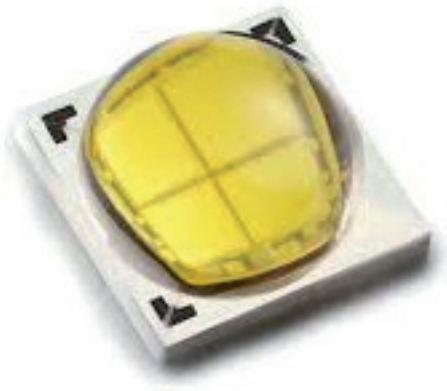


Fig. 1 - Power LED

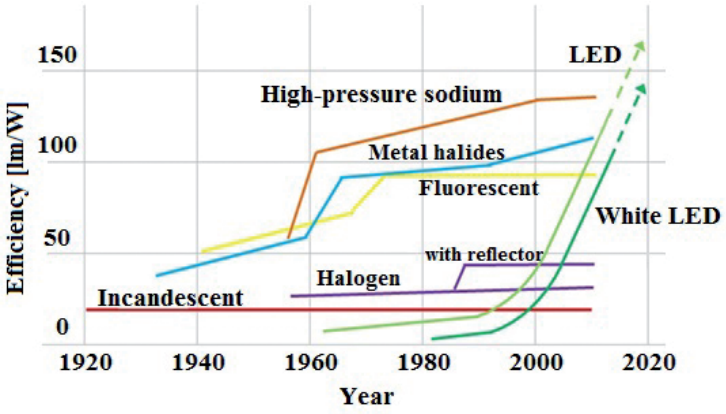


Fig. 2 - Lighting efficiency trends over time for the most common types of lamps

The following are the main characteristics that need to be considered for the use of light sources [2]:

- *life-cycle*: the duration of a lamp is equal to the period of time that elapses between switching it on and the moment the luminous flux produced is equal to 70% of the initial value. A LED has a longer life-cycle (≈30,000 hours) than any other lamp: this regards both fluorescent (≈10,000 hours) and gas discharge (≈12,000 hours) lamps;
- *lighting efficiency*: **figure 2** shows the figures regarding the luminous efficiency trends of different types of lamps used in the lighting industry. The graph in figure 2 shows that the luminous efficiency value of a white LED lamp (120 lm/W) is slightly higher than that of a fluorescent lamp;

- *physical size:* LED sources are smaller than all other light sources. This is important because it allows designers freedom of choice to design lighting systems that perform their task in the best possible way;
- *switching on the power and circuits used to switch it on:* LEDs do not require any particular auxiliary circuit to be switched on, which is instantaneous, as opposed to discharge lamps which typically also need a certain amount of time to reach the minimum operating conditions. This aspect must be considered in relation to the use made of a lighting system.

1. Standard

It is important to define the applicable standards before proceeding with an energy assessment. Since this application is a hazardous environment for the formation of explosive atmospheres caused by gas leaks or oil fumes, it is necessary to follow Atex directive 94/9/EC and the related IEC/EN standards for the classification of areas [4]. Therefore, explosion-proof lighting devices classified for Zone 1. for "places where, occasionally, there is likely to be an explosive atmosphere composed of a mixture of air and flammable substances in the form of gas, fumes or mist, during routine activities" were considered in this study.

In regard to the technical illumination aspects, the Norsok Standards were also taken into account, since the system in question was constructed in accordance with said standards. **Table 1** shows the average illuminance values for the drilling infrastructure sections covered by the study [5].

The average illuminance level of the various sections was measured at a height of 1 m above the floor and was found to be suitable for the task or process that takes place in the area concerned, in such a way as to ensure an appropriate level of lighting. In order to maintain a certain brightness uniformity within each section, the ratio between the average illuminance and the minimum illuminance must be at least equal to:

- 0.5 in the utility, process and drilling areas;
- 0.7 in individual work areas.

Table 1 - Average level of illuminance at a height of 1 m

Description of the location	Average level of illuminance (lux)
Walkways and external access routes	100
Stairs, walkways and access routes in internal working areas	150
General process and utility areas	200
Laboratory	500
Drilling cabin	400 adjustable
Drill floor	350
Derrickman (*) platform (monkey board)	200
Area rack for drill	200
Laboratories for measurements and well and drilling fluid data records	500
Vibrating sieve for the separation of drilling debris (shale shaker)	300
Drilling mud area, mixing area	200
Drilling mud area, control units (test stations)	300
Drilling mud laboratory	300
Operator's cabin in the drilling unit	400
Blowouts prevention system area (BOP) and wellhead	150

(*) Derrickman: an operator positioned on a bridge on a derrick, who has the task of guiding the length of the drillpipes during drilling activities of safety and time, and which is then placed in a vertical position using the plant's winch

2. Case studies

The comparison in terms of installed power is carried out with a lighting system based on the use of standard luminaires and a lighting system based on the use of semiconductor light devices (power LED) in relation to the equal illuminance required by the standard. To do this it is in any case necessary to know the precise shape and size of the system to be illuminated and the types of lamps and devices to be used.

2.1. Oil plant

The study was carried out on an offshore oil plant. Generally, a drilling installation (**figure 3**) is composed of [6] [7]:

- derrick;
- drill floor;
- BOP (Blow Out Preventer) deck;
- mud module.

A derrick is a lattice metal structure, with a square base, tapering upwards, which stands on the drilling floor of a rig. A derrick has vertical drill pipes attached that are screwed in or unscrewed when lowering or recovering the drills. There are also one or two small floors, depending on the height, at different levels, from which workers can move the drill pipes. A derrick is typically 45 m high.

The drilling floor is a working level of the drilling system, located at the base of the tower and raised above the main deck of an oil installation, from which the well drilling activities are carried out. This area is composed as follows:

- rotary table, which guides and transmits the movement power to the drill string;
- drilling cabin;

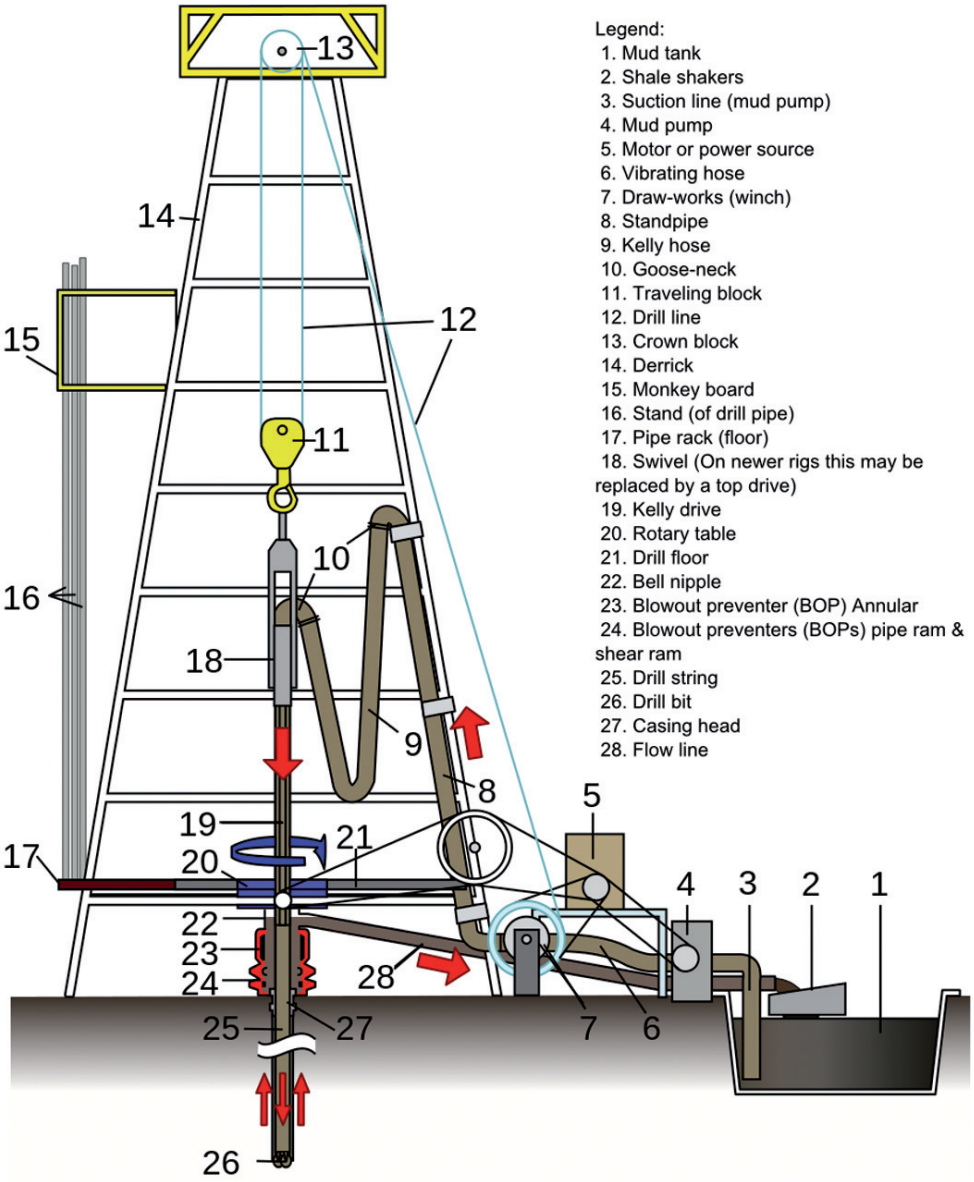


Fig. 3 - Drilling installation diagram



Fig. 4 - Drilling tower

- winches that support the drill (drawworks);
- BOP accumulator, i.e. a device that acts as a hydraulic power reserve to choke an erupting well;
- pipe ramp, i.e. a sloping plane which connects the drilling floor to the pipes, used to bring various equipment and tubular material to the drilling floor.

A BOP deck is an area located under the drilling floor which has a device to prevent blowouts (blowout preventer). It is a device for the prevention and control of well blowouts during drilling operations. The BOP is installed over the wellhead and is composed of a set of valves that allow the control of the flow of fluids of a well layer during a blowout.

The mud module is a semi-open construction, distributed over several floors, which contains the entire mud treatment circuit, which is an essential fluid used when drilling oil or gas wells. It is divided into the following sections:

- sludge storage tanks area;
- vibrating screens area;
- geologists area, geological monitoring of the drilling mud;
- *degassing area* ([1]), kill and choke *manifold* ([2]) and *flow diverter* ([3]).

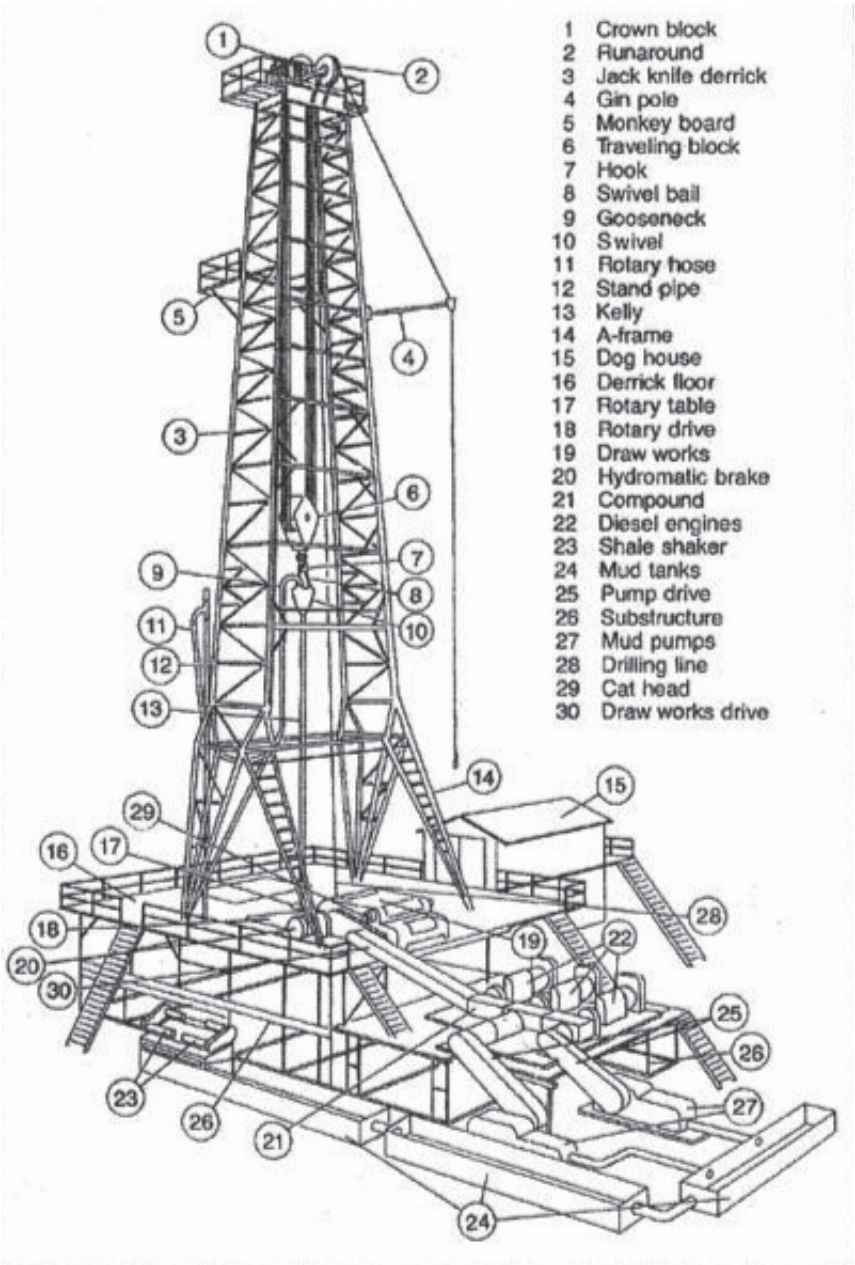


Fig. 5 - Drilling structure

The derrick analysed in the study (**figure 4**) was of the *mast* ([4]) type, designed by Woolslayer companies, installed and managed by Saipem; it is supported by a support vessel, the Saipem TAD (Tender Assisted Drilling barge), which has part of the equipment for its operation on-board (oil and sludge pumps, engine power generators etc.).

Figure 5 shows all the components that make up the extraction plant the comparison concerned.

2.2. Lighting devices

The lighting of the application described above is usually carried out using light fittings with high pressure sodium discharge lamps, integrated with fluorescent tube lighting fixtures. **Tables 2** and **3** show the main characteristics of Nuova ASP [8] lighting devices used in the simulations. In particular, table 2 lists the technical specifications of the floodlight SFDE shown in **figure 6**, and table 3 has the characteristics of the EVFG fluorescent lamps luminaries shown in **figure 7**.

The LED lighting system used for the comparison is composed of floodlight SFDE and EVFG luminaries equipped with LED sources (**figures 8** and **figure 9**) manufactured and marketed by Nuova ASP. **Table 4** and **table 5** show the technical characteristics of the LED luminaires used for the simulations.

Each LED of the floodlight SFDE LED can be equipped with different secondary optics depending on the use; 65° and 21° optics were mostly used for this study.

2.3. Photometric simulations

Before proceeding with the actual calculation, it was necessary to develop a 3D of the entire derrick using Dialux software [9]. Subsequently, with the same software, photometric simulations were carried out for each of the areas described above, in one case using traditional lighting fixtures and in the other the LED fixtures as described in paragraph 2.2. In order not to complicate the explanation, only some of the results (offset colour images) are shown for the various drilling sections. More specifically, only the results of the comparison carried out for the area defined as the “Pipe Ramp” and for the area called the “Drilling mud processing module” are shown.

Power rating (W)	150	250
Power consumption (W)	183	280
Total luminous flux (lm)	14.500	27.000
IP protection	IP66	
IECEx / ATEX	Ex de IIB+H2 - Ex tb IIIC	

Table 2 - Technical specifications of Nuova ASP high-pressure sodium Floodlight SFDE

Power rating (W)	2 × 18	2 × 36
Power consumption (W)	40	80
Total luminous flux (lm)	2700	6700
IP protection	IP66	
IECEx / ATEX	Ex de IIC – Ex tb IIC	

Table 3 - Technical specifications for Nuova ASP fluorescent lighting fixtures EVFG



Fig. 6 - Floodlight SFDE of Nuova ASP

Power rating (W)	144	192
Power consumption (W)	157	210
Total luminous flux (lm)	11.000	15.000
LEDs (n.)	18	24
IP protection	IP66	
IECEx / ATEX	Ex de IIB+H2 – Ex tb IIIC	

Table 4 - Technical specifications of the Nuova ASP floodlight SFDE LED

Pipe Ramp

Figure 10 shows the offset colour rendering of the illuminance obtained with traditional sources, while **figure 11** shows the illuminance obtained using LED lighting devices.

Drilling mud processing module

Figure 12 shows the offset colour rendering illuminance obtained with traditional sources for the sludge treatment module, while **figure 13** shows the illuminance obtained using LED lighting devices.

3. Conclusions

In accordance with the illuminance required by the Norsok Standard, 1 m above the ground, the number of required devices and consequently the installed power for all the derrick's areas were calculated.

Table 6 summarises the results of the simulations. In particular, it shows the average illuminance values and the installed power to achieve them for the two lighting systems. Note that the level of illumination for the mast has not been included, since the presence of a body in motion is exclusively reported for this part, but it does not necessarily have to be illuminated with a specific illuminance value.

It should be noted that table 6 has a column called "Var. (%)"; these values indicate the percentage variance in installed power of the LED system compared to the conventional light sources system. The "minus"



Fig. 7 - EVFG luminaries with fluorescent lamps of Nuova ASP



Fig. 8 - Floodlight SFDE LED of Nuova ASP



Fig. 9 - EVFG LED luminaries of Nuova ASP

Power rating (W)	2 × 9	2 × 20
Power consumption (W)	30	84
Total luminous flux (lm)	2100	4600
IP protection	IP66	
IECEx / ATEX	Ex de IIC – Ex tb IIC	

Table 5 - Technical specifications of Nuova ASP EVFG LED luminaries

sign indicates the reduction of installed power of the LED solution compared with that of the traditional lighting system.

It is important to note that the plant solution with LED devices proves to be, in each section of the rig, more advantageous than the solution with traditional devices in terms of less installed power. In fact, considering all the sections of the plant, the use of LED devices allows a reduction of about 43% of the total power draw (the total power in the traditional solution is about 10.3 kW, while the LED solution is 5.8 kW).

The use of LED sources for this particular application therefore ensures the lighting required by the standard with a lower installed power, and consequently this results in a reduction of:

- energy costs based on consumption;
- plant running costs.

The energy savings resulting from the use of LED light sources significantly affects the total costs since the entire derrick has to remain continuously lit. In fact, a derrick should be visible from the sky and sea at all times and in all weather conditions [10]. Also bear in mind that the above is a simulation of a part of the whole plant only. In fact, not all of the internal areas

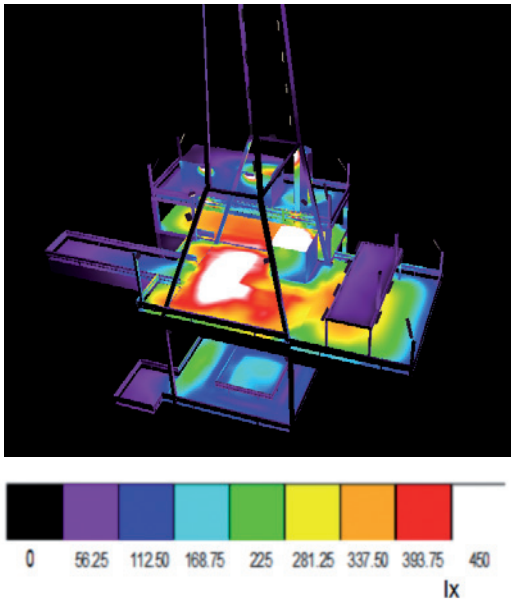


Fig. 10 - Offset colour rendering of the drill floor, winch, BOP accumulator and pipe ramp with traditional lighting

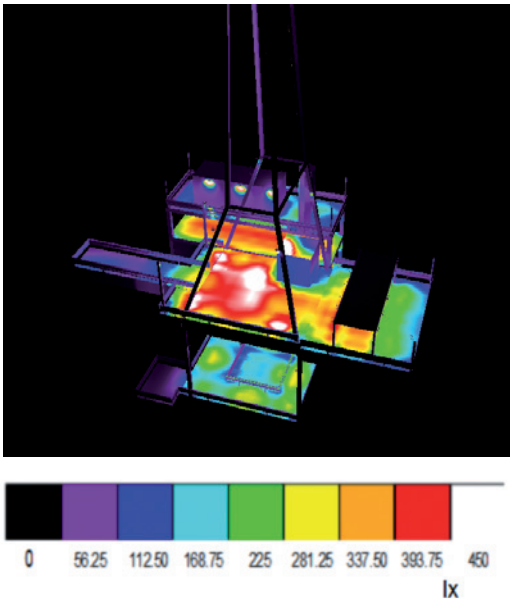


Fig. 11 - Offset colour rendering of the drill floor, winch, BOP accumulator and pipe ramp with LED lighting

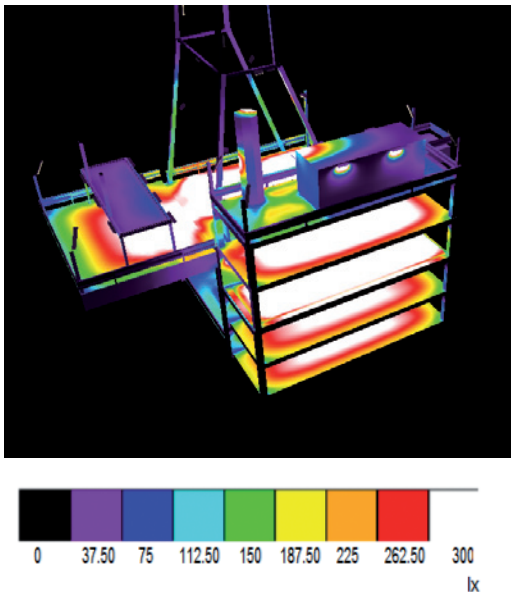


Fig. 12 - Offset colour rendering of the mud module with traditional lighting

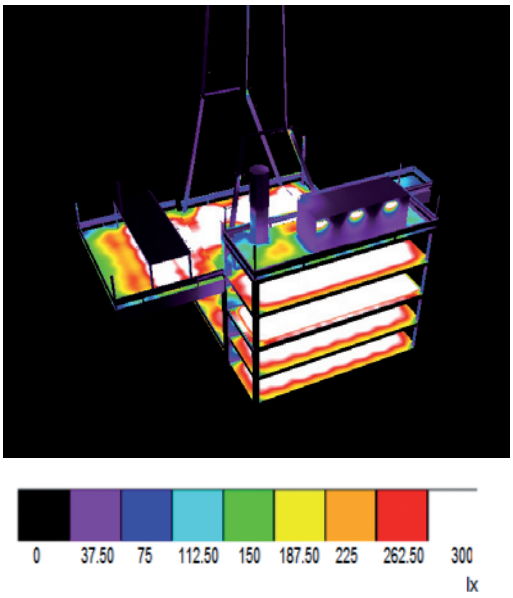


Fig. 13 - Offset colour rendering of the mud module with LED lighting

(rooms, bathrooms, dining room etc.) were considered, where it is now known that LED devices have far exceeded all other sources of lighting in terms of energy efficiency.

