mcT 2012 - Tecnologie per il petrolchimico

Safety, Performance & Innovation in Oil&Gas Rotating Machines
Market Analysis
Compressors and Pumps

- About 2000 new compressor and 5000 new pumps installed every year for Oil, Gas & Petrolchemical market (from 2010 data)
- 30% of the market are motor & VSD driven
- New LNG plants & new pipelines (Asia, Brazil, Russia and North America)
- Compressing and pumping are expensive processes
- Main source of inefficiency:
  - Old machinery
  - Sub-optimal control schemes
  - Bad tuning & maintenance
The Power of Integration
Process and Power Automation together
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[Diagram of integrated process and power automation system]
Traditional control solution for rotating equipments
A fragmented architecture
Lesson Learnt
From Traditional Solution....
Lesson Learnt
...to an Integrated Solution
DEIC
Drive & driven equipment integrated control system

- The integrated solution providing all the functionalities required for the driving and driven rotating machine

- Features
  - Complete libraries of control and protection functions
  - Supervision & monitoring on the assets
  - Open & modular structure
  - Easy integration with other ABB or third party systems
  - Small footprint
  - Reliable and safe hardware certified by TÜV Rheinland
  - Software designed according to IEC61131 standard
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DEIC
Drive & driven equipment integrated control system

DEIC-700
Compact version, fully functional, no PC required

DEIC-800
Complete DCS solution, granting best performance and high safety level

DEIC-900
Designed to respond to highest and strictest safety requirements, up to SIL3 level
ENI Norge Goliat FPSO

- Reservoir: Oil & Gas
- Start production: late 2013
- Production: more than 100,000 oil-drums per day, 3.9 million cubic meter gas per day and store 950,000 oil drums
- Client / Country: ENI Norge
- Duration: 2010 - 2014
- Scope of Work: Feed, Electrification, Instrumentation, Control, Advanced Solution, Telecommunication
- ENI Norge requirement:
  - Minimize the number of interfaces for Electrical, Instrumentation, Control and Telecommunication systems
  - Support during FEED
  - Service Support
GOLIAT Automation Architecture

Safety & Protections

Process Automation

Machine Control

Electrical Automation
GOLIAT Automation Architecture

Safety & Protections

Process Automation

Machine Control

Electrical Automation
Not just Integration
The other areas of Innovation

Main areas of innovation:

- Anti-Surge & Drive-assisted Anti-Surge Control
- Advanced Load Sharing
- Performance Monitoring System
Compressor instabilities

Surge

- Gas compressors are unstable in certain operating conditions
- Unstable operation can be easily depicted in
- “Surge” is the most dangerous instability, related to low flow, high discharge and/or low suction pressures
- Surge’s pressure and flow oscillations cause high compressor’s blades thermal and mechanical stress
- The stress can be intense and cause blades breaking
- Maximum efficiency stands very close to surge limit
Compressor instabilities
Anti Surge Control

Pressure drop

Flow drop

Pressure Pitch
Antisurge control

Includes all “standard” anti-surge control functionality:

- Control-line control
- Surge protection by ensuring 100% valve signal before reaching the surge line
- Suction/discharge pressure control
- Gain-scheduling and valve linearization functionality
- Fast control cycle time (10ms)

Provides a fully open and integrated anti-surge control system:

- Reduces installation, commissioning, training, and maintenance costs
- Providing the operators with the same look and feel of the other control blocks
Anti surge control
The contribute of VSD

- Variable Speed Drives (VSD) as driver of compressors and pumps is the new growing trend
- This solution enhances availability and energy efficiency of the system
- The only solution for subsea applications
- VSD have a response time of few milliseconds to a step speed reference change
- Gas turbines have a response time of several seconds
- This rapidity can pave the way to new surge protection schemes
Anti surge control
The contribute of VSD

- Standard Anti-Surge Control suffers the “slow” speed of the anti-surge valve
- Surge can take few fractions of seconds to appear.
- VSD are significantly faster than the ASV and can help the compressor to stay safe while the ASV opens.
- Coordinated control between VSD and ASV is a challenge in compressor protection systems
Advanced Load Sharing
What is Load Sharing Optimization

Case Study: Two Similar Compressors operating in parallel

Initial operating point
Less efficient
(Same Speed / Flow)

Optimized operating point
Energy Saving
(Different Speed / Flow)

Same Head

High Efficiency
Advanced Load Sharing
What is Load Sharing Optimization

Control
Optimization
Identification and learning
Advanced Load Sharing
A new approach

Currently the load balance between parallel compressors is computed by:

- Same flow
- Same distance from surge

Advanced load sharing is based on optimization of machines performance taking into account:

- Performance maps
- Compressors aging
- Field information

The optimization parameters are adapted as the system changes by using learning algorithms.
The Performance Monitoring System provides continuous monitoring of the status of rotating equipment (Compressors, Pumps, Turbines, ..)

The actual status, measured from the field and the expected status, defined by a model of the rotating machine

A vibration analyzer (Analyst) monitors the status of the bearings and of the shaft supported by

This tool provides a powerful help for:

- Machine online status monitoring
- Predictive maintenance
- Fault diagnosis
Contact information

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