High-megawatt Electric Drive Applications in Oil & Gas

Workshop on Future Large CO2 Compression Systems

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Oil & Gas Applications for Turbo Machinery
A Typical Conventional Compression Train

- Gas Turbine + Compressor
- Fixed low speed operation
- Efficiency/emission limit
- Maintenance cycle
A Changing World ...

**Scenario**

- Demographics & industrialization
- Supply / demand disconnects
- Elevated cost of energy
- Increasing environmental regulations
- Higher investor / stakeholder expectations

**Challenges**

- Limited resources
- Spare capacity
- Unconventional energy sources
- Reduced emissions
- Cost control
World Is Going More Electric
Power Generation & Distribution

Thermal, Nuclear
- Synchronous
- Mechanical/Electromagnetic Conversion
- Centralized grid

Renewables
- Asynchronous
- Electronic Energy Conversion
- Mini and distributed grid

Constant speed
50/60 Hz AC

Variable speed
DC
World is Going More Electric – Prime Mover

More Electric or All Electric Prime Movers

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World Largest LNG Train from GE (8 MTPY) tested in Massa, Italy
Electric Drives in High Power Compressor Trains

Needs & Challenges

- High power > 10 MW
- High reliability
- High performance
  - low torque ripple
  - low grid harmonics
Very High Power to Ultra-High Power Drives: LNG/e-LNG example

**LNG**
(Gas Turbine Driven)

**e-LNG**
(Electric driven)

- **Higher Availability**
- **Higher Power**
- **High Power Quality**
- **Lower Emission**
- **Higher Efficiency**

LNG Super Train
(Gas turbine driven w/ electric drive)
High Power High Performance Drive Example

**Challenges**

- High power **35MW @ 100Hz**
- Low torque ripple
- High reliability

**Solutions**

- Multi-thread parallel
- Interleaving control
- Less parts-count & proven building block

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High Reliability - High Quality Waveform
35 MW Drive System Test Results at GE Oil & Gas

Massa Testbed, Italy

35 MW, 110 Hz capability

High waveform quality and less complexity

Inverter Currents

Motor Current
Performance Comparison with LCI

Motor Mechanical Torque Ripple (steady state)

LCI

Torque Ripple: 14.8% @ 31MW 3400rpm

IGCT Drive System

Torque Ripple: 3.7% @ 30MW 3300rpm

Torque Ripple reduced by more than 3x
High Speed High Power Direct Drive Compression

- NO GEARBOX
- INCREASED RELIABILITY
- LOWER MAINTENANCE COSTS

High Power High Speed/Freq. Reliable Solutions

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Applications

- **Transportation**
  - Pipeliners
  - Storage
- **Natural Gas**
  - Sales Gas
  - Export
  - Dry Clean Gas Services
- **Downstream**
  - Feed Gas
  - Fuel Gas Boosters

**Integrated Compressor Line:**
- Simple to install
- Easy to operate
- Environmentally friendly

**Integrated high speed motor-compressor**

**Serve the O&G segments up to 15 MW**
Subsea ... Next Frontier

Future Demands/Technologies:

- Long Stepout
- Deeper waters
- Increased power
- Multiple loads

Reliability ... Availability
High Power Electric Drives for Oil & Gas Applications

- LNG
- Large Pipeline Re-injection
- Subsea
- Small Pipeline & Storage

System Speed

Power Rating
Conclusions

- World is going More Electric ... happening in Oil & Gas industry too

- Diverse range of applications for high power electric drives started to emerge

- Many new applications call for new technologies
  - High reliability/availability/maintainability
  - High power
  - High voltage
  - High speed
  - Harsh environment
  - ...
Questions?