Furthermore, for an equal voltage, a lower installed power means a lower total current required by the LED devices; therefore, considering an equal current density for the cables, the plant running costs are lower, since the cables' section is narrower (reduction of the amount of copper used). Although, as is known, LED luminaires cost more than devices with traditional sources, this difference in costs is significantly reduced, in fact almost eliminated, by the lower plant running costs arising from the use of the above-mentioned LED devices.

Another very important advantage given by using LED sources, in particular from an Ex point of view, is the reduction of maintenance costs. As mentioned previously, LEDs have a longer life span than any other light source, which means maintenance is reduced and consequently also the relative costs. Also, it is important to bear in mind that these costs do not only concern the change of power supply, the lamp itself or cleaning, but above all the costs related to the safety of workers who carry out the maintenance in question.

Lastly, but perhaps something that is not generally considered or known, but which is of considerable importance, especially in industry, is what is called the

Table 6 - Installed power and average illuminance (1 m) for the two lighting systems in question

Section		Installed power (W)			Average illuminance (lux)	
		Traditional system	LED system	Var. (%)	Traditional system	LED system
BOP floor		915	534,9	- 42	173	240
Drilling floor		1486	896,8	- 40	418	382
Winch and BOP accumulator		1092	590	- 46	294	294
Pipe ramp		280	125,9	- 55	109	137
Mast		720	566,4	- 21	-	-
Operator floor		183	94,4	- 48	221	222
Mud treatment module	Degasser bridge and PCR	639	306,8	- 52	159	175
	Well degassification and safety	1176	637,2	- 46	377	359
	Geologists	1764	920,4	- 48	522	521
	Sieves	1008	566,4	- 44	335	334
	Mud collection tanks	1008	566,4	- 44	335	334

flicker effect or flickering. This effect is caused by abrupt and repetitive changes in voltage of small amplitude, which may be generated in limited extension systems connected to substantial power users that work intermittently, such as the start-up of electric motors to get them running. The flicker effect produces a periodic variation of the luminous flux produced by the discharge lamps, which causes visual fatigue and in some cases can make the rotating elements look as if they are still. On the contrary, LED devices are not affected by this phenomenon because they are supplied in DC.

Since Nuova ASP is aware of the significant advantages that LED technology can provide industry with, the company is constantly committed to the development of LED products that combine cost-efficiency and high-performance standards at the highest market levels. In fact, Nuova ASP is like a partner for its customers. Thanks to its focused analyses, the company is able to deliver the best LED solutions capable of satisfying any plant requirements.

References

[1] Faranda R., Fumagalli K., Tironi E.: *Il risparmio energetico nella Casa del Futuro* - Casa del Futuro, maggio/giugno 2007

[2] Faranda R., Guzzetti S., Lazaroiu C., Leva S.: *LEDs Lighting: Two Case Studies* - UPB Scientific Bulletin, Series C: Electrical Engineering, n. 1, Vol. 73, 2011, pp. 199-210, ISSN 1454-234x

[3] Faranda R., Fumagalli K.: *Vantaggi economici derivanti dall'uso dei LED per segnalatori antinebbia (costs advantages through the use of LEDs for fog warning lights)* - Luce, 2007

[4] Standard IEC 60079-10-1: *Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres*

[5] Norsok standard S-002: *Working environment*

[6] www.eniscuola.net

[7] www.saipem.eni.it

[8] www.nuovaasp.net

[9] www.dialux.de

[10] Iliceto F.: *Impianti elettrici* – Vol. I (Electrical systems), Pàtron press, 1984

Note

([1]) *Degassification*: process of removal of the gases present in the drilling mud in the well lift. This plant includes high and low pressure separators and a small stripping unit that serves to purify the oil and extract hydrogen sulphide

([2]) *Choke manifold*: set of pipes, valves and nozzles, through which the drilling mud is circulated when the BOPs are closed (i.e. active) to keep the pressure under control during well blowouts

([3]) *Flow diverter*: safety system used to remove fluids that escape in case of blowout from the well when the drilling starts, and the safety devices (BOP) have not yet mounted. In the event gas pockets are drilled through during drilling activities, the diverter is closed, thereby diverting hydrocarbons from the drilling floor to an appropriate side discharge

([4]) *Mast*: simple and inexpensive derrick which is mounted horizontally, with significant benefits in terms of safety and time, and which is then placed in a vertical position using the plant's winch.



Kim Fumagalli

Kim graduated in Electrical Engineering at Politecnico di Milano in 2005. He achieved a Ph.D in Electrical Engineering at Politecnico di Milano, Italy, in 2009. His research areas include LED Sources and LED Lighting Systems, Electrical and Lighting systems for Ex environment, Ex Products Certification and Testing. He has been the R&D and Certification Manager of Nuova ASP since 2011. He is a member of the IEC Work Group WG40. He is a member of the CEI (Italy), CT31 and SC34D Standards Committees.

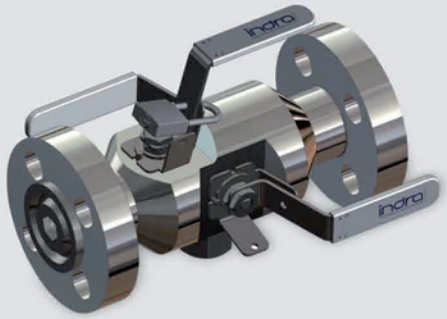
100% Manufactured in Italy

indra VALVES & CONTROLS ITALY

Iblok Series - Integral type

Drastic reduction of: costs • installation and maintenance time • weights • support systems and / or anchorage • leakages

DBB Three Balls



DBB Sampling & Injection type



DBB Needle Type



DBB Ball Type



Reference standards:
ANSI / ASME, API 589, Ped, Nace std, etc.

Standard materials:
AISI 316, A105, etc.

Special materials:
Duplex, Superduplex, Monel, Inconel, Incoloy, Hastelloy-C, etc.

Options/accessories:
locking systems, electrical signals, etc.

Certification:
Fire Safe Api 607/Iso 10497
Fugitive Emission/Ta-Luft (Iso 15848-1)
Nace Standard MR.01.75
Atex 94/9/CE
Ped 97/23/CE
CU-TR (ex Gost)
CRN

ATEX
PED
CU-TR
TA-LUFT
CRN
FIRE SAFE

Headquarter: via Novara 10/B-C - 20013 Magenta (MI) Italy
Phone +39 02 97298663 - Fax +39 02 97291855 - E-mail indra@indra.it - www.indra.it

ITALY

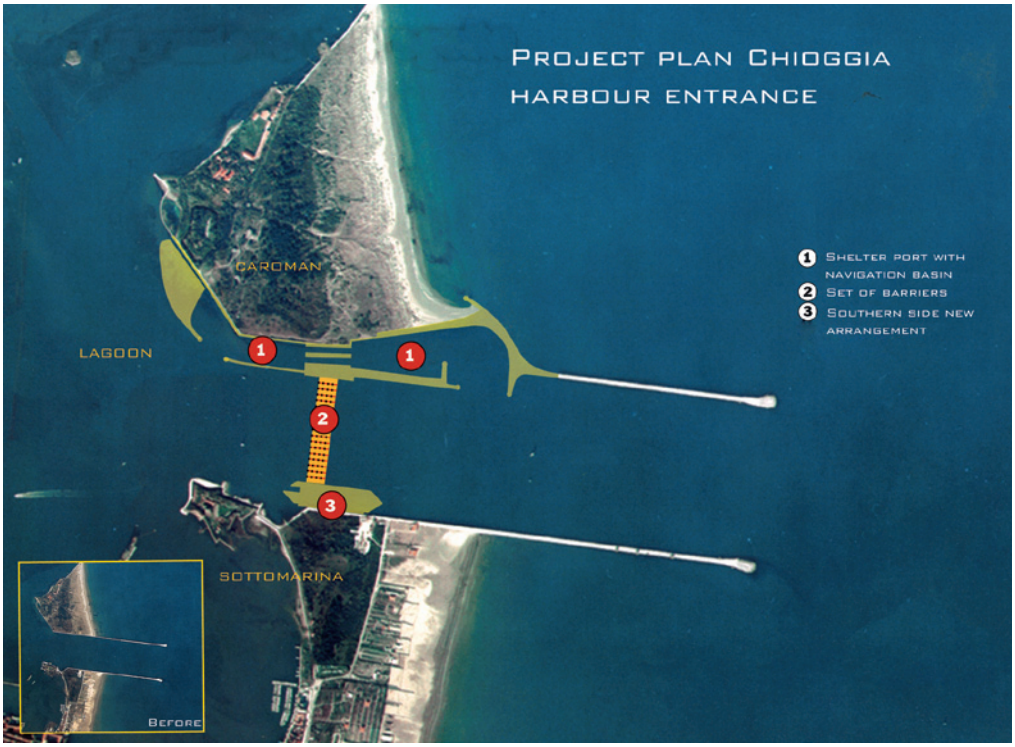




Fig. 1 – Bocca di Porto, Chioggia

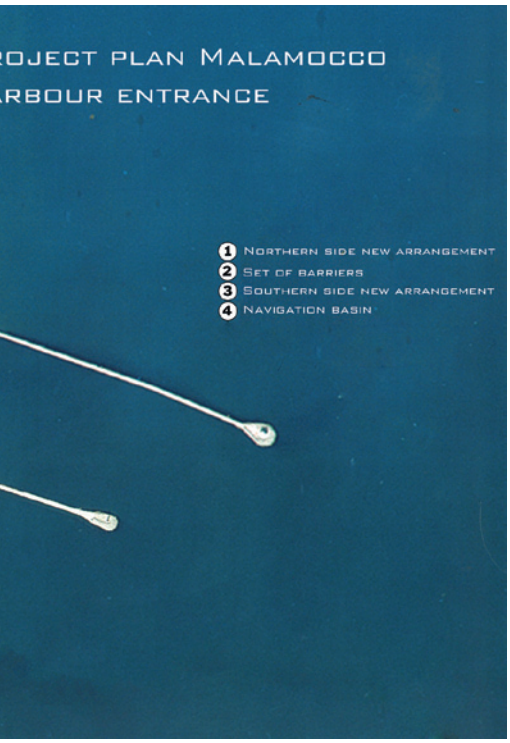
Fig. 2 - Bocca di Porto, Malamocco

Fig. 3 - Bocca di Porto, Lido Treporti

Installation of the MOSE Defense System in Venice

Fagioli performed extremely precise operations in the sea with zero accident

Rudy Corbetta, Francesca Tabloni
Fagioli SpA





Venice has always been hit by frequent high tides throughout the year. Regularly the majority of the city's area is flooded and this leads to Lagoon's inhabitants discomfort and difficulties and to historical and architectural heritage degrade.

A Consortium was created in order to provide a definitive solution to protect Venice from flood. The work is being performed by the Consorzio Venezia Nuova acting on behalf of the Ministry of Infrastructure and Transport - Venice Water Authority. This innovative project is called MOSE, the acronym of Modulo Sperimentale Elettromeccanico (Experimental Electromechanical Module).

The scope of this project is to erect and position artificial dams or barriers which will automatically lift during high tides or flood risk situation. Four barriers are placed in front of three harbor entrances (Bocca di Porto di Chioggia, **figure 1**, Bocca di Porto di Malamocco, **figure 2**, and Bocca di Porto di Lido Treporti, **figure 3** in order to prevent sea streams from entering the lagoon so that to maintain different sea levels inside and outside of the lagoon (**figure 4**).

The integrated defense system is composed of 79 mobile gates which are able to isolate the Venetian lagoon from the Adriatic Sea when the high tide exceeds a fixed level of 110 cm and they can stop the water up to a maximum of 3 m (9.8 ft). The barriers lay in tailor-made caissons on the seabed, filled up with water, until high tides or storms come. The barriers will be floated by filling them up with high pressure air, blocking in this way the stream from the sea to the lagoon and effectively reducing high water levels. **Figure 5** shows how the barrier works in case of high tide.

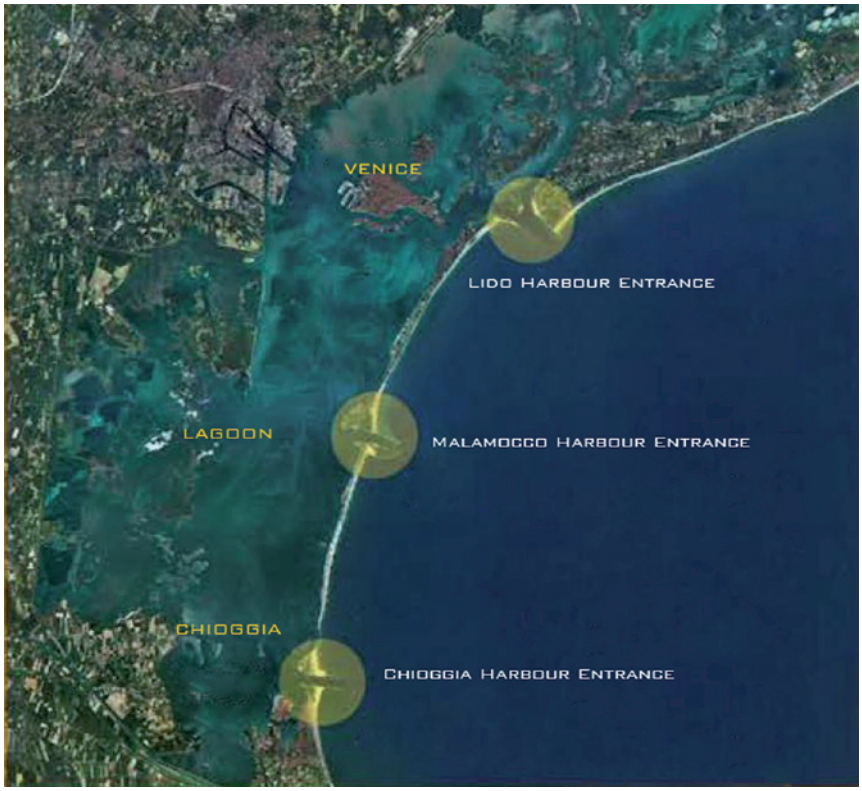


Fig. 4 - View of the harbor entrances

Fagioli project overall description

Fagioli was awarded by Ing. E. Mantovani S.p.a. the contract for different activities related to the transport, and installation of several sections and items

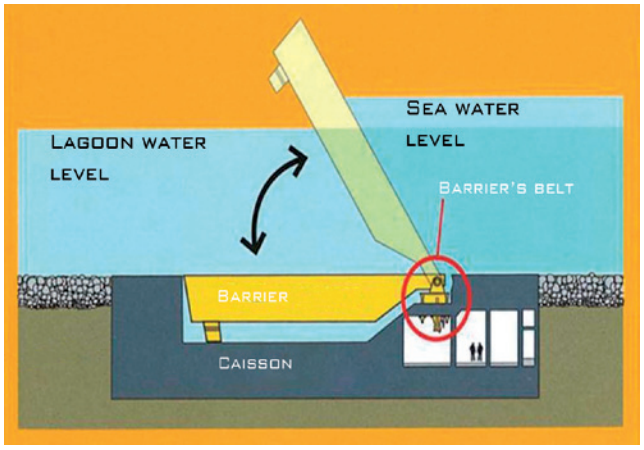


Fig. 5 – How the barrier works in case of high tide



Fig. 9 - Detail of Fagioli gantry lifting system



Fig. 6 - Malamocco Harbor entrance



Fig. 7 - Aerial view of "Syncrolift"



Fig. 10 – Fixed anchor housing



Fig. 8 – Load out of a 600 ton beam by means of SPMTs

composing the MOSE architectural composition. The overall project performed by Fagioli is divided in three main steps:

transport and installation of the main sections for the construction of the "Syncrolift", an "elevator" structure which allowed the launching of the caissons at Malamocco harbor entrance;

building of a specially made catamaran (composed of two group-owned river barges and dedicated crosshead beams) to transport and install the caissons to Bocca di Porto Lido Treporti;

transportation and launching of the first four mobile gates (other mobile gates will be positioned by Fagioli in the next future).



Fig. 11 – Sequence of operations

The Syncrolift

While at Lido Treporti and Chioggia harbors the caissons were built on dried yards which were then flooded with lagoon water at Malamocco harbor there were not enough space to create such a building yard. In order to bypass this problem it was decided by main contractor to install an elevator called Syncrolift which was used to sank the caissons under the water level to allow the sea transport till final destination (**figure 6**, **figure 7**).

The Syncrolift was composed of 57 m long beams (built by Omba) connected side-by-side to create a wide area where the caissons were skidded and lowered into the water. Each beam weighed between 600 and 900 ton with width ranging from 6.5 m to 11.5 m and height of 5 m each.

Fagioli scope of work was the transport of the beams at storage area close to the port, onto the group-owned barge called Mak. Fagioli used special trailers called SPMTs (Self propelled modular transporters) to perform the hauling operations. SPMTs are multi-axle modular trailers designed for the transportation of heavy cargoes with an outstanding transport capacity.

The load carrying capacity of a transporter platform (or group of platforms) is directly proportional to the number of axle line: the capacity of each axle line used for this job was 30 ton. In order to complete the load out of the beams onto the barge Fagioli used 2 × 14 axle lines trailers (**figure 8**). Fagioli was also responsible for the engineering and ballasting operations during load out.

Once the barge arrived at Malamocco the beams positioned onto the SPMTs were turned 90° by the hydraulic system of the trailers. In the meantime Fagioli had already prepared a dedicated lifting system composed of:

- skid tracks;
- 2 × 600 ton capacity gantry lifting system provided with 2 × 300 ton capacity strand jacks positioned on top of it (**figure 9**).

After the rotation of the beams the two gantry lifting system were skidded onto the track in order to connect the beams to the lifting structure with link plates and fixed anchor housings (**figure 10**).

After the connection operations, the beams were lifted by the gantry lifting system (while the barge

Fig. 12 - Lifting of the barge at Cremona river port





Fig. 13 - Transport of the barge by means of SPMTs



Fig. 14 – Crosshead beams



Fig. 15 – Strand jacks

with SPMTs was towed away) and then lowered into the water and connected to the skeleton of the Syncrolift structure (**figure 11** shows the sequence of the operations).

Assembly of the catamaran

Fagioli contractor for the sea transport and installation of the 12,000 ton caissons was Ing. E. Mantovani S.p.a..

Due to the particular weather condition in the lagoon of Venice and to the high and low tides, the summer season was selected as the best period to perform the operation. Fagioli was involved in the transportation and sinking operations of the caissons of Lido Treporti.

One of the most challenging aspects of the entire operation was the initial stage of designing a vessel on which to transport the concrete caissons. After working on a variety of 3D simulations Fagioli eventually settled on building a tailor-made catamaran vessel (Alfa), constructed by securing two 190 ton river barges (39.2 m × 9.7 m × 3.82 m) with a pair of steel cross-head beams.

In order to install the caisson Fagioli's in-house engineering came up with the idea to use two group-owned barges (190 ton each) connected together by two cross-head beams to build a catamaran which could carry the caissons and lowered them into the water. Following the approval for the catamaran's design by the Italian Marine Registration Authority (RINA), both floating barges were lifted at Cremona Port by means of Fagioli gantry lifting system at group-owned quay area (**figure 12**) in order to be moved by means of 2 × 6 axle lines SPMTs to be modified onshore in a storage area close to the port (**figure 13**).

In the meantime in another storage area Fagioli prepared and assembled the crosshead beams (**figure 14**). Three different sections were connected together -including the strand jacks and power pack systems, then they were transported by SPMTs to the quay and loaded onto Ticino river barge (the third barge involved in the project). The crosshead beams were equipped with 4 strand jacks with capacity of 180 t (**figure 15**). In addition other 12 strand jacks with individual lifting capacities ranging from 50 to 300 ton (L50 and L300) were installed in the two catamaran barges.

They left the storage area and were reloaded onto the SPMTs and offloaded into the water by gantry lifting system. The Ticino barge loaded with the crosshead beams was towed into a shipyard followed by the two group-owned river barges which will compose the catamaran structure. In this

shipyard they were painted, renamed “Alpha A” and “Alpha B” and connected with the two crosshead beams by means of a 200 ton crane (**figure 16**).
Fagioli engineered and fabricated a wedge shaped structure to better connect the beams with the two barges offshore (**figure 17**). The set of strand jacks were positioned onto the crosshead beams for lowering the caissons and alongside the barges to drag the caissons from the building yards to the canals, once in position the catamaran was ready (**figure 18**, **figure 19**).

Transport of the caissons and launching operations

The caissons are huge cement structures weighing roughly 12,000 ton each. They were built in a huge dried basin used as building yards (**figure 20**) pretty close to the canal where they should have been placed.
Once ready, the basin was flooded and the caissons started floating, two tugboats dragged the caissons (once at a time) out of the basin in a bigger repaired sea area. The caissons were connected not only to the tugboats but also to four mooring lines resistant propylene wires hooked to four SPMTs (6 axle lines each) on the shoreline as safety procedure (**figure 21**). Once in position the tugboats were disconnected and hooked to the catamaran.
The launching operations consisted of connecting the lifting points of the caissons to the catamaran and proceeded with the so called “secondary mooring system”, a mooring system with pulling strand jacks L50 that was engineered to keep secured the caisson to the catamaran against lateral movement. Once the structure had been connected, the catamaran was pushed by tugboats and joint to a so called “primary mooring system” equipped with strand jacks L300 which allowed the “catamaran and caisson” to reach the designated area for the sinking operations.
Long wires (called “trench axis”) showed the “pathway” or line to follow in order to get out of the basin and reach the precise sinking point (**figure 22**).
Once in position, the floating caissons were ballasted and sunk by using strand jacks positioned onto the crosshead beam on the catamaran. After reaching a certain level during lowering operation, “water cushions” (bags) previously positioned by the civil contractor into the water were opened, “gently” taking the load of the caissons before touching the ground. The bags were then deflating allowing the placement of the caissons at their final positioning (**figure 23**).



Fig. 16 - Installation of the crosshead beams



Fig. 17 - Detail of the wedge shaped structure

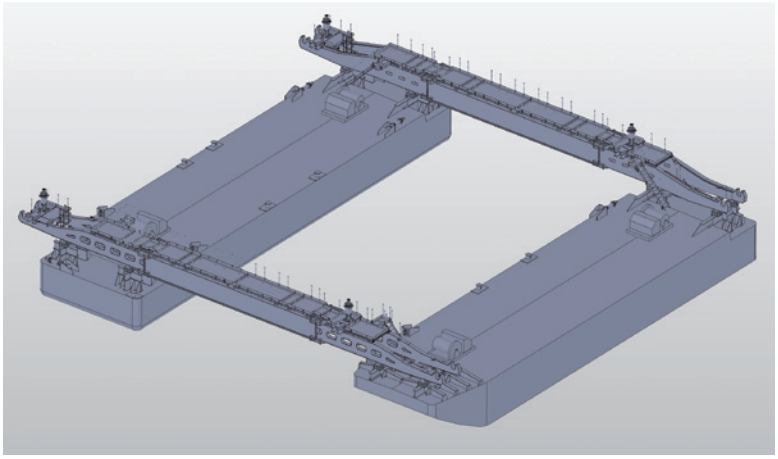


Fig. 18 - 3D Catamaran rendering



Fig. 19 - Fagioli catamaran

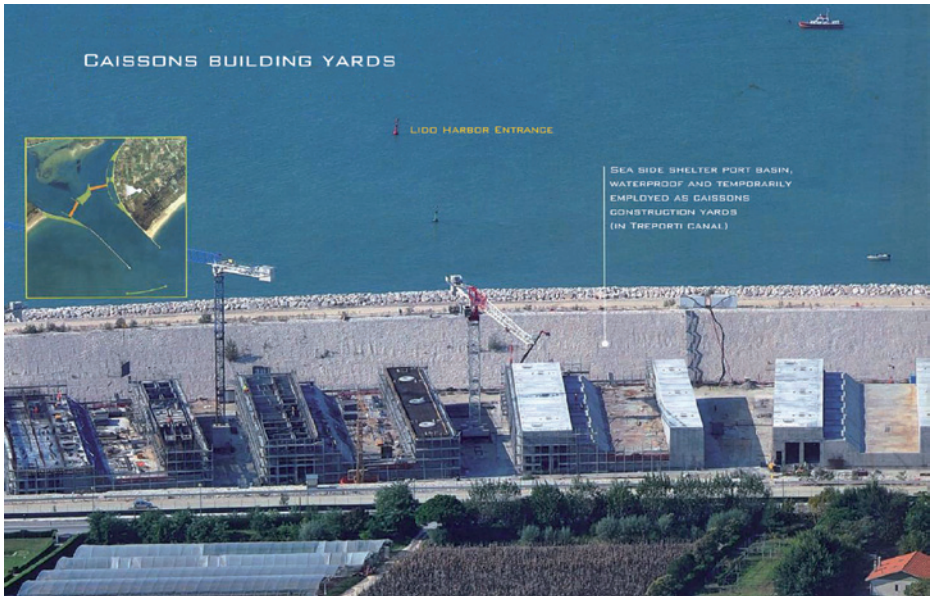


Fig. 20 - Aerial view of the caissons





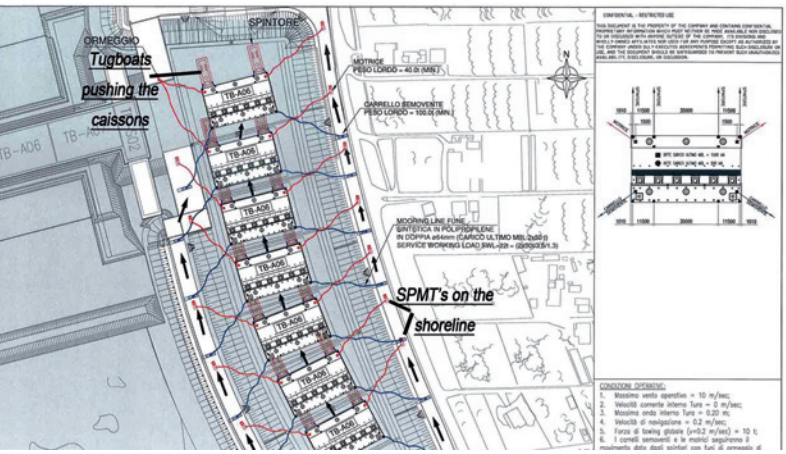




Fig. 21 - SPMTs connected to the caissons to guarantee safety



Fig. 22 - "Trench axis" detail

Transport and positioning of the first four mobile gates

After the installation of the caissons by means of the dedicated catamaran, Fagioli were awarded another high-level engineering operation for the same project: the installation of four mobile gates connected to the huge caissons already installed in the lagoon, which will automatically lift during heavy rains and announced floods.

Fagioli built a tailor made launching gantry structure (**figure 24**) weighing 360 ton made of four towers sections (top frames), two crosshead beams equipped with four L180 ton strand jacks, to lift and position into the water the 210 ton mobile barriers. A lifting beam named "fishing beam", which would be used to hook the mobile barrier, was hooked to the four L180 ton strand jacks on the launching gantry system. The whole structure was moved onshore by means of 14 + 14 axle lines SPMTs (**figure 25**).

In the meantime a barge equipped with four sets of gantries that had been previously fixed, was maneuvered into position ready to receive the convoy. Fagioli SPMTs executed the load out of the whole system onto the barge (**figure 26**).

A second set of SPMTs carried the mobile barrier onto the barge. Then the barge left Marghera port

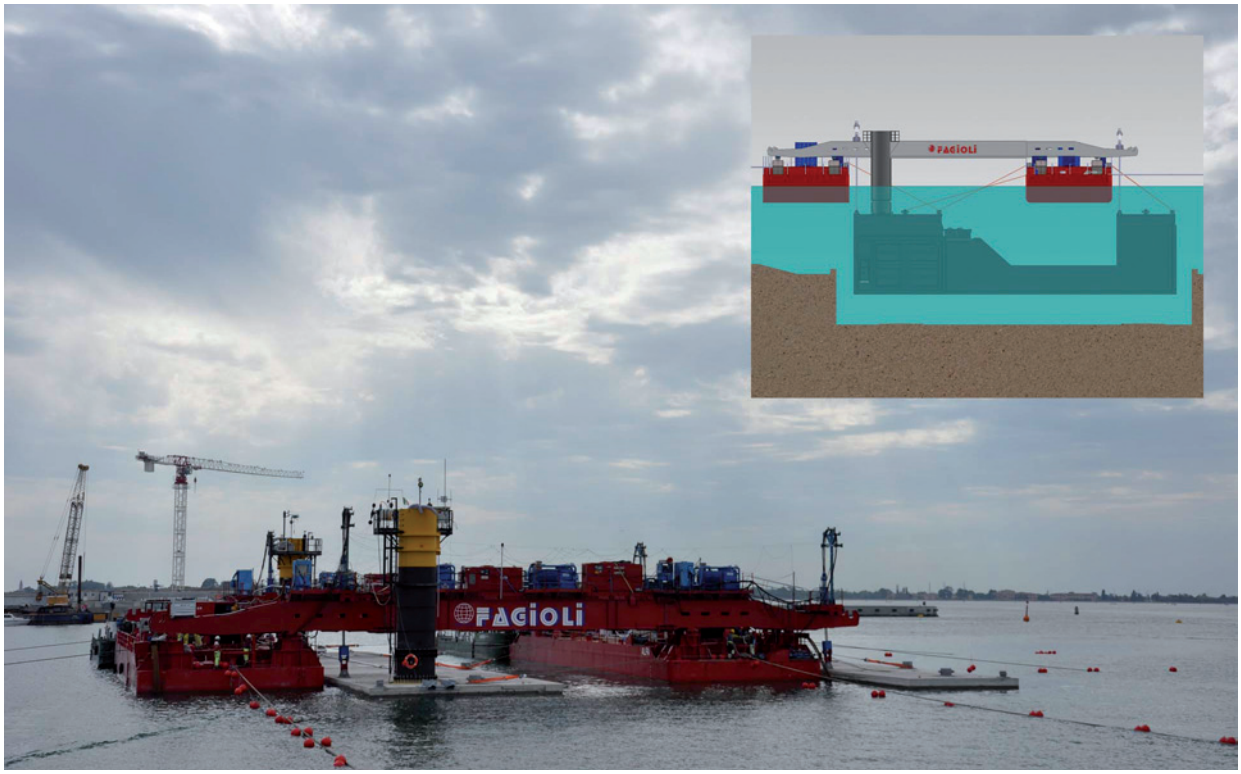


Fig. 23 - Rendering of caissons final positioning



Fig. 24 – Launching gantry structure



Fig. 25 - Load out of the launching structure



Fig. 26 - On to the barge



Fig. 27 - Fishing beam detail



Fig. 28 - Detail of the barrier during installation

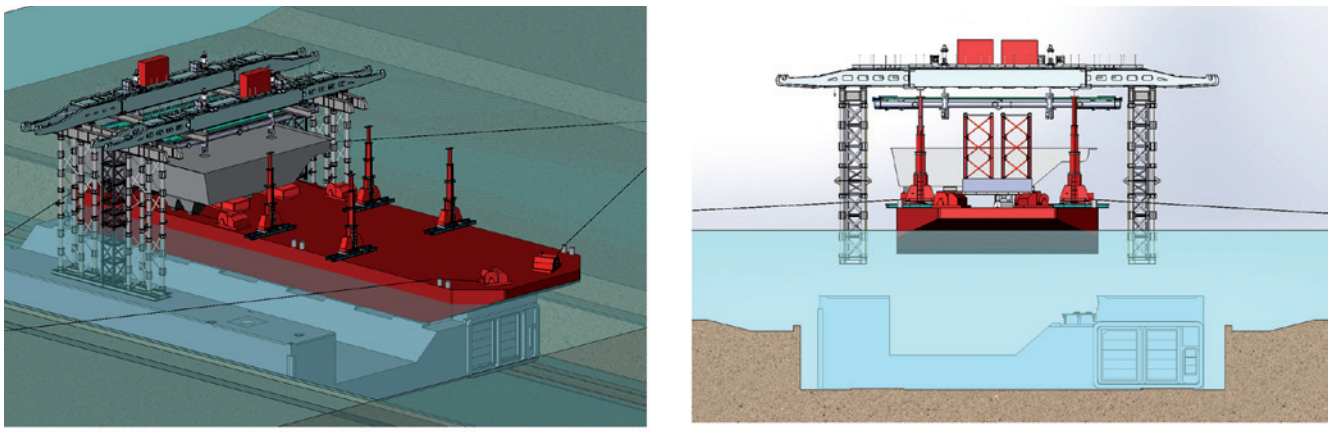


Fig. 29 - Barrier installation sequence

headed to Lido Treporti where another set of tower legs connected to a bottom frame were joined to the four towers sections (top frames) by means of a mobile crane. At this stage the launching gantry structure was lifted by the four fixed gantries then the SPMTs with the temporary supports were removed.

The launching structure was then lowered into the water and laid on the caissons that had been previously positioned by Fagioli on the seabed. Once laid on the caissons, the SPMTs loaded the mobile barrier that was moved under the launching structure and connected to the support structure (fishing beam) (**figure 27**).

After this connection, the area was cleared from the barge and the barrier was lowered into the water by means of the four strand jacks positioned onto the crosshead beams (**figure 28**, **figure 29**). Then the mobile barrier was unhooked from the support structure and fixed to the caisson.

Finally, the barge came back to load the launching gantry system and repeat the whole operation with the other three barriers.

Conclusion

The described operation will definitely represent a landmark in the history of naval engineering and that Fagioli are proud of having taken such a major role. Thanks to engineering and safety studies Fagioli have been able to perform extremely precise operations in the sea with zero accident.

Following the successful installation of the first nine caissons and completion of the two year project including engineering phase, Fagioli won an Esta award (European Association of abnormal road transport and mobile cranes) for “Innovation and Development” for its role in the MOSE project in April 2013.



Rudy Corbetta

Rudy, graduated in “Foreign Languages” at the University of Bergamo, is currently Marketing Manager and Publicity Officer at Fagioli SpA



Francesca Tabloni

Francesca, graduated in “Asiatic Languages, Trades and Cultures” at the University of Bologna, is currently Marketing Assistant at Fagioli SpA, Sant’Ilario d’Enza (Reggio Emilia)

essential.



MarelliMotori®
Group of Companies

www.marellimotori.com

Enhancing Energy Efficiency of Gas Turbines

Mann+Hummel Vokes Air demonstrates the straightforward actions of retrofit to existing air intakes

Thomas Helf, Carlo Coltri
Mann+Hummel Vokes Air

Europe's larger combined-cycle power plants are currently navigating rough seas. Low-cost US coal, renewable energy and economic crisis have all combined to slash the average running hours of plants that utilize gas turbine technology. In this market, energy operators are focused more on flexibility than the efficiency of their equipment.

Nevertheless, there remain a number of smaller gas turbine facilities that are continuing to work baseload. CHP (Combined Heat and Power) and district heating plants are still working with more than 5000 running hours/year and the operators of these plants are definitely interested in energy efficiency.

The main topic that will be discussed in this article is the air intake of a gas turbine (air filtration system) and how it can be improved through the retrofit of existing power plants. Evidences and real case studies will demonstrate the theory, while other aspects such as typical intake problems will also be examined.

Case study 1: Employing a combined prefilter/coalescer

The first case study examines the air intakes of two neighbouring, 250 MW gas turbines. Both intakes had new filters installed in April 2012, but whilst the first turbine had the traditional arrangement of coalescer, prefilter and final filter, the second turbine trialled a new filter which condensed the first two stages into one.

Macrogen GT Duo employs a hydrophobic media that provides effective water removal whilst also delivering particle filtration to G4 or M5 efficiencies. This means that separate coalescer and prefiltration stages are unnecessary and that the redundant filter phase can be removed (**figure 1**).

This situation with two air intakes in near identical environments provided an excellent opportunity to demonstrate the benefits of employing a combined coalescer/prefilter system.

	Stage 1		Pre-Filter		Final Stage
Gas Turbine A	[None]	➔	Macrogen GT Duo M5	➔	F9
Gas Turbine B	Coalescer	➔	Bag Filter G4	➔	Compact F9

Fig. 1 – Effective water removal of gas turbines A and B

Results of Case study 1

The key findings are:

- Macrogen GT Duo exhibited very stable pressure drop performance over the observed period of 4800 running hours, rising from 65 Pa in April 2012 to 90 Pa in late January 2013 (**figure 2**, see graph of gas turbine A);
- gas turbine B's separate coalescer panels required changing after 2000 hours of operation in November 2012 (**figure 2**, see graph of gas turbine B);
- performance of the F9 final filters was very similar in both the air intakes;
- the F9 final filters downstream from the Macrogen GT Duo system ran for a greater number of hours and had a slightly lower pressure drop (105 against 110 Pa) over the trial period;
- this result is due to the fact that the Macrogen has not only reduced the pressure drop but, at the same

time, has increased the efficiency of prefiltration (from G4 to M5) better protecting the final filter;
- the total initial pressure drop of the (Macrogen GT Duo-equipped) turbine A was 165 Pa, significantly lower than turbine B (275 Pa) configured with coalescer pads, G4 bag prefilter and the same F9 final filter.

Other points of note are:
- the behaviour of Macrogen GT Duo was much more stable than the solution with coalescer pads; after nearly 5,000 running hours the total pressure drop was 220 Pa;
- the parallel solution B showed a total pressure drop of 350 Pa after just 2200 hours, at which time it was necessary to change the coalescer panels;
- in December 2013, the filtration system of turbine A was still in service and operating with a low pressure drop.

Previous research has generally confirmed that a 50 Pa saving in pressure drop corresponds approximately to an increase in the efficiency of the turbine of 0.1%.
The chart of **figure 3** summarises the results of the test and the savings regarding pressure drop.
Just considering the initial pressure drop, gas turbine A (with Macrogen GT Duo) has yielded a reduction of more than 100 Pa compared with gas turbine B. This pressure drop saving increased over time, especially as the coalescer pads became dirty and wet.
This means that the gas turbine A has seen an increase in efficiency of at least 0.2%. This was achieved just by changing the filter stages and without any investments in retrofitting. Such performance represents a huge saving for the operator, especially considering that the

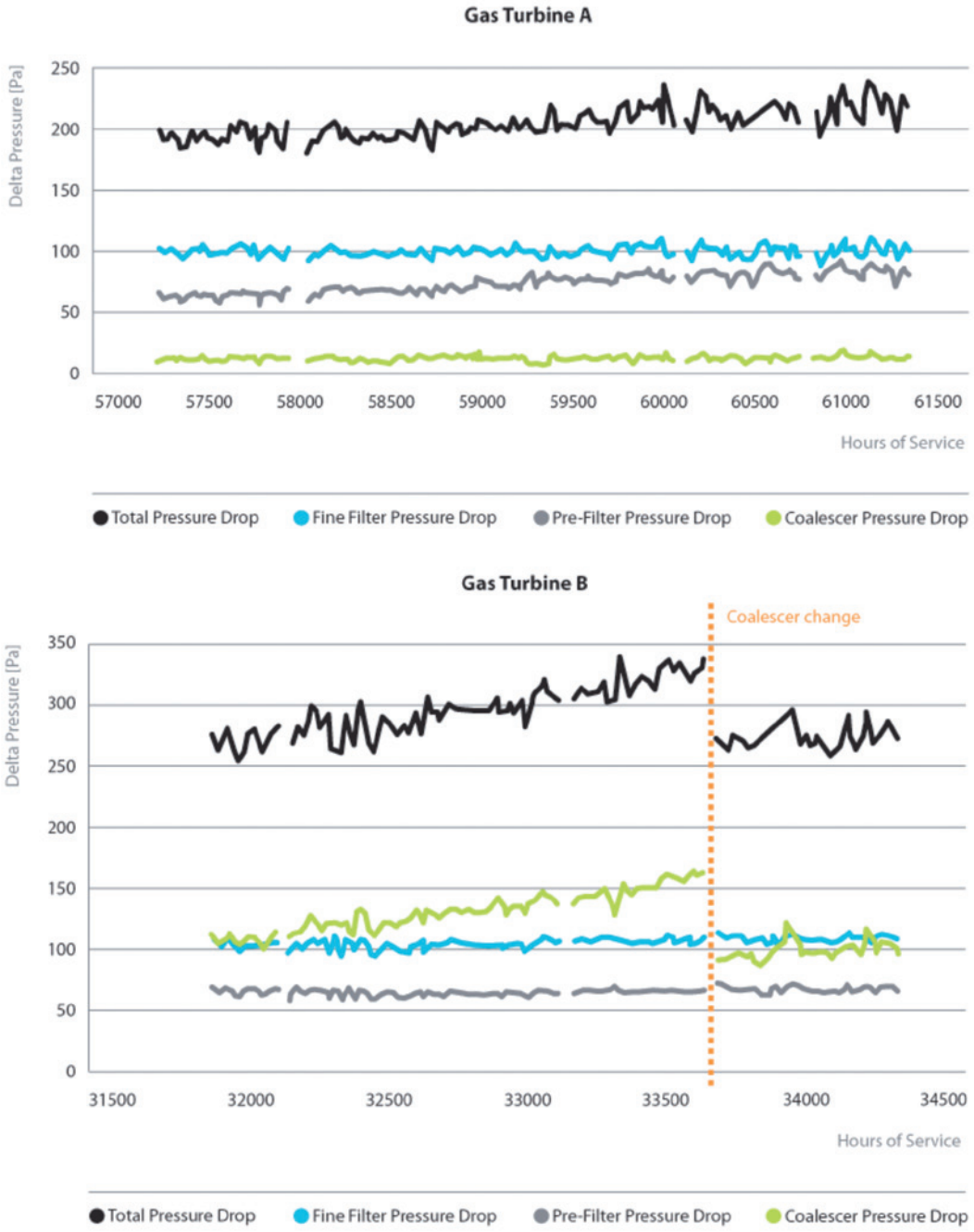


Fig. 2 – Pressure drop performance of gas turbines A and B

Turbine	Filter Configuration	Flow Rate	Initial PD	Final PD
A	Macrogen GT Duo (M5) + Compact Final Filter (F9)	4,250 m³/h	165 Pa	220 Pa after 5000 hours
B	Coalescer Pads + Bag Prefilter (G4) + Compact Final Filter (F9)	4,250 m³/h	275 Pa	350 Pa after 2200 hours

gas turbine is 250 MW in size and running for approximately 5000 hours/year.

Case study 2: Retrofit and upgrade to filter class E11

The following case study will show how it is possible to increase the efficiency of the gas turbine through a retrofit of an air intake with EPA (Efficiency Particulate Air) filtration.

For energy operators, the main benefit of an increase in filter class is reduced fouling of the compressor blades. Less fouling offers an efficiency enhancement of the gas turbine itself, which has been covered extensively in previous publications.

However, a normal retrofit with EPA filters will see an increase in pressure drop brought about by the switch to a higher filtration grade. The following case study will demonstrate how it is possible to carry-out such a retrofit without increasing the pressure drop of the filter system.

The German power plant in this case study had experienced problems with final filters supplied by an international filter manufacturer. In fact, 20% of the final filters installed were damaged as a result of high moisture, dust and low burst pressure of these final filters (**figure 4**).

Experts of Mann+Hummel Vokes Air began with a survey and full analysis of the gas turbine, preparing a solution that optimised the entire air intake – from the weather hood to the silencers. The chart of **figure 5** shows the before and after of the retrofit actions.

The scope of supply of the retrofit included:

- new weather hood with improved performance: from 30 Pa to 10 Pa;
- removal of separate droplet separator (150 Pa saving) with the use of Macrogen GT Duo;
- installation of new filter wall system for a dual-phase compact filter F9 and E11 mounted together (**figure 6**);
- relocation of anti-icing duct to free space for three more filter units;
- new silencers – change from aluminium to stainless steel (**figure 7**);
- sealing and painting of the air intake (inside and outside);
- replacement of the coupler;
- rebuild of the roof construction.

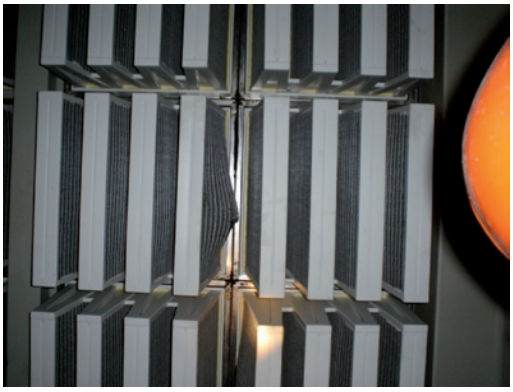


Fig. 3 – Results of the test and the savings regarding pressure drop

Fig. 4 – Burst final filters

Results of Case study 2

The air intake retrofit allowed an upgrade in filter class to E11 and a switch to three filter stages with an initial pressure drop increase of just 20 Pa. Main benefits for the operator are:

- reduced dust penetration to the turbine of approximately 10 g/year, operating 8000 h/year (PM10) with the related efficiency enhancement of the gas turbine;
- filter life of stage 1: one year;
- filter life of stages 2 and 3: from two to three years;
- on- and off-line washing unnecessary.

Based on 3,500 m³/h per filter		Init. Pressure Drop [Pa]	
		Original	After Retrofit
Weather Hood / Bird Grid		30	10
Droplet Separator		150	-
Stage 1	G4 Bag Filter	65	-
	G4 Macrogen GT Duo	-	65
Stage 2	F8 Compact Filter	90	-
	F9 Compact Filter	-	100
Stage 3	E11 Compact Filter	-	180
Total initial Pressure Drop:		**335**	**355**

Fig. 5 – Before and after retrofit actions

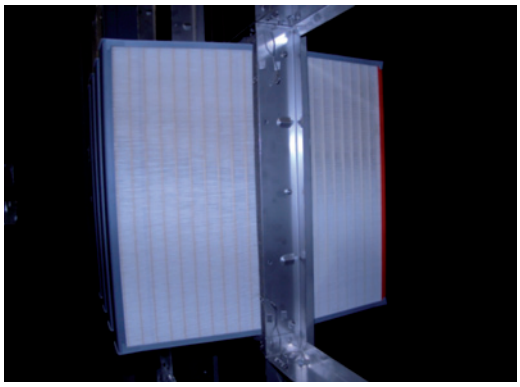


Fig. 6 – Dual-phase compact filter



Fig. 7 – New stainless steel silencers

Other aspects and commonly-encountered problems

Besides air filters, as previously mentioned, there are several technical points that can be improved in an air intake:

- *anti-icing system*: in some cases the anti-icing system is behind the filters, allowing ice to form on the filters. This has a dramatic effect on pressure drop; increasing by up to 2000 Pa. Furthermore, bleeding from gas turbine for anti-icing can be definitely expensive (up to 10 MW during winter) and must be defined very carefully;
- *oil mist close to air intakes*: on the roof of the power plants it is common to find a chimney for oil mist coming from the lubrication system of rotating equipment. If this oil mist is unfiltered by an appropriate system, it will simply enter the air intake and the air filters;
- *air intake too small*: whenever the air intake is too small and the flow rate for each filter element is too high (5000 m^3/h) severe problems with pressure drop are evident;
- *pulse jet cartridges*: this type of filter is extensively used in Middle Eastern desert conditions. Employing pulse jet cartridges in a clean environment can cause a high pressure drop with no benefit to the gas turbine;
- *position of the air intake*: when there is a green-field project for a new power plant, the gas turbine air intakes must be a sufficient distance (or at least not in the downstream wind direction) from dirty, dusty sites. It is also imperative that sufficient space is provided away from the cooling towers, which can wet the filters and increase pressure drop.
-

Conclusions

The two case studies and field experience has shown the huge potential to increase the energy efficiency of gas turbine through a few, straightforward actions of retrofit to existing air intakes.



Thomas Helf

Thomas Helf is Product Manager Powergen & Industrial – Retrofit, Mann+Hummel Vokes Air



Carlo Coltri

Carlo Coltri was born in Milan in 1970; he has a degree in Engineering at Politecnico di Milano.
His experience in Energy business started with KSB Italy (pumps and valves), as marketing manager and as a key account manager for the Business Unit Energy.
Currently holds the position of Country Sales Manager for Vokes Air in Italy, Swedish multinational manufacturer of air intake filters for gas turbines.
Since 2011 he is also responsible for corporate business development of Power Generation Unit for Vokes Air Group.
He is member of steering committee of energy sector of Animp and member of advisory board of Power Turbine Europe.

What you can do



with a touch of blue.

You can...

Improve your refinery profitability by maximizing the production of clean transportation fuels with our leading residue upgrading technologies.

Deliver the best in refinery hydrogen production while reducing your operating costs with our unique Terrace Wall™ reformer design.

Enhance the efficiency of your overall sulfur recovery to achieve peak operating and environmental performance with our SRU technology.

And these are just the technology options. There is so much more you can do with a touch of blue.

FOSTER WHEELER

Visit our website at www.fwc.com



Pilot plant methanation reactors

Substitute Natural Gas (SNG) Pilot Plant in China

A novel technology by Foster Wheeler

Luigi Bressan, Fabio Ruggeri, Letizia Romano
Foster Wheeler



The need to satisfy natural gas demand, by exploiting the coal resources, which in many areas of the world are more evenly distributed and more abundant than gas, has given a great boost to the development of so-called alternative fuels derived from coal gasification: CTL (Coal to Liquids) and SNG (Substitute Natural Gas). In particular, SNG production from coal, that is, for example, still the primary energy source in China, could diversify energy options and reduce the dependency on fossil fuels with their fluctuating prices.

Further advantages of converting coal to natural gas are represented by the fact that SNG can be transported and distributed using existing natural gas infrastructure and it can be combusted in any conventional gas turbine to produce low carbon energy.

The catalytic synthesis of methane from carbon monoxide and hydrogen is described by the following reaction:

$$CO + 3H_2 \leftrightarrow CH_4 + H_2O \qquad (1)$$

Carbon dioxide can also be converted to methane according to

$$CO_2 + 4H_2 \leftrightarrow CH_4 + 2H_2O \qquad (2)$$

Both these methanation reactions are strongly exothermic (even if CO_2 methanation is less exothermic than CO methanation), therefore high methane yields require or are favoured by low temperatures and high pressures.

Methanation processes are characterized by a large amount of heat released during methanation, and so the main issue to be faced during the design of a methanation process is the control of the reactors' temperature by means of an efficient heat transfer system [1]. The optimal heat recovery of the reaction heat from the methanation reaction is also a critical aspect [2].

Methanation processes are characterized by a large amount of heat released during methanation, and so the main issue to be faced during the design of a methanation process is the control of the reactors' temperature by means of an efficient heat transfer system

Generally methanation catalysts have to work in a reaction temperature range between 250-600 °C, while properly stabilized catalysts can tolerate temperatures up to a maximum of 700 °C.

To moderate the exothermic methanation reaction temperature several techniques can be envisaged: the recycling of products, the dilution with inert or steam, otherwise the installation of isothermal reactors. The main drawback of CH_4 recycle is the need for recycle compressor which represents a significant part of the investment cost and of the overall power consumption, and complicates the scheme of the system.

A typical conceptual scheme of the standard methanation process is reported in **figure 1**.

The VESTA process

In this field, Foster Wheeler has developed a simple methanation process, called VESTA, using catalyst provided by Clariant, Foster Wheeler's partner in SNG technology.

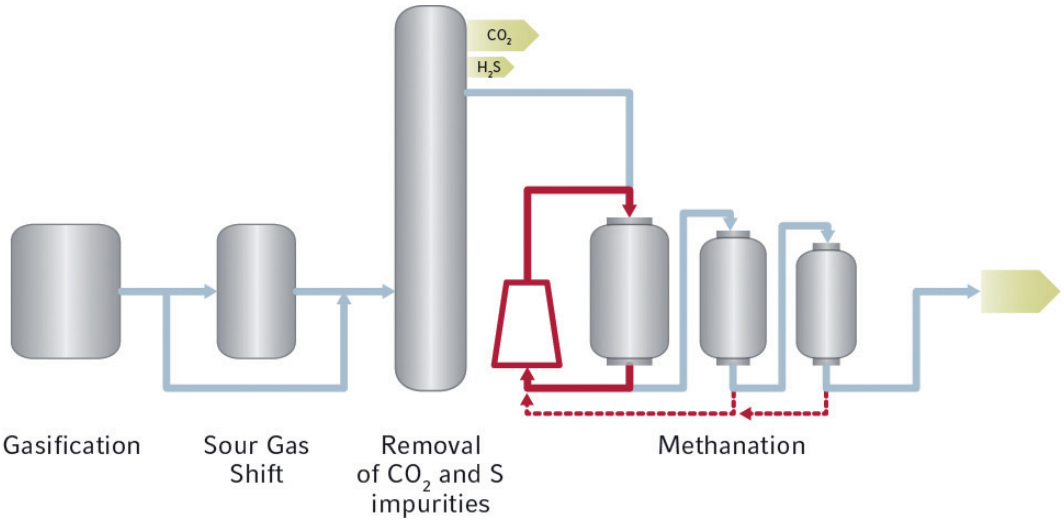


Fig. 1 - Block diagram for the SNG production standard process

As well as in all methanation processes, syngas (mainly composed of CO and H_2, but also H_2O, CO_2, CH_4 and N_2) must be purified before the methanation process, to remove organic contaminants (e.g. tar), inorganic contaminants (H_2S, NH_3 etc.) and particulate matter. This purification is aimed at the removal of all contaminants with particular attention to the separation from syngas of sulphur (H_2S or COS), the presence of which leads to the irreversible deactivation of the catalysts used in the downstream processes [3]. In contrast, in the VESTA process, unlike competing technologies, CO_2 removal from syngas is not required; the CO_2 can be left in the process gas, so that it may act as temperature moderator, and be removed only after the SNG production section (**figure 2**).

Sulphur-free syngas from AGR unit is routed to sweet shift reactor in which the high temperature water gas shift reaction is accomplished on ShiftMax® 120 catalyst beds (3):

$$CO + H_2O \leftrightarrow CO_2 + H_2 \quad (3)$$

The stream leaving the shift reactor is sent to the methanation reactors where the reaction (4) takes place over Clariant's SNG 5000 catalyst beds:

$$CO + 3\,H_2 \leftrightarrow CH_4 + H_2O \quad (4)$$

This reaction is highly exothermic, therefore it is carried out across a series of reactors with interstage heat recovery. Reaction runaway conditions, in methanation process, are the major concern. In the VESTA process this risk is avoided by the presence of CO_2 that acts as a thermal flywheel and moderates temperatures. Temperature control is one of the reasons why Foster Wheeler chose to remove the CO_2 not upstream but downstream of methanation section. This strategy eliminates the need for reaction gasses recycle (solution proposed and used by competitors) and its associated compressor. This choice reduces the high capital and operating costs associated with the recycle compressor; furthermore, the CO_2 recovered downstream of the methanation section could have a higher purity than that recovered from the syngas upstream and may be used for other industrial purposes.

Process description

The heat recovered by the cooling of the reaction is exploited for the production of steam. By thermal integration, the steam required for the process (sweet shift reactor) is produced, but a significant amount can be exported. The thermal integration is designed and optimized in order to meet the customer's requirements: the production of medium or high pressure (saturated or superheated) steam and low pressure steam at the same time, if

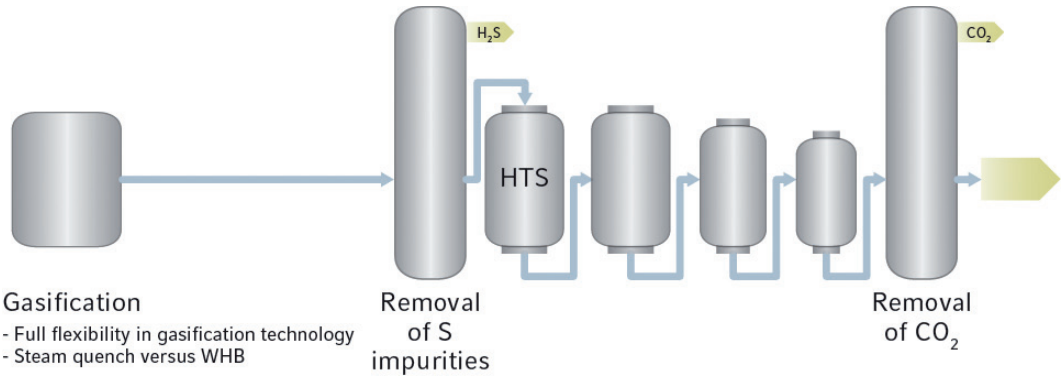


Fig. 2 - Conceptual scheme of the Foster Wheeler VESTA process

possible. The plant designed by Foster Wheeler has a very simple process scheme that facilitates excellent performance both in terms of SNG product and steam exported. The plant performances were modelled with commercially available process simulators, with the reactor performances regressed on the basis of reserved laboratory data measured by Clariant.

Conceptual scheme of the Foster Wheeler process is represented in figure 2.

After sulphur impurities removal in the acid gas removal (AGR) unit, syngas is sent to the methanation section, in a once-through operation with no gas recycle: the system consists of a shift reactor followed by three methanators in series. After being cooled, the raw SNG coming from the third methanator is routed to the CO_2 removal section, to improve the SNG quality and to make it suitable for natural gas grid specification. If required, the SNG composition can be refined adding a further methanation reactor.

A flexible process

The plant shown allows the production of 2 billion Nm^3/year of SNG (composition shown in **table 1**).

Notably the plant is not only thermally self-sufficient but also allows export of high and low pressure steam as quantified in **table 2**.

The most important feature of the VESTA process is its great flexibility: it can handle syngas of a variety of compositions coming from different sources such as coal, biomass, petroleum coke and solid waste.

In particular, the use of biomass feedstock, a carbon-neutral fuel, is an opportunity to reduce greenhouse gas emissions; several technologies are available and sufficiently mature for commercial application [4, 5, 6].

This technology is also a possible solution for refineries where coke disposal is a problem or for refineries that do not use delayed coking units because they are concerned about coke disposal. The petcoke [7] can be gasified to produce SNG, which can finally be used for internal refinery consumption or distributed outside the refinery fence.

To demonstrate this VESTA SNG production technology, Foster Wheeler and Clariant are erecting a pilot plant in Nanjing, China, which is expected to be in operation at the end of May 2014. The pilot plant was designed for a capacity of 100 Nm^3/h of SNG produced and includes all reactors in order not only to verify the chemical reactions but also to completely simulate a real plant. Foster Wheeler has signed a cooperation agreement with Clariant International AG and Wison Engineering Ltd to build the pilot plant to demonstrate the Foster Wheeler VESTA SNG technology. According to this agreement Wison Engineering is providing engineering and construction services, Foster Wheeler has licensed the technology, and Clariant will supply the proprietary catalyst. The cooperation agreement also sets out a framework for long-term cooperation to deliver and build methanation plants based on this technology in China.

Gas composition	% mol
H_2	0.10
CO	0.00
CO_2	0.10
H_2O	0.00
CH_4	99.30
N_2	0.30
Ar	0.20
H_2S + COS	0.00

Table 1 – Reference conditions and composition of the SNG produced by the VESTA process

Parameters	Low pressure steam	High pressure steam
Temperature (°C)	sat.	sat.
Pressure (barg)	3.5	90
Mass flow rate (ton/h)	150	294

Table 2 - Typical exported steam production

Although the process has not yet achieved commercial references, nevertheless the technology is based only on well-proven equipment (fixed bed reactors, shell and tube exchangers etc.) and the catalyst, a nickel-based catalyst, has already been extensively tested by Clariant. Clariant has significant experience with the production of many commercial nickel-based catalysts and is the lead supplier for this many of these applications. The methanation catalyst used in the process is a newly developed catalyst and exclusively available for the Foster Wheeler/Clariant VESTA cooperation and its customers. The chemistry of this catalyst has been optimized to meet the high quality standards demanded by the new application.

Conclusion

Foster Wheeler is able to produce up to 2 billion Nm^3/year of SNG with a single train, without the presence of a recycle compressor.

With reference to the electrical energy consumption, the VESTA process does not need a recycle compressor (that, in standard process schemes, typically recycles about 90% of the first reactor effluent), this delivers significantly lower electrical power consumption within the SNG section. With reference to the steam production, the process is able to recover about 90% of the heat released by the reactions, producing high pressure superheated steam.

The main advantages of the scheme in terms of capital expenditures are related to the absence of a recycle compressor and to the utilization of low alloy steel for all the reactors, instead of high alloy steel (or refractory walls) required by conventional processes. The low alloy steel is a suitable choice for reactors because of the milder temperature conditions, compared to the standard processes, and due to the absence of the risk of metal dusting, thanks to the properly selected operating condition which also enable a negligible formation of coke [5, 7].

All these characteristics allow a substantial reduction in the investment cost and make the plant cost-competitive in comparison with competitors.

However, the process is made unique by a characteristic even more important than those listed up to this point: the process is designed to be intrinsically safe, because runaway reactions cannot occur.

These features make the VESTA process a very attractive option for the market and Foster Wheeler is ready for its commercialization.

References

[1] *Ulmann's Encyclopedia of Industrial Chemistry* - 5th completely revised edition - VHC Verlagsgesell schaft mbH, D-6940 Weinheim, Federal Republic of Germany, 1989

[2] http://www.syngasrefiner.com/SNG/agenda.asp

[3] Higman C., Van Der Burgt, M.: *Gasification*- Burlington, MA: Gulf Professional Publishing Elsevier, 2003

[4] Domenichini R., Collodi G., Mancuso L., Hotta A., Palonen J.: *Biomass Gasification for the Production of Substitute Natural Gas (SNG): A Practical Route Through Available and New Technologies* – IChemE, Advancing Chemical Engineering Worldwide, 2012

[5] Ruggeri F.: *The Novel Process VESTA for Substitute Natural Gas Production* - Gasification Technology Conference, Washington, 2012

[6] *La Gasificazione delle Biomasse per la Produzione di SNG* (Substitute Natural Gas) - ATI Conference: "Bioenergie: dove siamo? Con quali mezzi affrontiamo il futuro", Milano, 2010

[7] Bressan L., Collodi G., Ruggeri F.: *SNG VESTA. Substitute Natural Gas (SNG): a Valuable Option for Countries where Coal Resources are Prevailing* - Coal to SNG, Urumqi, 2013



Luigi Bressan

Luigi Bressan is Director of Process and Technology in Foster Wheeler in Italy. A graduate in Chemical Engineering, he has been with Foster Wheeler since 1976. His experience covers process design of refinery and chemical units, utilities and offsites systems and power stations.

In addition to his expertise, he has been involved in the optimization and design of combined cycle and integrated gasification combined cycle power plants from the very beginning of their appearance on the market. Luigi's duty is also to assess available technologies for Foster Wheeler worldwide. He is a member of several National and International Committees and author of many papers.



Fabio Ruggeri

A graduate in Chemical Engineering, he has been with Foster Wheeler since 2006. His experience covers process design of refinery and chemical units and he is author of several papers. He is leader of the Hydrogen Technology Group in charge of continuously improve the hydrogen technology. Fabio is also involved in the development of SNG technology.



Letizia Romano

A graduate in Chemical Engineering, she has been with Foster Wheeler since 2013. Letizia is involved in the development of SNG technology.

MAUS ITALIA

CERTIFICAZIONE DI SISTEMA QUALITÀ ISO 9001 DNV

CERTIFICAZIONE DI SISTEMA SICUREZZA OHSAS 18001 DNV



Choose the best tool for heat-exchangers maintenance





www.mausitalia.it



- Tube bundle extraction
- Tube bundle trasporting
- Tube bundle cutting
- Tube bundle cleaning
- Tube bundle inserter
- Tube bundle testing

- Tube cutting
- Tube extraction
- Tube plugging
- Tube expanding
- Tube-to-tubesheet TIG *orbital* welding



Please send a fax or an E-mail
to receive the technical catalogue

Maus Italia
26010 BAGNOLO CREMASCO (CR) ITALY
SS PAULLESE KM 30
TEL +39 0373 237014 - FAX +39 0373 237039
e-mail: expo@mausitalia.it

...delivering Excellence since 1936

COOLING TOWERS, AIR COOLED CONDENSERS



Energy efficient and highly performing

- Cooling Towers
- Air Cooled Condensers
- Air Fin Coolers

Service

- Maintenance, Revamping and Upgrade
- Spare parts supply
- Global Service & Online remote monitoring System

SPIG S.p.A. • Ph. +39 0322.245401 • Fax +39 0322.245499 • info@spig-int.com • P.zza San Graziano 31, 28041 Arona (NO) • ITALY
www.spig-int.com

Air Cooled Condenser for a Geothermal Power Plant

Spig technology for a plant based on organic Rankine cycle in Turkey

Gabriele Micciché, Marianna Caputo
Spig SpA



Fig. 1- Geothermal binary plant project at Pamukören, Turkey

The Spig Group is a leading global player specializing in the design, engineering, manufacturing, supply and service of cooling towers, air cooled condensers and air fin coolers. Spig cooling systems have been provided worldwide, since 1936 for applications ranging from oil refineries, chemical and petrochemical complexes to district cooling, geothermal power plants etc.

With regard to geothermal power, the global market is expanding rapidly and according to the latest report published by the Geothermal Energy Association, it is expected to grow substantially, reaching a 14,000 MW worldwide capacity, by the end of the current decade. Kenya remains the world's most important developing market, with Turkey being recognised as an extremely promising emerging country, with a current installed capacity of 163 MW.

Spig capabilities to satisfy the geothermal requirements date back to 1977 when a 10,600 m³/h design water flow wooden cooling tower was installed at one of the Italian energy giant Enel, geothermal fields. More recently, Spig expertise has been deployed for a 212 MW and a 45 MW geothermal power plants in Kenya and in Turkey, respectively. Over the years some 260,000 m³/h of water have been successfully processed by Spig cooling systems, for geothermal power application.

Spig capabilities to satisfy the geothermal requirements date back to 1977 when a 10,600 m³/h design water flow wooden cooling tower was installed at one of the Italian energy giant Enel, geothermal fields

Spig contract in Turkey

Turkey has committed to a target that 30% of its total energy comes from renewable sources by 2023. The power generation industry forward looking strategy is over and over aimed at sustainable and environmentally sound development. In recent years several energy plans have been developed to prioritize the local production of energy from wind, hydropower and geothermal sources by local companies and emphasize the need for improved energy efficiency in the country. Currently, Turkey

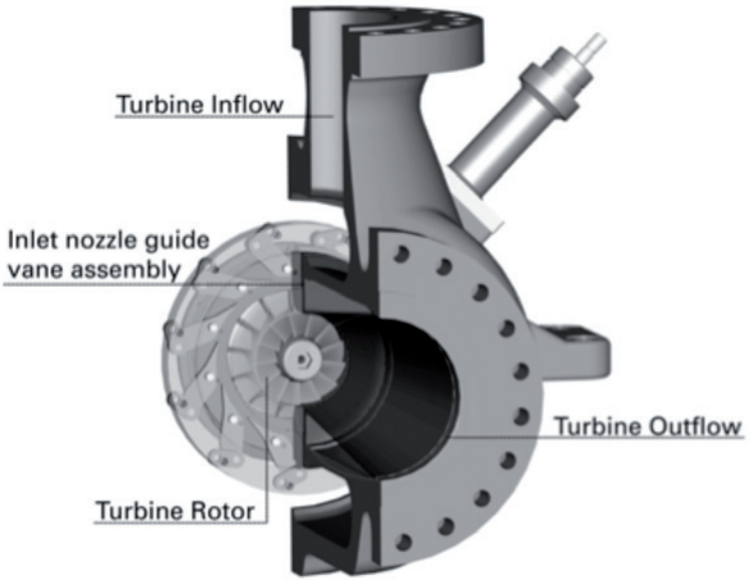


Fig. 2 – Atlas Copco turboexpander with variable inlet guide vanes

has some 59 geothermal projects under development and 310 MW under construction.

In this context, geothermal projects investments are becoming an attractive option to replace fossil fuels and Pamukören Geothermal Electric Power Project testifies this trend.

The consortium worked in synergy to guarantee a reliable and outstanding job, achieving the plant optimization and high performance, according to contractual obligations. In 2013, the customer confirmed its satisfaction selecting the consortium for an additional 80 MW geothermal plant to be developed and executed in the next future

Back in 2011, a consortium led by the Gas and Process Division of the Swedish company Atlas Copco and its partners process-design expert exergy and air-cooled condenser specialist Spig won a geothermal contract for the construction of a binary geothermal power plant to be delivered in the Aydın Province, Aegean Region of Turkey (**figure 1**).

The order from Celikler Jeotermal Elektrik Uretim A.S. of Turkey includes two turbo expander generator trains which is able to deliver 2 × 22,5 MW of clean energy. Pamukören 1 and 2, using Organic Rankine Cycle (ORC) technology, have been built in the geothermal field at Pamukören, a high potential growth region for geothermal energy. This is the first geothermal plant in Turkey equipped with radial inflow turbines, two identical units with two expanders each. This will also be by far the largest binary cycle plant in the country. The radial turbine design of Atlas Copco, the heart of the plant, is an excellent match for the requirements of an ORC based power plant. Being equipped with variable inlet guide vanes that are ensuring that the angle of attack of the flow on the leading edge of the rotor blade of the turbine is kept correct, even if the flow changes. (**figure 2**). This ensures a constant turbine rotational speed and therefore constant power production. Even in off-design conditions, efficiency and performance only decrease slightly.

The consortium worked in synergy to guarantee a reliable and outstanding job, achieving the plant optimization and high performance, according to contractual obligations. In 2013, the customer confirmed its satisfaction selecting the consortium for an additional 80 MW geothermal plant to be developed and executed in the next future.

Spig air cooled condenser tecÚology

Spig was chosen to design and supply the air cooled condenser serving the 45 MW geothermal binary plant project at Pamukören geothermal field (**figure 3**), using ORC technology based on butane fluid. The condenser is composed of 28 bays with a total 56 fin tube bundles. Each bay includes 2 axial fans supplying cooling air to the bundles (two bundles for each bay). The bays are arranged in two parallel units, each unit includes two sub-unit installed in parallel, each one include 7 bays with

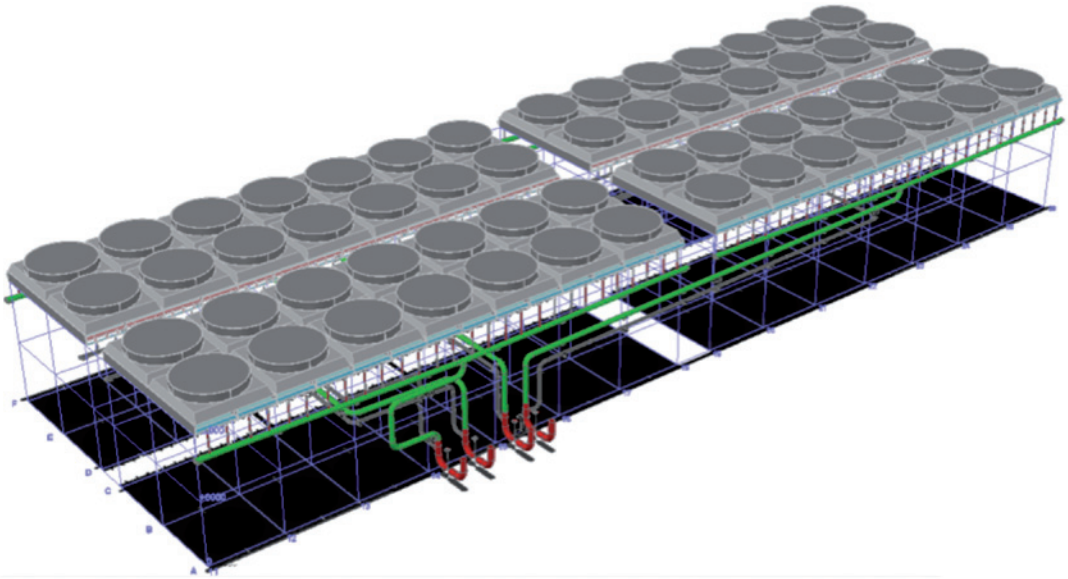


Fig. 3 - Spig air cooled condenser for Pamukören geothermal binary plant project

14 bundles and 14 fans group induced draft execution.

The condenser horizontal arrangement, purposely studied for this geothermal application, is composed by tube bundles obtained from carbon steel round tube diameter 1 inch with aluminum fins, mechanical bond of fins with core tube can be achieved by embedded technology Gfin type, tube sheet and header, welded type, in carbon steel material, tube to tube sheet welded joint type. The tube bundles are complete of side frame and bracing supports in carbon steel material hot dip galvanized surface protection.

The main purpose of the tube bundles is to condense the vapour and collect the condensate back to the condensate tank. All the equipments were supplied in order to operate in a classified area as per Atex standards. Given the harsh and highly corrosive geothermal environment, Spig's engineers have considered special materials and surface treatments for all the relevant components. Spig designed the supporting steel structures, steam manifolds and condensate piping considering the seismic area in which the air cooled condenser is installed. The overall air cooled condenser has been designed in order to respect the noise emission limits according to the local project requirements.

The Spig Group welcomes and takes pride of this achievement in the fastest growing Turkish market where it is playing an important role, in both wet and dry Technologies, supported by its local operation Spig Soğutma Sistemleri Tic Ltd Şti.

Spig in Turkey

The Spig Group has an outstanding track record in Turkey where is actively and successfully operating by providing highly performing and environmentally sound cooling technology suitable for a diverse array of applications including thermal power plants, petroleum refineries, petrochemical industry, steel mills, sugar refineries, food industry, district cooling etc. Spig clientele is supported locally by Spig Soğutma Sistemleri Tic Ltd Şti to offer a prompt assistance for both new projects and service requirements.

Spig Soğutma has been instrumental in the award of several cooling contracts having as scope of supply cooling towers or air cooled condenser. Among the most noteworthy dry cooling projects the company has been recently involved in, is the 850 MW combined cycle gas turbine power plant equipped with state of the art single row tube technology, using 42 cells, in Turkey. A 2 × 22.5 MW geothermal ORC application using dry technology in a 56 cell installation and a 13.2 MW geothermal power plant deploying a 40 cells air cooled condenser were completed the last year, in Turkey (**figure 4**).



Fig. 4 - Spig air cooled condenser for geothermal application, Turkey

Moreover, two energy efficient, customized Fiber Reinforced Plastic (FRP), wet cooling towers cooling 14,400 m³/h, each serving a 2 × 135 MWe coal fired power plant to come online the first quarter of 2014, should be also mentioned. A natural draft cooling tower processing 29,600 m³ of water per hour, to be designed and installed at a 360 MW power plant has been awarded the last year to Spig Soğutma.

In the recent years Spig supplied also 25.200 m³/h design water flow natural draft cooling tower for an oil refinery and a 3 × 25,000 m³/h concrete cooling tower operating at customer fullest satisfaction, at a 6 × 165 MW coal fired power plant in Turkey.

When it comes to process cooling technology both wet and dry, Spig Soğutma has an impressive experience, and a consolidated position in the country, confirmed by the many prestigious projects successfully accomplished for the most renowned local players.

Spig experience in geothermal

The Spig Group has had a significant presence in geothermal application since the nineties of the last century, when developing its business with Enel, the Italian energy leader, owning and operating several geothermal fields, in Italy. Through that successful relationship still existing between the two players, Spig had the opportunity to study and design the most advanced solutions, suitable to cope with each specific requirement. In fact, Spig provided Enel with several highly performing customized cooling towers for a total 160,000



Fig. 5 - Spig cooling tower for geothermal power plant, Kenya



Fig. 6 – Spig cooling tower for geothermal power plant, Turkey

m^3/h, in geothermal projects.

Over the years Spig consolidated its capabilities and know-how, becoming one of the leading cooling systems providers, for geothermal application. Nowadays, SPIG is also present in the two most sparkling geothermal markets, Kenya and Turkey.

In Kenya Spig is supplying the cooling towers which will serve Olkaria I Units 4 & 5, 2 × 70 MW geothermal power plant and Olkaria IV Units 1 & 2, 2 × 70 MW geothermal power plant. As per the scope, the cooling technology leader will provide the customized design, engineering, manufacturing, testing and delivery of four field erected Fiber Reinforced Polyester (FRP) cooling towers, 8 cells each for a total design water flow of 70,000 m^3/h, equipped with low clog film fill (**figure 5**).

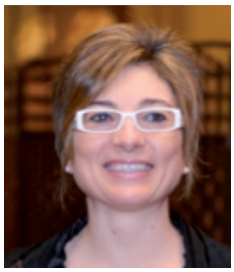
In Turkey as well, Spig is playing a prominent role by providing the above described Pamukören project and 13.2 MW geothermal power plant using a 40 cells air cooled condenser, both deploying dry cooling technology. Moreover, 25,000 m^3/h design water flow, fiber reinforced polyester cooling towers are operating in the Aegean Region for geothermal power plants (**figure 6**).

At Spig, state of the art solutions are readily available to support flagship geothermal projects and guarantee benefits in terms of high performance of the plants, long life operation, low mainte nance, energy efficiency and water conservation.



Gabriele Micciché

Gabriele graduated in 2007 in Aerospace Engineering at Palermo University, Italy. After three years of experience in the thermal engineering division of an international group providing cooling systems, as Sales Engineer first and then in the R&D department. He is actually in charge at Spig as Sales Engineer.

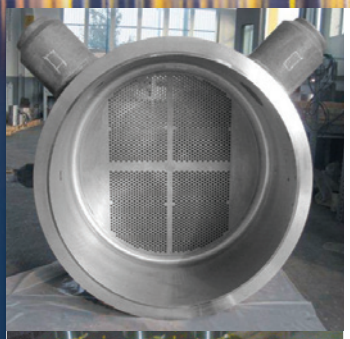


Marianna Caputo

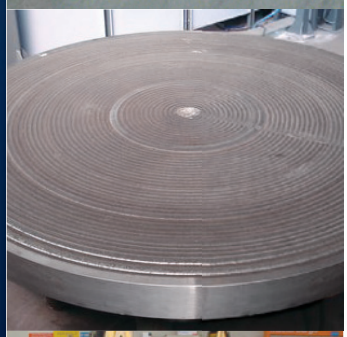
Marianna graduated in Political Sciences at the University of Pavia and then obtained a Marketing and Sales Management B2B master diploma at SDA Bocconi, in Milan. She is in charge as Marketing Manager at Spig SpA. She has been working with Spig since 2001, coordinating the marketing activities, supporting the sales team and contributing to the Spig Group positioning in the global markets.

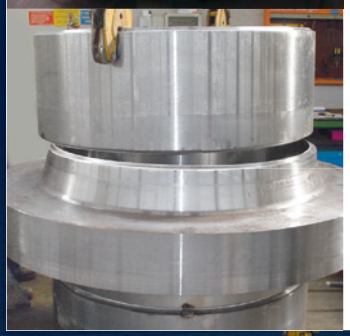
Memit
FORNITURE INDUSTRIALI





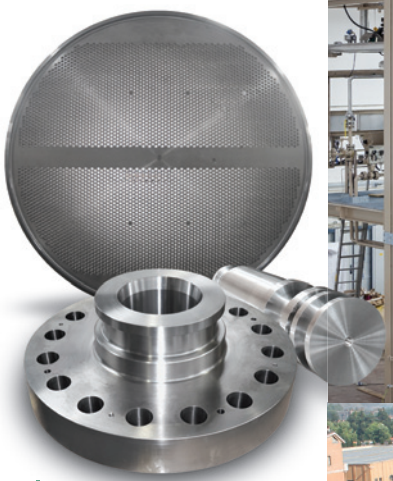






Nozzles, flanged nozzles and self-reinforced nozzles. Tubesheets, special pieces with cladding, anchor flanges. Olets, spectacle blinds, orifice flanges, valve components & quick opening closures.

Through our associates, we supply: tubes for heat-exchangers, bi-metal tubes, pipes, bars, discs, rings and fittings in Copper and Nickel Alloys, Duplex, Superduplex and Titanium.



Memit
FORNITURE INDUSTRIALI

Memit Srl
Via Alla Chiesa n.45,
20030 SENAGO (MI)
Tel. +39.02.99058656/657
Fax +39.02.99051889
www.memitsrl.com











EMPOWERING YOUR PROJECTS





Complete electrical and instrumental turnkey projects as customer requirements
Design and contruction MV/LV substations-MV/LV switchgears
Complete Industrial Automation Systems
PLC, SCADA, HMI software development
Industrial Weighing Systems

COSTRUZIONI ELETTROTECNICHE CEAR s.r.l. Via Monza 102 20060 Gessate - Mi - Italy
Ph. +39 02 929290.1 Fax. + 39 02 92151670 e-mail: info@cearsistemi.it - internet: www.cearsistemi.it

Neutralisation Package Unit in a Chemical Plant in Jordan

Cear realized a turnkey electrical and automation system to guarantee service reliability and easy installation

Alessandra Ranno
Marketing Manager, Costruzioni Elettrotecniche Cear s.r.l.



View of JIFCO plant

In the context of large chemical plants, supply, power and control systems play a determining role and facilitate optimising the performance of operations in the entire process plant. This applies not just to "megaplants" but also to single packages which form part of a more complex system.

Costruzioni Elettrotecniche Cear has been working for more than thirty years in electrical engineering and automation to assist process and plant engineering companies and has many times encountered the most diversified international plant needs ranging from material handling and storing chemical materials to the chemical treatment of substances derived from the main process.

As experts in the electrical and automation fields, it is not enough to simply provide electricity and instruments, it is both fundamental and necessary to act as a client's partner, to learn about processes and to propose, if necessary, solutions that meet their needs and those of end-users. This applies specifically to the realization of the phosphoric acid (P_2O_5) and sulphuric acid (H_2SO_4) plant in Jordan (1500 t/day of phosphoric acid and 4500 t/day of sulphuric acid) and related facilities at the Eshidiya site, which is still under construction, for FLSmidth Italy Mineral Processing. Cear in fact created a complete automation system for the FSA (Phosphoric Sulphuric Acid) neutralization package utility.

Cear began work in 2012 and is currently in the process of providing on-field support and supervision for installation, commissioning and start-up. This however was essentially a "turnkey" operation including:

- the development of customised electrical, instrumental and control system engineering;
- design and manufacturing of power & control shelter and electrical equipment (MCC, PLC control panels, VFD panels),
- automation software development for PLC & Scada systems;
- supply of field junction boxes, local control panels, electrical and instrumental cables and, finally, earthing material.

The engineering and design study started with a P&I process engineering document, which was discussed with our client and from which the following key requirements emerged:

- service reliability;
- the "high" availability of an automation system;

The engineering and design study started with a P&I process engineering document, which was discussed with our client and from which the following key requirements emerged



The power & control cabin

- reduced installation time for the power and control room;
- simplification and ease of use of the operator / control system interface (HMI / Scada).

Redundancy for service reliability

Operational continuity was achieved by an engineering design that aimed to maintain a state of system redundancy in terms of both electrical/ instrumental supply.

On the electrical engineering side, to ensure power to the system even in the event of a power failure and to prevent interruptions in the production process, Cear designed an automatic switching system between the main network and a generator powered backup network.

Power distribution and motor control is provided by a Power Motor Control Center (PMCC) with withdrawable units; when set up correctly, this solution provides optimum continuity of service as well as simple inspection and maintenance procedures for the motor control centre units.

The PMCC with its withdrawable units was specially designed so that the system can constantly analyse voltage and frequency values on the two incoming lines. In the event of a fault on the main incoming line, the generator starts and the breaker switches open to provide network requirements. When power is restored, the main line automatically returns to its initial configuration.

In any case, the user can also have the option to switch the networks manually at its own discretion, through the use of a security key.

> In the event of a fault on the main incoming line, the generator starts and the breaker switches open to provide network requirements

On the other hand, redundancy of the control system was achieved by using two CPU (Central Processing Units) and redundant distributed periphery from a separate UPS (Uninterruptible Power Supply) system which guarantees power even in the event of a power failure at the plant.

The aim of this technical solution was to keep the reliability of “high” automation.

In the event of a failure of the main control unit, a backup unit takes over operating the system. This means that production and control can continue and real-time faults, errors and interruptions in communication can be controlled.



Inside the cabin

Easy to use automation system

The automation system was designed using the latest generation software solutions and international brand names that can be easily found anywhere. The system acquires data, monitors and controls a variety of functions and remote processes from a centralised location in the power & control room inside the plant.

The automation software collects data on process “statuses” and “measurements” from a large number of points in the plant system. This data is sent to a single data centre (PLC) which quickly puts together a large number of parameters that are displayed on the Scada system in manner that is intuitive for the operator.

This means that the end user can have the following information in real-time:

- the dynamic display of electrically and electronically controlled device status;
- the possibility of manually controlling all other electric and electronic devices;



A view of the MCC

- the possibility of sending commands and plant management programs using the function keys on the operating console with guided menus from the relevant video-graphic page;
- main plant parameter display and settings;
- access to automatic and manual plant control functions with several password levels;
- the acquisition, display and archiving of alarms in compliance with ISA directives;
- signals relating to plant working status and controlled devices;
- production report.

The control room designed for fast installation

All the power and control panels, switchboards (PMCC, PLC control panel and VFD panels) and the Scada station were placed in a containerised power & control room. The ISO Standard-High Cube 40 foot container was designed for extreme environmental conditions such as deserts where there is a high degree of temperature changes. The container was completely insulated and designed with backup air conditioning to provide the electrical equipment inside with insulation from outside temperatures and to ensure good operating conditions.

The choice of containerised solution offers multiple benefits not only in terms of cost compared to a prefabricated control room, but also in a considerable reduction in the time required for both installation and whole system testing.

The fully equipped containerised power & control room comes out of the factory fitted with electrical panels and auxiliary equipment which means that all the power equipment and power and control panels are subjected to an integrated FAT (Factory Acceptance Test) procedures in which every single function of the automation system is simulated and tested to minimise the margin of error that may occur under normal conditions during SAT (Site Activity Test) activities.

Once tested, the container is shipped to the field where it only needs to be mounted on suitable plinths and be connected to the power grid.

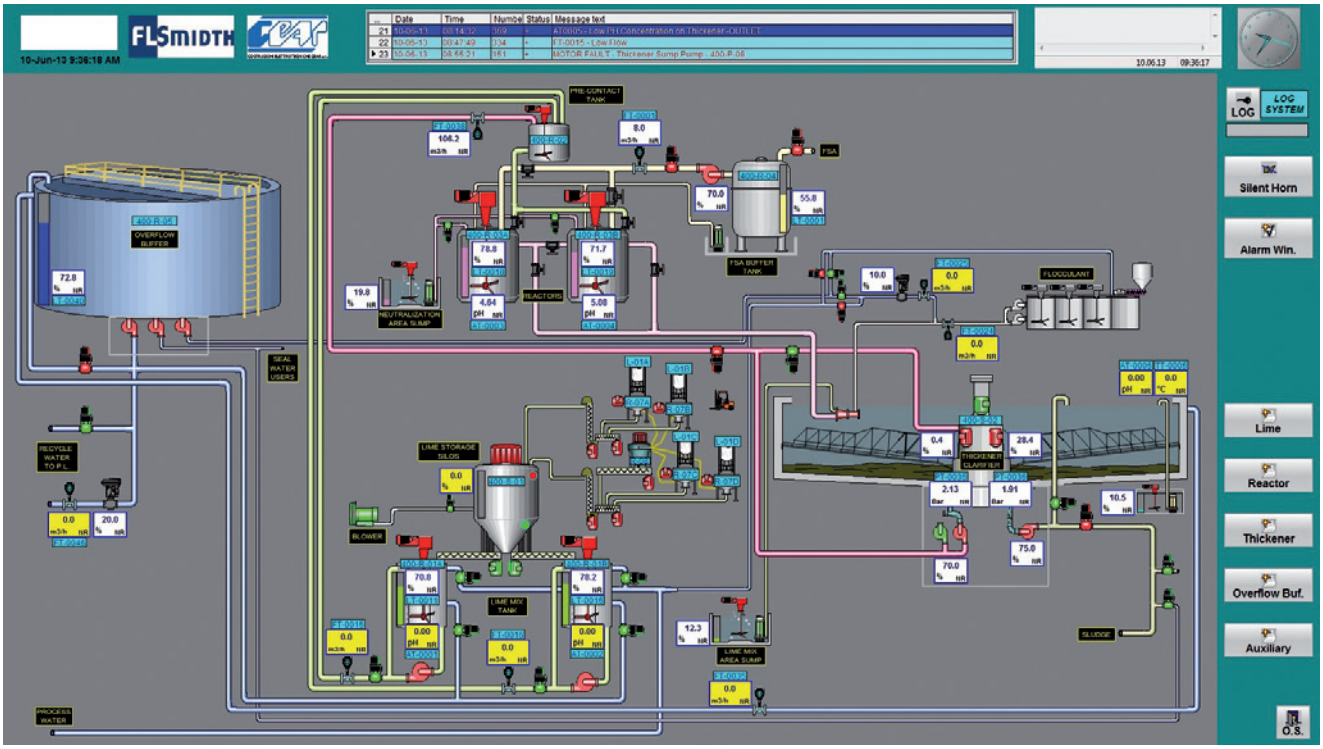
Choice of field materials for an aggressive environment

As regards the engineering plant, further measures were put in place to ensure continuity of service. The choice of electrical and instrumental equipment for the field is crucial when the severe desert environment is taken into account.

It was decided to use armoured cables with high performance insulation to prevent potential mechanical or other failures due to extreme

The Scada station





A detail of HMI

temperatures or acid vapours. The cables were laid in different zinc coated steel ducts depending on voltage and function.

The control stations and junction boxes installed in the field are also made of AISI 304 stainless steel which is highly resistant to corrosion.

Conclusions

A system with high reliability and low installation costs designed to minimise installation times and margins of error before and during installation in the field. The benefit of supplying containerised solutions not only makes economic sense, it also involves direct contact with the end user with a shared goal of analysing and solving electrical and plant engineering problems to produce an integrated solution. This also minimises the misunderstandings that can so easily arise when dealing with multiple suppliers. Such "turnkey" projects involve only three parties: the end user, you and Cear, the System Integrator.



Alessandra Ranno

Alessandra has studied Languages and Communication, then graduated in Marketing & Communication at the University of Milan. She's in Cear since 2010 and she's in charge as Marketing Manager for coordinating marketing activities, implement international markets and support sales team.

gruppo rem

Nidec

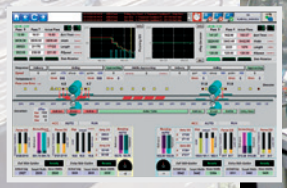
All for dreams

Laminatoio a freddo, Cina

Il nostro cliente sognava di diventare leader nella laminazione a freddo per soddisfare la crescente domanda interna e al contempo cercare di ridurre l'impatto sull'ambiente.

Nidec realizza.

ARTICS, il nostro sistema di controllo real time è stato progettato per garantire la massima sicurezza e la migliore qualità produttiva. I nostri ingegneri e project managers hanno contribuito alla realizzazione di questo nuovo impianto con una produzione annua di 5-7 milioni di tonnellate di ferro zincato.





Pulpito di controllo

Li Hua sogna di sostituire la sua vecchia lavatrice con un modello di ultima generazione, dalle migliori prestazioni in termini di efficienza.

Nidec ASI, trasformare sogni in risultati.

Nidec ASI

ARTICS Industrial Automation

Answer DRIVES

SISTEMI INDUSTRIALI

www.nidec-asi.com


Proud to be here
ANSALDO
ENERGIA
ansaldoenergia.com

International Plant Achievements in the Energy Sector

Ansaldo Energia recent projects: a 825 MW combined cycle power plant in Turkey and a thermoelectric power station in Egypt

The articles in these pages have been prepared by the Ansaldo Energia Press Office on a joint basis with the company's sales and project management offices

Turkey: more power, more efficiency, more satisfaction



The photographs on this page and in the following one show various stages in the construction of the combined cycle power plant built by Ansaldo Energia in Istanbul's industrial zone

On July 13, 2011, the contract came into force for the construction and maintenance of an 825 MW combined cycle power plant in Kocaeli-Gezbe, an industrial district in Istanbul. The plant entered commercial service on December 20, 2013: two and a half years to build a plant designed to work on a cyclic and even daily basis, to the highest thermal efficiency standards and with the minimum environmental impact. The plant is fired by natural gas and satisfies all the requirements stipulated by the Turkish electricity grid.

Ansaldo Energia was in full charge not only of the construction of the main rotating machinery, but also of the design work, the purchase of all plant components, transport, civil works and electromechanical erection, commissioning and testing.

The plant consists of two AE94.3A gas turbines (class F) with the relative electric generators (model TRY-L56) and an RT-30 steam turbine with the relative generator (model TRX-L56), all manufactured in the Ansaldo Energia workshops. The other main components were procured from third parties: two heat recovery steam generators, an air condenser, three step-up transformers, an electric substation, a gas reduction station and auxiliary systems. The civil works and erection activities were contracted out to leading local companies, which were also asked to supply components produced on the Turkish market.

Ansaldo Energia also helped finance the project, investing about Euro 86 million for a 40% stake in the project company Yeni Elektrik Uretim AS on a joint basis with majority shareholder Unit Investment N.V., an accredited operator on the Turkish electricity market.

Plant construction was completed on schedule and the main milestones included grid synchronisation of the first gas turbine on June 22, 2013 and, a month later, the synchronization of the second turbine. The





Table 1 - Values measured during warranty trials

	Values guaranteed (by contract)	Values obtained (during warranty trials)
Net combined cycle power (MW)	**825**	**827.30**
Combined cycle yield (%)	**57.90**	**58.33**

steam turbine was synchronised on September 25, 2013 and the plant entered commercial service on December 20, 2013 after receiving provisional acceptance from the Turkish Energy Ministry.

The values measured during warranty trials were better than the contract values, as illustrated in **table 1**, and can be summarised as: more power, more efficiency and more satisfaction for both company and customer.

The improved performance achieved translates into fuel savings, benefitting both the customer and environmental resources.

The plant also perfectly satisfied the stringent requirements of the Turkish grid code, according to which every gas turbine has to be able to deliver a 15 MW increase in power in one minute in response to primary demand (i.e. to support the grid in the event of unbalanced power conditions), whereas in the case of secondary demand, which is a service sold by the plant operator to the grid operator, the plant showed that it had the capacity to supply 260 MW in five minutes. Both these requirements are extremely demanding and, among the various manufacturers who bid for the contract, only Ansaldo Energia successfully managed to certify all these performance criteria in Turkey.

> Plant construction was completed on schedule and the main milestones included grid synchronisation of the first gas turbine on June 22, 2013 and, a month later, the synchronization of the second turbine

Egypt: “fast-track” plant construction is the key to success



Ansaldo Energia has been working in Egypt since 1983, building both substations and hydraulic and conventional steam power stations. A new golden period began at the end of 2007 when Ansaldo supplied steam turbines and condensers for the El Atf and Sidi Krir combined cycle power plants, both rated 278 MW.

Then, in 2011, Ansaldo Energia won a contract to supply 4 steam turbines for the Giza North and Banha projects, with a total capacity of approximately 1100 MW. In March 2011, the Genoa-based company was awarded a turnkey (EPC) contract for the fast-track supply of four AE94.2 gas turbines rated 150 MW for the 6th October Power Project (600 MW open cycle). Ansaldo Energia completed the project according to a very short timetable of just 14 months.

In 2011, Ansaldo Energia won a contract to supply 4 steam turbines for the Giza North and Banha projects, with a total capacity of approximately 1100 MW

In June 2013, Ansaldo Energia was awarded the 6th October Power Project Extension contract worth over Eur 240 million by the Cairo Electricity Production Company, a subsidiary of the Egyptian Electricity Holding Company.

The 6th October Power Project Extension is located inside the fenced-off area around the High Voltage Lab, 25 km from Cairo. The plant is situated next to the existing one, which was completed according to a very short contract timetable in 2012, with warranty period expiring in July 2014. This rapidity was one of the main factors in the customer’s decision to renew its confidence in our company. The new 6th October Power Project Extension will offer the possibility of completing the combined cycle plant in the future by adding the steam turbine generator and air condenser system.

With this new order, Ansaldo Energia confirms its North African leadership in the supply of open cycle plants, with a total of twenty seven units delivered in the area since 2007.



Various views of the “6th October” open cycle power plant built by Ansaldo Energia in just 14 months, next to which the Genoa-based company is already working on the construction of a new plant

The 6th October Power Project Extension consists of the following main equipment:

- 4 gas turbine generating units with all necessary turbine auxiliaries (Ansaldo holds EPC responsibility); these 4 gas turbines will deliver 600 MW at the generator terminals;
- the necessary auxiliary equipment includes a

natural gas reducing and handling facility (EEHC holds responsibility for engineering, procurement, construction and commissioning) and 220 kV GIS (Gas Insulated Switchgear) switchyard facilities (Ansaldo holds EPC responsibility);

- natural gas will be used as the primary fuel and solar oil as the secondary fuel.

Work on the new thermoelectric power station will, once again, be completed in just 14 months. This "fast track" approach, as it is known, is increasingly common in this geographical area, where plants have to generate electric power in the shortest possible time to satisfy demand driven by rapid economic development in these countries. Ansaldo Energia has transformed this requirement into a point of strength, for which it is gaining a growing reputation on markets.

This new order confirms the excellent relations between Ansaldo Energia and the Egyptian Electricity Holding Company, to which the Genoa-based company has supplied plant and equipment totalling about 3,000 MW over the last three years

This new order confirms the excellent relations between Ansaldo Energia and the Egyptian Electricity Holding Company, to which the Genoa-based company has supplied plant and equipment totalling about 3,000 MW over the last three years.

Diego In - 2011



Steel Industry
Oil & Gas
Infrastructures
Cement Factories









Industrial
Furnaces



Energy
Transportation
Environment





On-Site
Services





Process & Plants
Automation





Industrial
Software

Electrical &
Control Panels

THE ART OF CREATING PLANTS

PRISMA®
Impianti

Via Asti, 7 | Basaluzzo | AL | Italy | T: +39 0143.48.98.91 | info@prismagroup.it | www.prismagroup.it



Fig. 1 – Export oil pipeline pump (BB5)

Centrifugal Pumps for an Offshore Platform

Termomeccanica supplied 14 pumps for the Greater Stella offshore FPF1 platform facing many design and management challenges related to the specificity of the project

Cesare Nardini
Termomeccanica Pompe - TMP

Within the development program of the Greater Stella oil & gas field, Ithaca Energy awarded Petrofac the refurbishment of the FPF1 platform which will be carried out at Remontowa Shipyard, Gdanz, in Poland.

The refurbished platform will be assigned to the offshore processing and export of hydrocarbons extracted from the Greater Stella field, located in the UK's Central North Sea continental shelf; the end user is a joint venture between Ithaca Energy, Dyas and Petrofac itself.

Termomeccanica Pompe scope of works is the design and supply of the 14 centrifugal pumps to be installed on the PFP1 platform, comprising 2 export oils pumps with their booster pumps, 3 circulation pumps and 7 utility pumps.

The installation of the pumps was completed last March and the start of operations with the pumping of oil for within the end of 2014.

Main oil export pumps & booster pumps

The export of oil is carried out by two BB5-type pumps (**figure 1**) (Termomeccanica MESB 150.11 model), each coupled with a 1.5 MW electric motor working under inverter. The use of the inverter is necessary so as to guarantee the pump working range under the various conditions expected during the development of the oil field, for a flow rate of 170 m^3/h with the head ranging from 1350 m to 2073 m, obtained by increasing speed from 2720 rpm up to 3280 rpm.

The use of the inverter has also proven necessary to increase the pumping pressure so as to remove the wax obstructions that may be generated during pumping stop at the typical North Sea temperatures, with the possibility to reach up to 2584 m at 3564 rpm with a flow rate reduced to 120 m^3/h.

The 2 export oil pumps are coupled with two OH2-type pumps (**figure 2**) (Termomeccanica 100AP50 model) working as booster. Both the main and booster pumps are provided with double pressurized mechanical seals with API Plan 53/b.

On top of the typical design issues that usually mark offshore projects, additional requirements from Petrofac Engineering, such as the installation on three-point baseplates and the blast load resistance design for both the main and booster pumps, have increased the contract design complexity (**figure 3** and **figure 4**).



Fig. 2 - Export pipeline booster pump (OH2)

It is also important to remember that this project stems from the refurbishment of an existing platform, with already defined spaces and a pre-existing hull, which will moreover operate in rough sea conditions. The combination of these additional project-specific factors entailed a further increase of the supply's

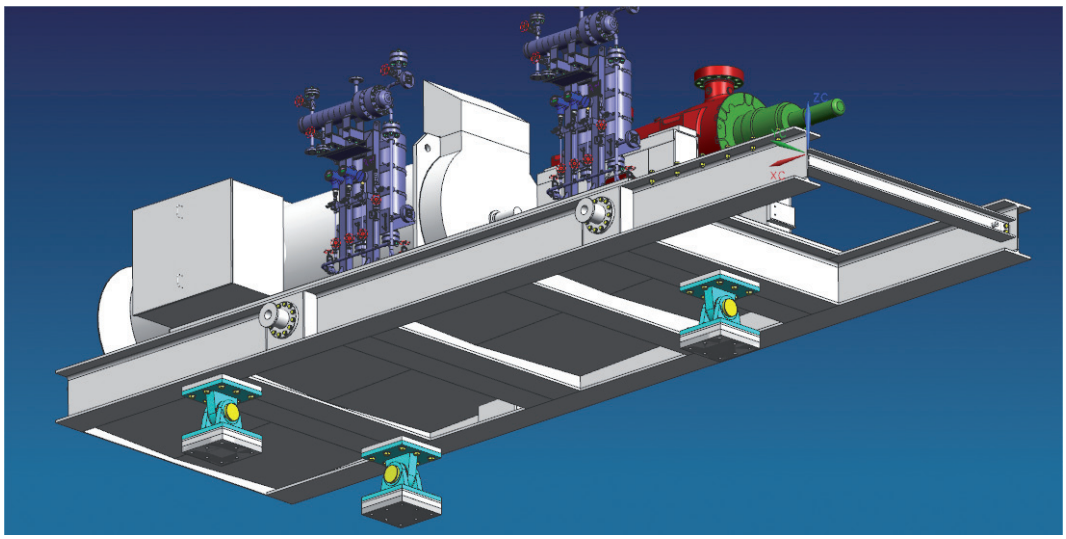


Fig. 3 – Base plate, general arrangement: bottom

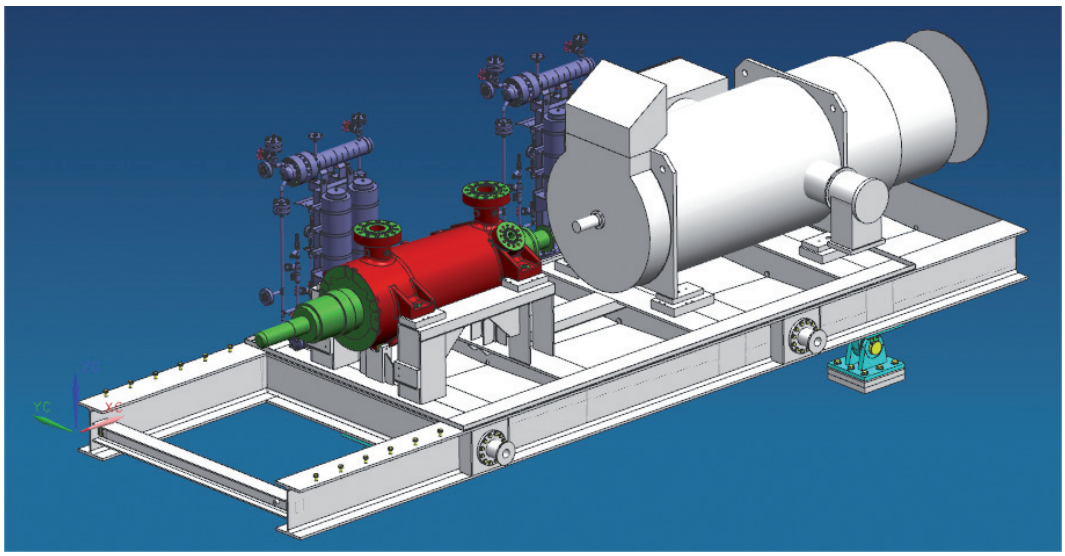


Fig. 4 - Base plate, general arrangement: top view

design complexity. In fact, design not only had to be adapted to the particularly limited spaces available but it also had to take into account the tight constraints of vessel motion specification on structural elements and accessories; design further had to take into consideration interface loads higher than usual for this type of application.

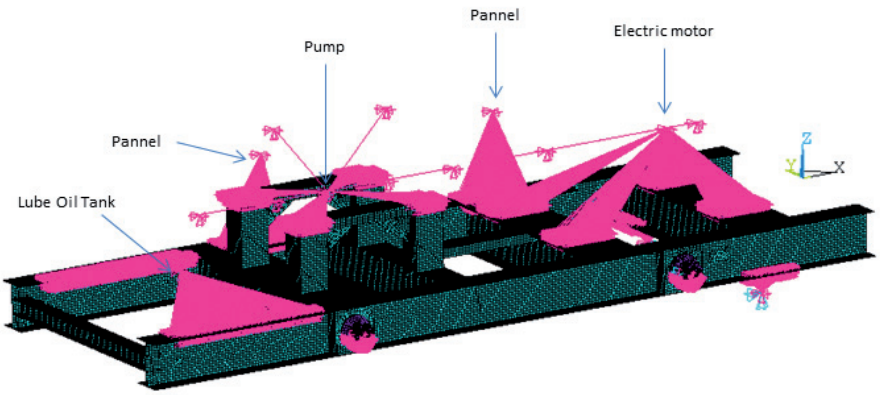
All the above requirements have entailed the necessity to dedicate considerable resources to engineering activities, substantially higher than for other comparable projects, whether related to the *ad hoc* design of the baseplate and other skid structural elements or to the methodical use of FEM (Finite Element Method) analysis (**figure 5**) for both design and verification of various components of the supply.

The engineering of auxiliary and electrical components, such as inverters, electric motors and lube oil system was also subject to the limitations imposed by the afore-mentioned requirements.

A Hazop (HAZard and OPerability analysis) review was conducted at design completion in order to verify that all measures necessary to guarantee the safe operation of the plant had been taken into account during the design phase.

The complete test of the pumping unit under all its operating conditions was carried out at Termomeccanica La Spezia's in-house test center facilities.

Fig. 5 – Baseplate FEM model



Cooling circulation pumps

For the cooling medium circulation service, the contract also included the supply of 3 vertical "in-line" API OH3-type pumps (**figure 6**), with a flow rate of 1050 m^3/h at a 52.5 m head and driven by a 230 kW electric motor.

In this case too, the specific requirements of this project, particularly the need to reduce overall dimensions without affecting technical requirements, have led to a tailor-made solution with the supply of Termomeccanica DDBV-type pumps. This is actually a typical solution for Termomeccanica which consists of "in-line" vertical pumps that are however axially-split instead of radially-split as for the API 610 OH3 standard.

Utility pumps

The remaining utility services of the platform are covered by 5 more OH2-type pumps: 2 "off-gas compressor suction drain pumps", Termomeccanica 25AP32 model, and 3 "heating medium circulation pumps", Termomeccanica 80AP20 model.

Vertically suspended pumps

Termomeccanica supply finally included 2 vertically suspended pumps: one VS2-type pump, working as glycol transfer pump (Termomeccanica CPP50.1 model) and one VS4-type pump, working as drain sump pump (Termomeccanica 25CPPL16 model).

Once again, the peculiarities of the project have prevailed over design standardization.

The lack of space on the platform deck did not allow the development of design according to API610

standard as originally planned. In fact, the entire upper part of the pumps surmounting the baseplate had to be completely re-designed so as to reduce its height and allow installation as well as maintenance of the pumps in the small space available on the deck.

Quality & certification

As it is usual for offshore projects, certification has represented an essential component of the scope of work of the supply. In addition to CE marking and Atex certification, project specifications have required the involvement of the Lloyd's Register as Inspection & Verification body for marine classification and Bureau Veritas as third party inspector. Moreover, TÜV has been involved to carry out Ped related activities.

Project management

In addition to the technical constrains described above, this project has also been subject to a major management challenge due to special customer requests.

For example, as part of the de-risking project of the Greater Stella Area Development, both the client and the end user have requested Termomeccanica Pompe's involvement in a series of activities aimed at reducing the delivery lead-time by one or two months according to pump type.

Termomeccanica succeeded in moving up delivery as requested and it managed to do so by involving not only many departments across the company but also its main sub-suppliers as well as the client itself (Petrofac).

Flexibility is the key

The design and supply of the 14 centrifugal pumps to be installed on the PFP1 platform of the Greater Stella oil & gas field has been characterized by uncommon design and management challenges that have not only tested Termomeccanica's experience and know how in the oil &gas off-shore sector, but also its flexibility to adapt and customize to the most diverse requests from both its client and end user. From this point of view, the positive feedbacks received by Petrofac and Ithaca Energy have confirmed the successful completion of the project by Termomeccanica.



Fig. 6 – Cooling medium circulating pump (OH3)



Cesare Nardini

After attending the University of Wollongong in Australia and Universitat Politecnica de Catalunya of Barcellona (Spain), Cesare Nardini completed his studies in 2000 at Politecnico di Milano obtaining a graduate degree in Management Engineering.

He started his work experience the same year at Alstom T&D in Montpellier (France), where he worked for two years on the development and installation of digital control system for electrical networks and substation, starting with product engineering development and then moving on to site- and project-management.

In 2002, he changed to the automotive industry and went to work as a project manager for Saira SpA, a company of Gruppo Industriale Tosoni, which focuses on the railway market. He was first in charge of all projects related to foreign markets but later moved on to the domestic market, being also the project manager for the engineering and supply of the components for the ETR 600 / New Pendolino project, developed in co-design with Alstom Transport and Giugiaro Design.

He finally joined Termomeccanica Pompe's Project Manager team in 2008, with whom he has followed to date more than 30 projects in the power generation market (including the nuclear sector) and oil & gas market (including both the onshore and offshore sectors).

raccortubi do brasil | tecninox do brasil | raccortubi middle east | raccortubi singapore

raccortubi

tecninox

Piping materials from stock:
pipes, tubes, fittings and flanges in stainless steel, duplex, superduplex, superaustenitics and nickel alloys

and from our production:
butt weld fittings in stainless steel and duplex, superduplex and 6Mo according to NORSOK M-650 Ed. 4

Raccortubi Group around the world

Subsidiaries in Brazil, Dubai and Singapore



www.raccortubi.com

raccortubi group

Multi-Level, Integrated Fire and Gas Control System

Major Middle East refinery benefits from the flexibility, power and simplicity of a single architecture for both plant and office facilities developed by SAFCO Engineering

Gianbattista Zago
SAFCO Engineering

The solution developed by Safco Engineering, with support from Rockwell Automation for fire and gas control, is unique in the market. Operators at the refinery can now leverage the capability, reliability, connectivity and open protocols used by the Programmable Automation Controllers (PACs) across the whole infrastructure. Normally there are so many product families, but in this instance we have one product family. PACs normally used for process control are being used for buildings for protection as well. The market has not really pursued this way because PACs are not normally linked to fire alarms.

The refinery will benefit in multiple ways. In the first instance the operators do not have to use several programs or software to make modifications, as RSLogix 5000 is used for all PACS and addressable devices. In the past, at least two software programs were needed, one for the PACs and one for the fire alarm; some form of software 'bridge' was also required to link the two systems. The HMI (Human Machine Interface) is also common across all systems, using FactoryTalk View instead of one display for the PAC and one display for the fire alarm panel.

The refinery will benefit in multiple ways. In the first instance the operators do not have to use several programs or software to make modifications, as RSLogix 5000 is used for all PACS and addressable devices

The biggest advantage is the fact that the solution runs on one common system. From each individual point, wherever the user is, they can gain access into the system using password authority to determine the level of access and control, to check all the components. The Allen-Bradley PanelView HMI display is also available over the internet, so users can gain access from remote or off-site locations – answering one of the customer's primary requirements, which was: "I want to control it from my seat, no matter where I am".

Why is this project so interesting? What's the challenge?

It is one of the first in the world to leverage a single architecture for both the refinery and the office buildings, using the PlantPAx process automation solution from Rockwell Automation alongside the Safco Engineering Intelligent Fire Panel.



A sight of an local fire alarm control panel for satellite instrument shelter (the opened one) and substation (the blind one)

SAFCO Engineering and Rockwell Automation

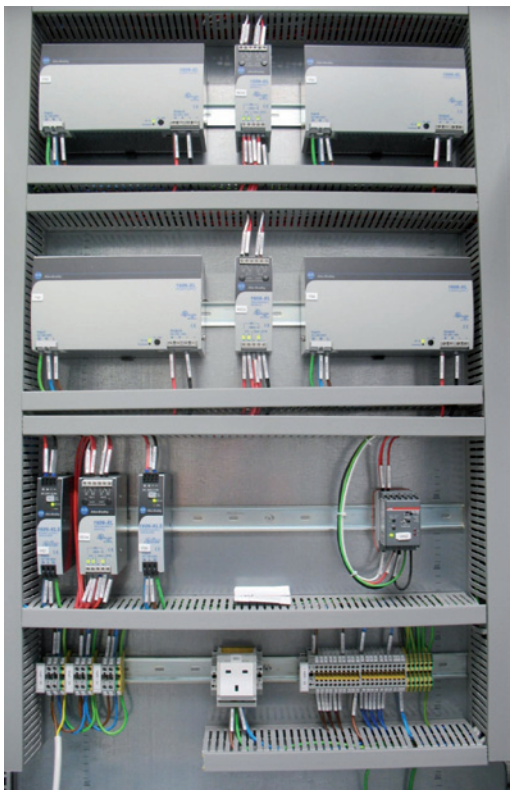
Safco Engineering was founded in 2003 for the design and manufacture of fire and gas safety systems and equipment for the industrial sector. Initially focussing on products, the company is now more focussed on system integration.

Highlighting its systems integration capabilities, it was recently called upon by a leading oil and gas company in the Middle East to develop and deploy an integrated, single-platform fire and gas safety solution for all of the assets in one of its major refineries.

Safco Engineering has a very good relationship with Rockwell Automation in Italy. When we started out, we already had an idea that we wanted to develop an integrated approach and we decided to approach Rockwell Automation, who, as it turns out, were very flexible and eager to help and support us. The relationship has since grown and Rockwell Automation gets deeply involved in many of our other projects; and we have the support of a very knowledgeable local engineer, who understands our issues and unusual questions.



An overview of Ruwais Refinery Expansion PLC cabinets



Typical local fire alarm control panel power lines: two redundant lines of 480 W power supply (Allen Bradley), a redundant line of 80 W power supply (Allen Bradley), and insulation control module

In this type of installation, the traditional approach is to have separate fire and gas safety systems for the plant and the office buildings. The individual needs of both areas are currently catered for by mature technologies, which are seen in applications around the world, but they often rely on completely different communication protocols and associated networks.

The challenge for Safco Engineering was to develop an integrated solution that would run on a single network using a single protocol – removing many of the communication and complexity barriers present in other systems. As well as the network/platform issues it also had to address the different legislation covering the two discrete areas.

The challenge for Safco Engineering was to develop an integrated solution that would run on a single network using a single protocol – removing many of the communication and complexity barriers present in other systems

In addition to this primary requirement, the project required multiple additional features, many of which are commonplace in the oil and gas industry. The refinery needed redundant hot-backup controllers, which employ communication via a redundant fibre optic network ring. It needed redundant OLE for Process Control Data Access (OPC DA) to interface with the Distributed Control System (DCS) and OLE for Process Control Alarm & Events (OPC AE) to interface with plant's alarm-managements system, while using the Simple Network Time Protocol (SNTP) to provide time synchronisation between the fire and gas system and the DCS. There was also the need to be able to hot swap single components.

Why the Safco Engineering solution is so innovative?

The innovative aspect of the solution developed by Safco Engineering was the use of PlantPAx to not only address the plant's fire and safety requirements, but also to control and communicate with the addressable devices within the office complex for fire protection.

The solution was divided into three logical levels using sub networks, which when connected all together, created a global network. Each level deploys interlinked equipment from within the PlantPAx solution from Rockwell Automation:

- at the lower level a local fire and gas panel is used for building protection, with an HMI providing the operator interface;
- at the medium level another fire and gas panel is deployed for building and process area protection; the medium level also exploits a server for data collection and interfacing with the PlantPAx DCS and the higher level;
- the higher level contains the main server, for data collection, disaster recovery and domain control of the network.

The entire network uses EtherNet/IP and ControlNet (with associated switches) to link to both the HMIs and the PlantPAx Scada solution.



A13 PLC rack of Allen Bradley showing control net card (purple), communication cables, digital output (blue) & digital input (green) which are wired to terminal strip trough dedicated pre-wired cable

The results mentioned above are specific to Safco Engineering's use of Rockwell Automation products and services in conjunction with other products. Specific results may vary for other customers.



Gianbattista Zago

Gianbattista Zago, started to work in the fire and gas field in 1989 as Project Engineer, Software Specialist and Project Coordinator.

In 1990, he held the position of Fire & Gas Systems Engineer in CSA Company and of Senior Project Manager in ItalFire Protection Company for Adnoc Ruwais Refinery, Adnoc Ruwais GUP and Takreer Ruwais Refinery (ULG) projects. In 2002 he worked in Kidde Fenwal as Proposal Manager and in 2003 he founded Saf.Co Fire & Gas (Safco Engineering in 2006) together with Luca Germani, the President.

Gianbattista Zago, having a huge experience in both engineering and site management, now is Safco Engineering Operation Director for Production, Engineering and R&D development.



Investing in Technology for Offshore Design

Intergraph “Smart3D” enables Vietsovpetro Nipi to enhance design of offshore platform designs

Eileen Tan
Intergraph



Vietsovpetro (VSP) is a leading pioneer in the Vietnamese oil & gas industry and is among the world's largest oil & gas companies. VSP's output has exceeded 200 million tons and continues to grow. The Science Research and Design Institute (Nipi) is VSP's scientific and engineering division, and is responsible for the design of offshore facilities for oil & gas appraisal, exploration and production.

VSP has been a longtime Intergraph customer.

The company chose to partner with Intergraph because of its global leadership position in the industry with a complete portfolio of engineering solutions to satisfy VSP's project execution needs. With a dedicated focus on design and engineering, it was important for Nipi to have access to next-generation technology. It first adopted PDS®. However, as the institute took on more complex offshore projects, it became apparent that Nipi needed to update its engineering design application.

Engineering design innovation

VSP and Nipi learned about Intergraph Smart3D (SmartPlant 3D and Smart3D) technology, featuring rule-based engineering and automation capabilities. The company decided it should adopt Smart3D solutions to support its offshore projects, which aligns with VSP's vision to leverage advanced technology to improve its engineering processes.

"Without a doubt, Smart3D is the future of engineering and we plan to apply Smart3D for any new projects from now on," said Le Viet Dzung, deputy director in charge of engineering at Nipi. "We recognize the importance of investing in next-generation technology to address our project needs and drive continued success, and Intergraph's SmartPlant and SmartMarine Enterprise suites of solutions will deliver great value to our business. Recently, Nipi has completed 3D design for our satellite platforms – BK16, BK17 and RP3-DGCP – by using Smart3D".

Powerful and user-friendly

Smart3D is the world's most advanced offshore and shipbuilding design solution, providing VSP with the capabilities it needs to gain and maintain an edge in a highly competitive industry. It features breakthrough engineering technology that is automated, knowledge- and rule-driven, streamlining marine asset design processes and improving delivery schedules, with increased detail and manufacturing design productivity of up to 30%. Smart3D is endorsed and used by leading offshore and marine companies globally, including the most productive shipyard, the top offshore owner operator, the top

About Vietsovpetro

Vietsovpetro (VSP) is a Vietnamese-Russian joint venture that was established in 1981. It is focused on the production of oil and gas from offshore sources, exploration and survey work for the oil and gas industry and well drilling. VSP also performs design, assembly and repair of offshore facilities. The company has become the main force of Vietnam's petroleum industry and economy. About 80% of Vietnam's produced oil and gas comes from VSP, ranking Vietnam third in oil production and export in Southeast Asia. VSP contributes about 25% of Vietnam's national revenue, making it the largest contributor to the state's economy.

fabrication yard and the top classification society in the world.

With Smart3D, Nipi could review and easily make any design changes for VSP's offshore platforms in a 3D environment. It was also easy for Nipi to manage and monitor the development of its design projects, with the ability to generate engineering deliverables quickly and accurately, including material takeoffs. Because Smart3D is a powerful solution, Nipi could even apply it to large and complex projects with ease.

Improving productivity and project execution

VSP has also adopted other Intergraph engineering solutions, such as SmartPlant Foundation, SmartPlant Instrumentation, SmartPlant Electrical and SmartPlant P&ID, as well as Intergraph CADWorx & Analysis Solutions, including CADWorx, Caesar II and PV Elite®. VSP was confident to expand its use of Intergraph technology because of the high level of support it receives from Intergraph and its local partner in Vietnam, True Technology Company Limited (formerly Credent Technology).

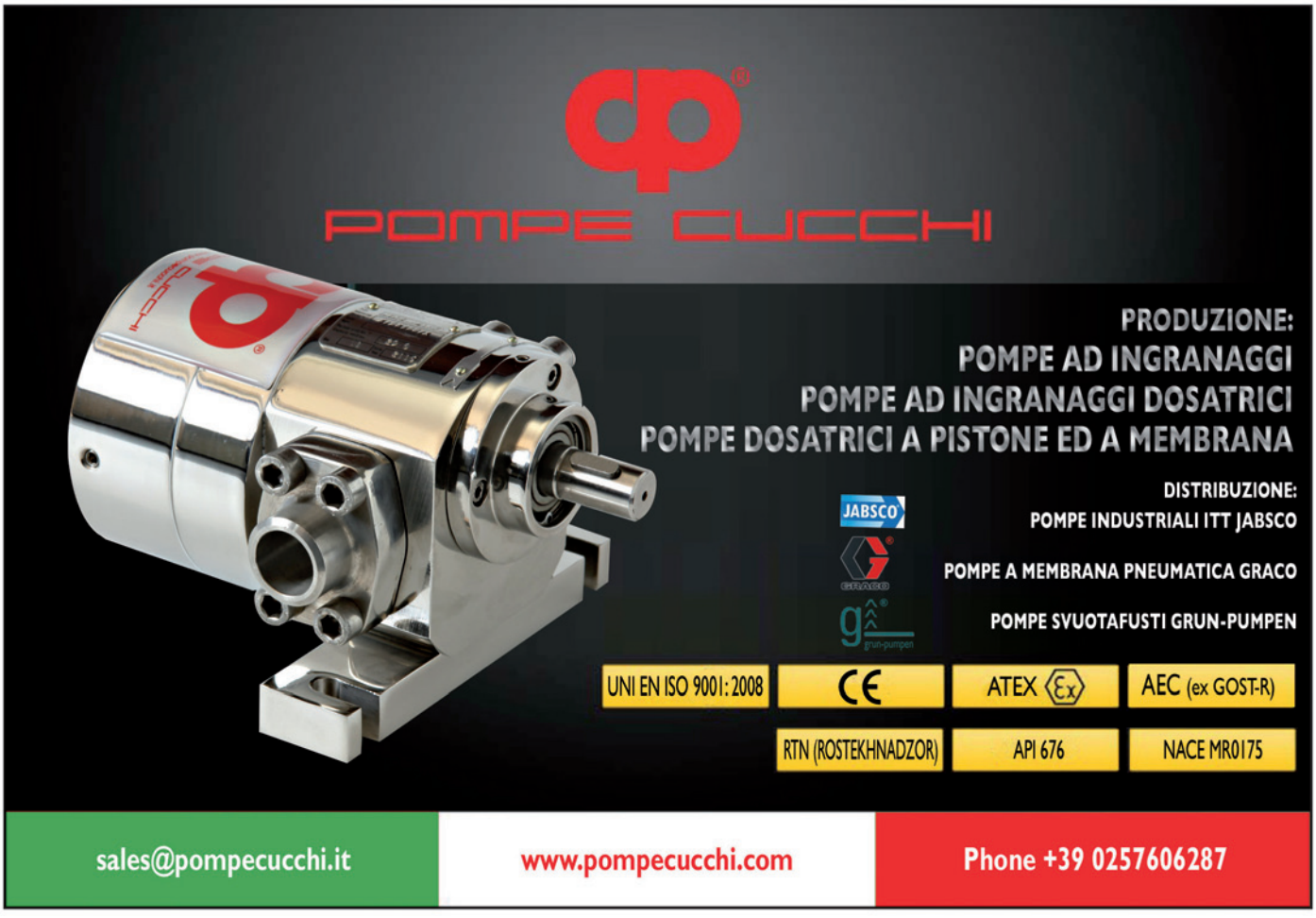
"We definitely see productivity benefits in using SmartPlant and SmartMarine Enterprise solutions" Le said. "By giving our employees access to the latest technology, we can enhance their professional knowledge and improve execution of our projects".

VSP plans to continue expanding its use of SmartPlant and SmartMarine Enterprise solutions in an integrated engineering environment. This will ensure that VSP has a complete solution across the entire project life cycle to support the development of its offshore facilities. It will also build up its engineering database with the relevant catalog and specification items to support all of its assets.



Eileen Tan

Eileen is Senior Communications Specialist for the Asia-Pacific region at Intergraph Process, Power & Marine. She is based in Melbourne, Australia.



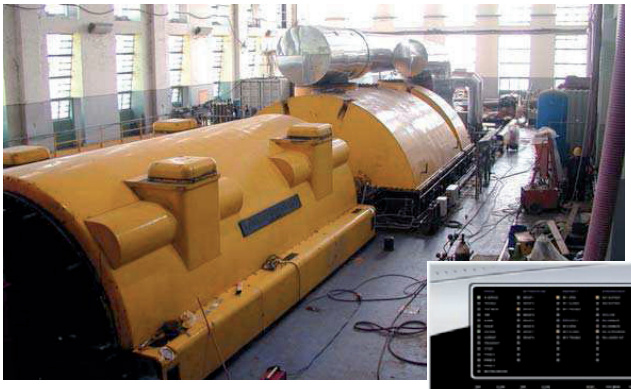
SAET for PROTECTION and SCADA IEC 61850







HV BAY PROTECTION

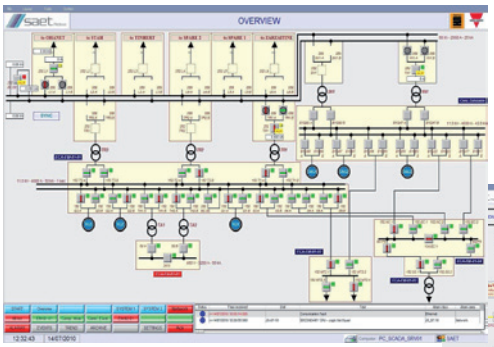


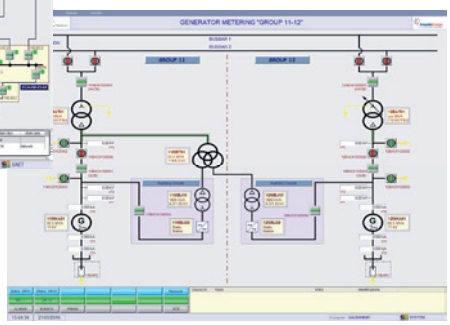


GENERATOR PROTECTION



ENERGY MANAGEMENT





EPCS
Electrical Protection & Control System (Load Sharing- Load Shedding)



IEC 61850 PROTECTIONS



saet Padova

SAET SPA – Via A. Moravia, 8 – 35030 SELVAZZANO D. (PADOVA) – Tel. 0039-049-89.89.711 – Fax 0039-049-89.75.299
E mail: info@saetpd.it - Internet: www.saetpd.it P.IVA e Iscr. Reg. Impr. di Padova nr. 00204610281 - R.E.A. n. 72871

Tecniplant

Since 1974

The Filtration and Flotation Solution.

Drum Vacuum Filters

for Solid-Liquid Separation

Experience and reliability.
High performing systems, easy to operate and maintain.
Numerous cake discharge devices, including pre-coat.
Profitability and environmental care.
Turn-key plants and skids.
Laboratory and pilot testing.





Flotators

for Oil-Liquid Separation

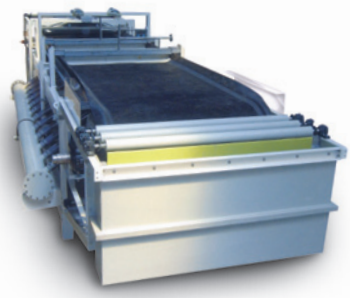
Impeller and Injector Flotators, atmospheric and pressure design (IAF, IGF).
Continuous operation ensuring high capacities and efficient oil removal. Engineering and construction of complete automated packages including CPI, API Separators, Static Mixers.



Horizontal Vacuum Filters

for Solid-Liquid Separation

High filtration rates.
Intensive and flexible for dewatering gypsum (FGD) and all slurries.
Belt and Cloth Horizontal Vacuum Filters.
Supply of complete plants from basic engineering design to start-up.



Tecniplant

Tecniplant S.p.A.
Via G. Carducci, 125
20099 Sesto San Giovanni (MI) Italy
Tel. +39.02.26262144 • Fax +39.02.26262147
info@tecniplant.it • ***www. tecniplant.it***

Intelligent Well Production

Emerson Smart Wireless solutions

Daniela Bastico
Emerson Process Management Italia



A ball trap connected to a turbine meter was used to measure oil flow from one of seven producing oil wells on any given header; a Rosemount 8800 MultiVariable vortex meter with a WirelessHart Thum now provides a low-maintenance option that gives continuous, one-minute updates for each individual well

Emerson's automation of oil and gas fields enables centralized management, avoids danger and time spent on field trips to remote facilities, improves safety and environmental performance, and increases production efficiency. Drawing from our wide range of Smart Wireless solutions, a key extension of Emerson's PlantWeb digital architecture, we help customers plan, engineer, and commission oil and gas applications for new fields and modernization of existing facilities.

Gain advantages with Smart Wireless tecÚology

The wellheads, flow lines, and separation areas in these fields have typically used wired approaches which involve significant commissioning time, and lengthy installation of wiring, trenching, conduit runs, and cable trays; or proprietary wireless networks which suffer from reliability issues. Emerson's Smart Wireless technology overcomes these issues.

Emerson's global brands like Rosemount, Fisher and many more are available as wireless devices that typically install and are operating in less than a few hours, transmitting data to Smart Wireless gateways and from there to the central control room and maintenance shop. Not only are Emerson's Smart Wireless solutions quickly installed and operational, ease-of-use is exceptional as a result of guidance from intense customer research done by our unique Human Centered Design Institute. It profiles customer roles and interaction of disciplines to guide Emerson's development of technology that delivers significant improvement in our customer's work force productivity.

Cost studies have shown that Emerson's Smart Wireless technology provides 30% or more installed cost savings over wired alternatives, whether automating a few wellheads or an entire oil or gas field. Significant savings from using Smart Wireless enable engineers to make improvements previously out of economic reach. Emerson's Smart Wireless instrumentation family, predictive maintenance software and services expertise deliver comprehensive capabilities for surface wellhead and downstream monitoring. Refer to the adjacent diagram and table for typical flow and description of monitoring applications.

The wellheads, flow lines, and separation areas in these fields have typically used wired approaches which involve significant commissioning time, and lengthy installation of wiring, trenching, conduit runs, and cable trays; or proprietary wireless networks which suffer from reliability issues. Emerson's Smart Wireless tecÚology overcomes these issues.

All our solutions are well explained by the case history that follows.

PXP improves oilfield operation by optimizing steam injection

Thermal energy is commonly used in oil extraction to stimulate production. Thermal energy is also the greatest cost of oil production for many tertiary recovery projects. The heat injected in the form of steam commonly accounts for 40 to 65% of a producer's costs and is responsible for much of the revenue derived from production of a well. On the Hopkins lease property 35 miles north east of Bakersfield in California, there are close to 171 producing wells. The wells are concentrated in a one square mile area, producing approximately 3,200 barrels of oil per day. This field also has 120 steam injection wells, each of which heat and push oil toward a pattern of producing wells. In order to meet the production goal and optimize SOR (Steam to Oil Ratio), it is critical to measure injected steam rate, total injected steam, and water and oil production to optimize the effect of thermal stimulation on production.



PXP wireless steam injection well flow rate monitoring

Because there was no power or communications in the vicinity of the wells, the field was monitored by mechanical chart recorders and operator trips to as many wells as possible in a day. The daily readings by operators were summarized once a day. The data was then sent to the office in Bakersfield where it was used to make business decisions. Manual monitoring methods were not the most effective method to prevent over-injection of steam that caused breakthrough and cut liners in producing wells. Cut liners would take a well out of production for months at a time, losing an average of around 20 barrels per day. If a new liner could be installed, the cost of repairing the damage was roughly $ 90,000. If there was a dogleg in the well, however, it would have to be idled and a new well would have to be drilled, for a total cost as high as $ 500,000. The company was averaging 10 cut liners per year. Furthermore, for each month each well was not producing because of a cut liner, an average of 600 barrels of production was foregone.

Manual monitoring methods were not the most effective method to prevent over-injection of steam that caused breakthrough and cut liners in producing wells

Manual monitoring methods also led to under-injection, which meant foregone production. Part of the problem was lack of timely information. With 120 wells to visit the operators could, at most, get one data point per well per day. The data then had to be manually entered into a database quickly and accurately. Even if the data was accurately gathered and entered, the data collection rate of once per day led to lag time in responding to issues that impacted costs and production.

Another part of the problem was the technology itself. The accuracy of metering with an orifice and a chart recorder was a concern. For one thing, PXP was dependent on a contractor to provide the proper coefficient for the orifice plate to get an accurate flow reading. For another, they had to be sure the orifice was installed properly and remained intact. Finally, the charts had to be read accurately, with the chart recorder properly calibrated (a task done every three months) with no plugged tubing.

Steam injection wells

PXP looked at wireless technology to provide real-time information to optimize steam injection rate. The mesh technology from Emerson combined with ProSoft Ethernet radios provided a robust, reliable solution across the one square mile property. PXP chose the Emerson wireless solution because of the security built into the network and the reliability of the robust, self-organizing mesh that is easy to install and expand. The solution from Emerson opened a new pathway to capture realtime, accurate, and nearly maintenance-free well test data.

The solution began with a pilot project to test the technology on four injection wells. Ten 3051S WirelessHart™ pressure transmitters were purchased and installed; one on the upstream side of a fixed bean choke to calculate flow rate (upstream

pressure and bore size from the fixed bean choke determine the flow rate) and another on the downstream side to help with troubleshooting. Two wells were dual-stream, utilizing a single upstream transmitter. A Smart Wireless Gateway, where process variables as well as process and instrument diagnostics are converted to Modbus TCP/IP data, was installed as well. A ProSoft Technology 802.11 industrial broadband radio provided a backhaul network, or a robust wireless network for long distances, to connect the gateway to an industrial PC in the office a mile away.

Once communications were established and tested, the first step was complete. However, the company still had to find a convenient way to make the real-time wellhead data accessible company-wide so that it could be stored, trended and analyzed to solve problems before production could be impacted. The customer also wanted to test the performance of the instruments. A 3rd party was brought in to test the true steam injection levels and compare them with the chart recorders and the new high performance 3051S wireless pressure transmitters. Once Emerson wireless technology proved it could handle the sparse distribution of transmitters on the large area that incorporated the four wells (spaced 150 feet apart and located 0.25 miles from the nearest gateway), PXP rolled out the bulk of the project, implementing a total of 249 WirelessHart transmitters and 4 WirelessHart gateways on 120 wells across an area of one square mile. Three industrial radios provide the backhaul to reliably communicate data to the office a mile away. Deployment of the wireless technology was made easy with Emerson's AMS Suite. Emerson's highly engineered tools take the complexity of configuration, installation, and startup out of the user's hands.

Three industrial radios provide the backhaul to reliably communicate data to the office a mile away. Deployment of the wireless tecÚology was made easy with Emerson's AMS Suite. Emerson's highly engineered tools take the complexity of configuration, installation, and startup out of the user's hands



Rosemount 3051S WirelessHart pressure transmitters on a dual injection stream well

Oil production wells

The project paid for itself in months. With this success, PXP continued to invest in wireless by adding twenty seven 8800 MultiVariable™ Vortex meters with WirelessHart Thums to the network to measure the mixture of oil and water out of the producing wells. These low-maintenance devices update production data for operators every minute on every well instead of once a day only on those wells that are in test. Therefore, they are no longer blind to what the majority of the wells which are not in test are doing.

Now operators get flow rate, flow total, and temperature for each of the wells. The temperature is used to determine how hot the production is emerging to indicate not only that steam is reaching the well, but to provide further field intelligence on whether the pattern injection wells are being over- or under-injected. For diagnostics, the shedder bar frequency is also monitored. This provides intelligence to the operators if any process disruptions are affecting the meter, so maintenance can remedy the problem and minimize the impact on production.



Daniela Bastico

Daniela is Marketing Communication Manager, Emerson Process Management Italia

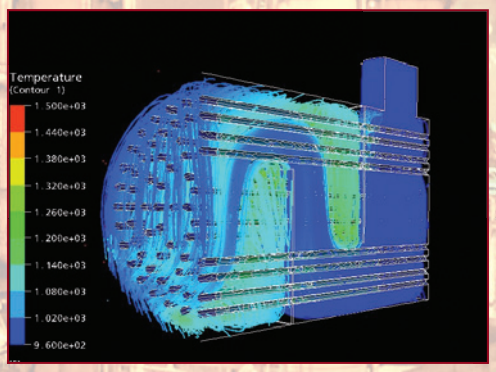
WATLOW®

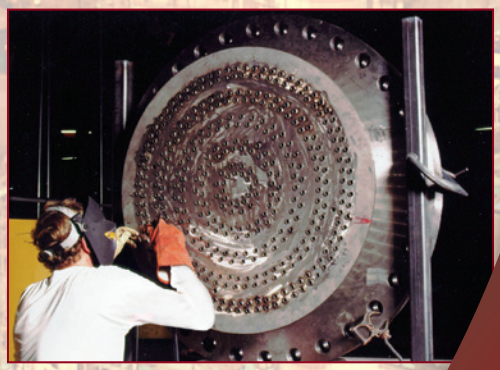
Need a Partner You Can Trust?

Designing and manufacturing complete electrical thermal systems is Watlow's expertise. We have over 20 years' experience working with our energy process customers to determine optimum thermal solutions for process heating applications.

Watlow® supplies engineering design, support services and products for:

- Liquefied Natural Gas (LNG)
- Gas Dehydration and Sweetening
- Catalytic Cracking and Regeneration
- Polycrystalline Silicon Ingot Production
- Nuclear Pressurizers





Call Watlow today for the best thermal solution for your energy process application.

European Technical Sales Offices

Germany +49 (0) 7253-9400-0
info@watlow.de

France +33 1 41 32 79 70
info@watlow.fr

Italy +39 (0) 2 458-8841
italyinfo@watlow.com

Spain +34 91 675 1292
info@watlow.es

UK +44 (0) 115-964-0777
info@watlow.co.uk



We like to think **BIG**

Industrial Project Freight Forwarding





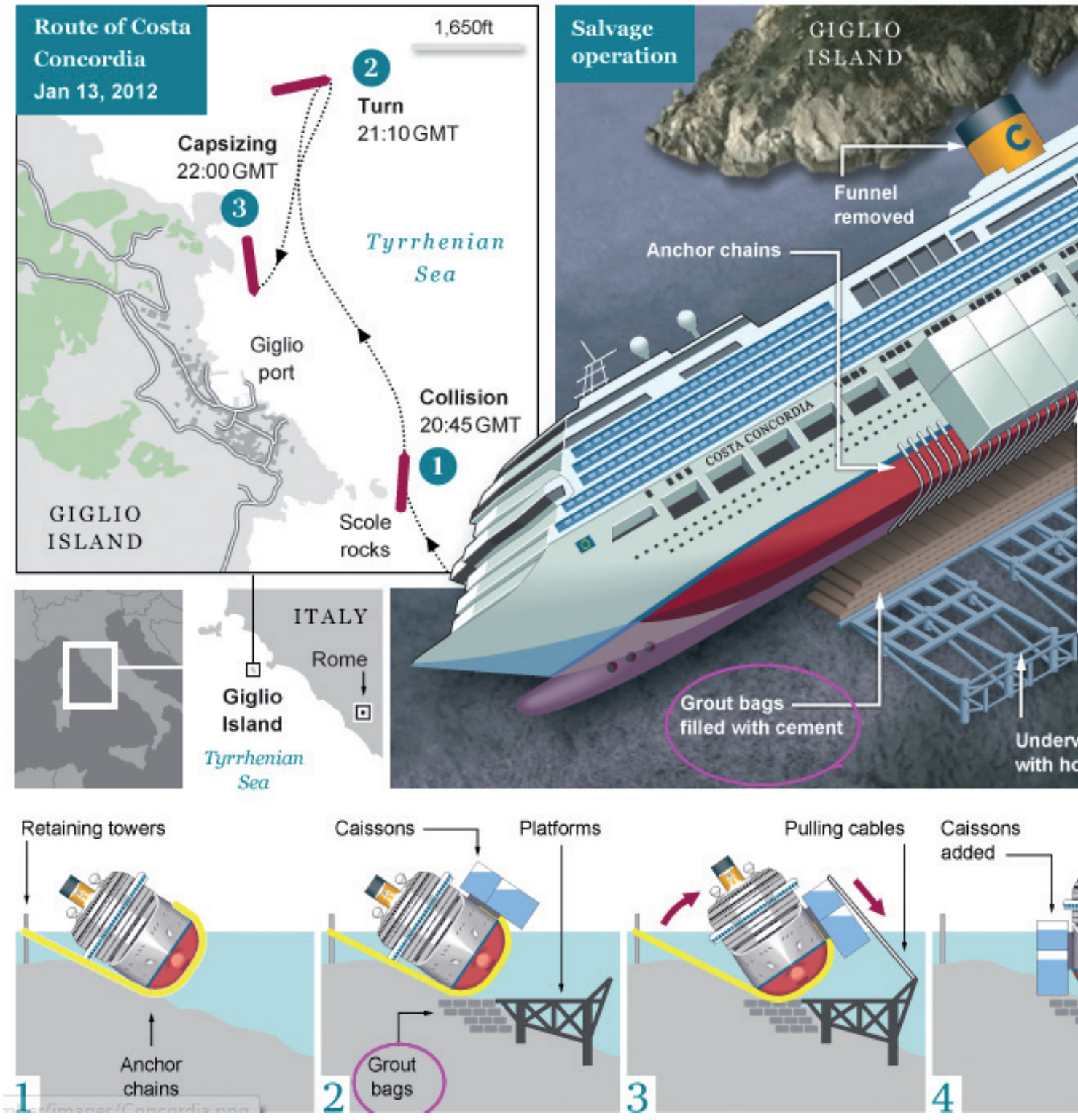
Geodis Wilson Italia
Industrial Project

GENOVA: Head Office +39 010 41 071
MILANO: + 39 02 92 79 14 24
ROMA: +39 06 88 39 20 11
industrialproject@it.geodiswilson.com

www.geodiswilson.it

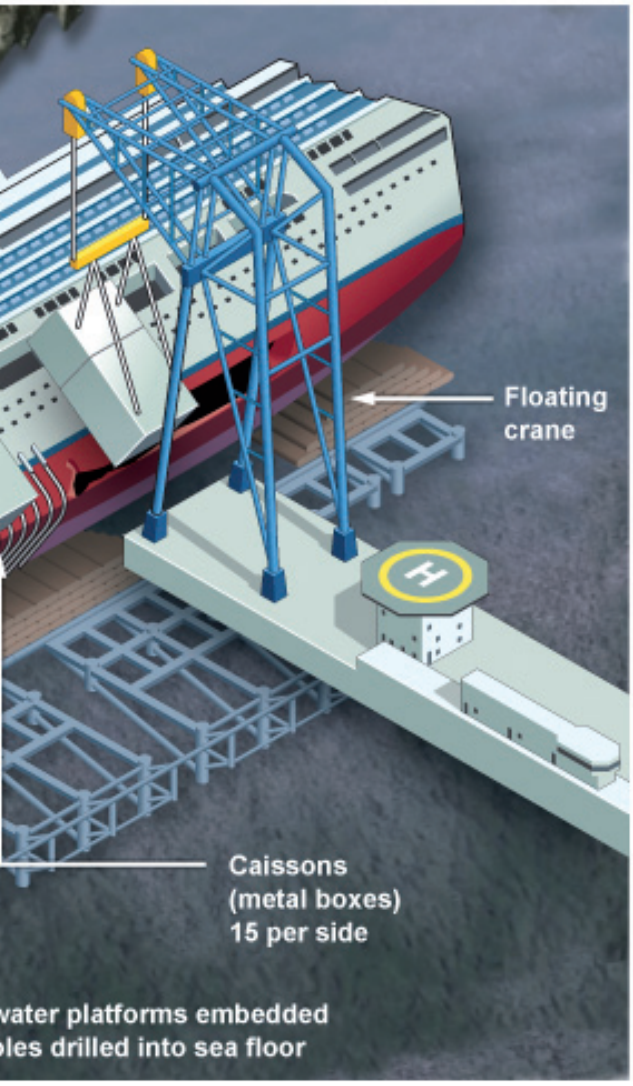
expect more.

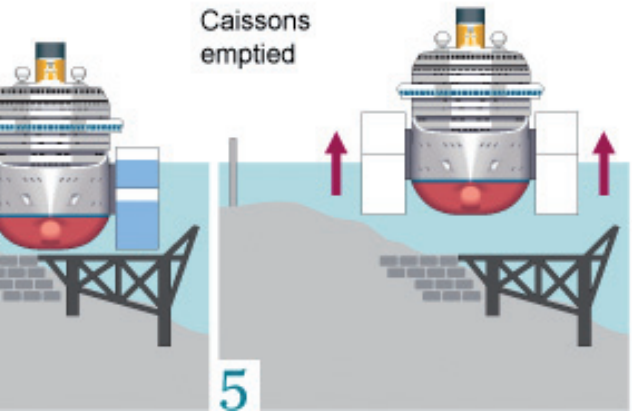
GEODIS
wilson



Pumps for Offshore Energy Industry

Seepex progressive cavity pumps are used by FoundOcean for structural grouting on oil & gas platforms, and for installation of offshore windfarms





Seepex progressive cavity pumps are used by FoundOcean in the offshore energy industry for structural grouting on oil & gas platforms, and for installation of off-shore windfarms. The FoundOcean subsea services have most recently been used to provide the structural support necessary to raise the Costa Concordia.

The Seepex supply relationship with FoundOcean is now over three years old and is based on pump performance and design to match the specific demands of offshore grouting.

The starting situation FoundOcean were looking to make their grouting times more efficient, with less downtime associated with pump issues such as grout settlement in the suction casing. Grouting is a high pressure application, carried out from offshore barges where space is at a premium and Seepex were asked to produce a solution to shorten the pump length as well as preventing settlement.

The solution Seepex N range have a short suction casing due to the coupling rod design and this, together with mixing paddles on the coupling rod to ensure continuous agitation of the grout mixture, prevented the settlement issues. The high pressure needed from the pump normally requires a conventional four stage rotor stator combination which due to its design has a long footprint. To resolve the space issues pumps were supplied with two stage even walled stator and heavy duty high pressure universal joint which enables 24 bar pressure to be produced by a shorter pump. The combination of shorter suction casing and even walled stator meant that the seepex pump was over two metres shorter than previous technology.



Seepex N range pump on FoundOcean grout pumping skid

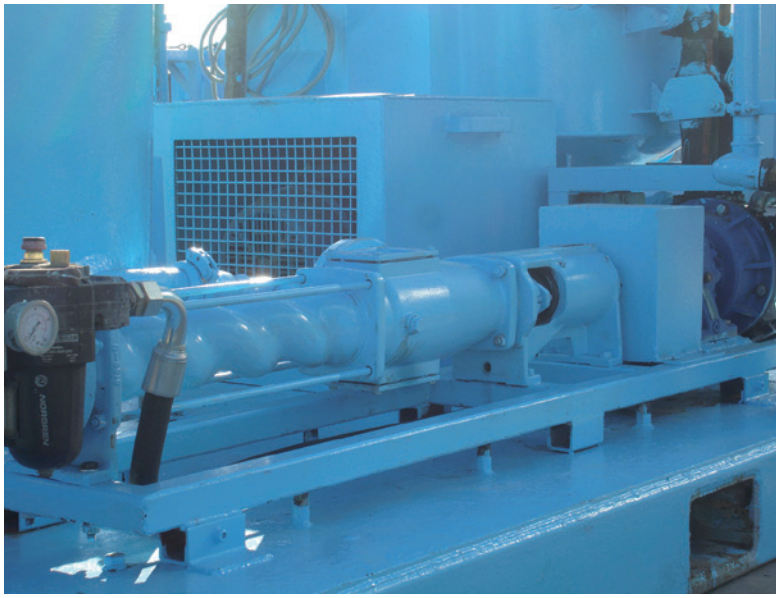
The Seepex supply relationship with FoundOcean is now over three years old and is based on pump performance and design to match the specific demands of offshore grouting

The pump was supplied complete with a control panel and a variable speed drive to provide an integrated automated system.

Seepex also supply these pumps with pneumatic motors where environmental conditions make this a

Seepex Pumps Help to Salvage Costa Concordia

Seepex progressive cavity pumps have played a role in the salvage operation to recover the cruise ship "Costa Concordia". The shipwreck made the news in January 2012 when it struck rocks near Isola del Giglio and has subsequently been declared a total write off. The salvage operation, the biggest of all time, has involved several steps, the first of which involved securing the ship and building an underwater platform to prevent her from sinking further.
It was in this stabilisation phase that Seepex pumps were used to pump the grout from a floating platform to a series of "specially designed bags" which formed the underwater platform.
Seepex is a long standing supplier of pumps to FoundOcean for grout pumping on offshore platforms and wind farm installations. This supply relationship started when FoundOcean was looking to make its grouting times more efficient, with less downtime associated with grout pump issues such as grout settlement in the pump. Seepex pumps have a shorter suction casing and this, together with a short coupling rod fitted with paddles to agitate the product, solved the original problem. Further pumping improvements were suggested by Seepex after an in-depth discussion with the customer.
The high pressure application is carried out from offshore barges where space is at a premium. Seepex suggested an alternative high pressure joint and even walled stator. This combination shortened the pump and provides FoundOcean with a compact design which solves all previous problems. Pneumatic motors have been provided depending on the specific needs of the pump units.
In addition to solving the problems associated with excessive downtime Seepex was also able to supply accurate dosing pumps for additives and vertical pumps for polymer transfer from IBC, thus providing a complete pump system for grouting applications.



Seepex N range pump with evenwalled stator

requirement. The package to FoundOcean is completed with dosing pumps for additives and vertically mounted pumps for dispensing out of IBC.

Keyfacts:

- problem solving approach by seepex design engineers;
- shorter suction casing with paddle mixers;
- high pressure joint and even walled stator;
- compact design for offshore use;
- improved reliability as settlement issues solved.

The benefits:

- the Seepex design of shorter suction casing and paddle mixers on the coupling rod overcomes all of the operational issues formerly associated with progressive cavity pumps, leading to less downtime, lower spares usage and reduced operating costs;
- the shorter pump coupling rod together with the advanced joint and stator design provides a compact pump for offshore use, perhaps as important is the technical expertise of Seepex engineers who understand the process needs of FoundOcean.

Cost savings:

- lower capital costs;
- reduced downtime;
- reduced maintenance costs.

LOCTITE®



Loctite® Sistema per la riparazione definitiva di tubazioni in acciaio

Un sistema innovativo di riparazione definitiva delle tubazioni in acciaio e dei dispositivi in pressione - certificato secondo la norma ISO/TS 24817. Rapida ed economica, questa soluzione completa di resine e fibre di rinforzo in composito è progettata per ridare struttura nelle tubazioni sottospessorate, corrose o con perdite.

Resiste a:

- alte pressioni
- alte temperature
- sostanze chimiche.

Certificato da

GL

Germanischer Lloyd



Henkel Excellence is our Passion

Scopri come utilizzare i nostri prodotti guardando il video su **www.loctite.it/pipe-repair**
Per maggiori informazioni scrivi a: **manutenzione-loctite@henkel.com**



The first high performance rupture disc manufactured with the newest technology



FIND OUT OUR NEW RUPTURE DISCS!
SCR/IS - SCD/IS - Y90/IS

- Maximum Precision
- Absolute Reproducibility
- Material Flexibility
- Design Flexibility

donadon SDD
SAFETY DISCS AND DEVICES

Address: Via Franceschelli, 7 - 20011 Corbetta (MI) - ITALY

P: +39 02 90111001
F: +39 02 90112210
donadonsdd@donadonsdd.com

www.donadonsdd.com

Advertisers

Ansaldo Energia 84
Aveva..... 4° cover
Bosco Italia ..... 2° cover
Costruzioni Elet. CEAR srl 78
DHL Global Forwording..... 4
Donadon SDD..... 112
Fagioli 29
Foster Wheeler It.na Srl..... 65
Garbarino Pompe 19
Geodis Wilson..... 107
Henkel Italia Spa..... 111
Indra Srl 49
Lever Srl..... 1
Marelli Motori Spa..... 60
Maus Italia Sas 71
Memit Forniture Industriali Srl 77
Nidec Asi 83
Nuova Asp Srl 40
Orsi ..... 3° cover
Prisma Impianti 89
Pompe Cucchi 100
Raccortubi Spa 94
Saet Spa..... 101
Spig Spa..... 72
Tecniplant..... 102
Watlow 106
Weg Italia 2

INDUSTRIAL PLANTS

May 2014
Special issue of "Impiantistica Italiana", n. 3
May/June 2014

Executive Editor
Daslav Brkic

Scientific Supervisor
Augusto Di Giulio

Editor in Chief
Giuseppe Bonacina

Secretary
Rossella Schiavi

Editorial Board
Delio Belmonte, Antonio Calabrese, Antonio Di Pasquale, Silvio Della Casa, Luciano Gandini, Alessandra Leni, Fiammetta Leoni, Michele Margarone, Cristiana Monti, Carlo Nicolais, Matteo Patera, Fabia Perrone, Silvia Sangiorgi, Sonia Rizzetto, Monica Tessi, Loredana Tullio, Aimone Vaccari, Anna Valenti, Tommaso Verani

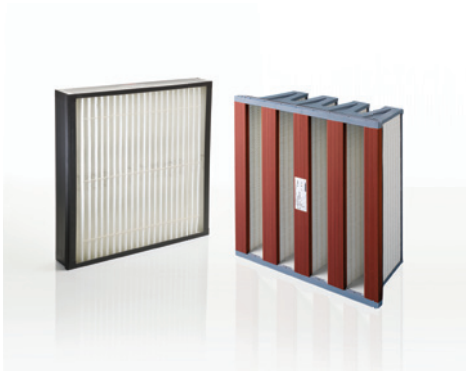
Advertising Agency
O.VE.S.T. s.r.l. Milano

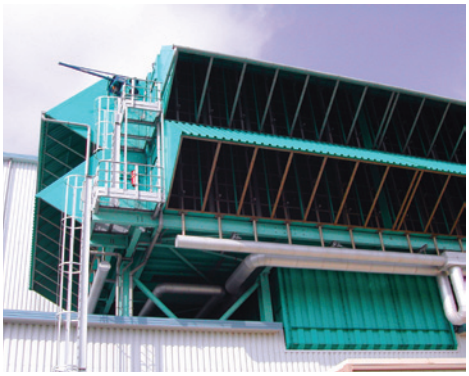
Graphic Design
STUDIO BART Milano - www.studiobart.it

Printer
Grafica Effegiemme, Bosisio Parini (LC)

To find out more visit **www.vokesair.com**







The **perfect** combination for GT air intakes

Macrogen GT Duo & Compatex TMPC

When it comes to gas turbine air filtration, there are three elements vital to overall system performance. The pressure drop, burst resistance and dust holding capacity regulate both the quantity and quality of air delivered to the turbine. Fortunately, two products work in unison to deliver best-in-class performance for each of these aspects.

At the first stage, Macrogen GT Duo combines the prefilter and water removal functions to allow the elimination of a dedicated coalescer phase. Of course, this also removes an entire stage-worth of pressure drop too, yielding an instant boost to turbine performance with no retrofitting required.

Following this is Compatex TMPC, which combines industry-leading pressure drop performance with the highest available dust holding capacity (now up to 30m^2 of filter area) and unrivalled burst resistance. It's also available in filter grades from F7 to E12 for EPA levels of defence.

Installing Macrogen GT Duo and Compatex TMPC will boost your turbine's performance; lower filter spend and operating costs; and provide assured safety to downstream components. **The perfect combination.**