Energy Oil & Gas
Gas/Electric Partnership Conference – February 10, 2011
High-Speed Motors and Drives
Presenter: Ingo Dieling
Components of a large drive system

Drive Topology

Semiconductors

Bearings:
Sleeve or
Active Magnetic

Type of Motor:
Induction or
Synchronous
Power Semiconductors

Typical drive power rating:

LV IGBT: up to 15MW

HV IGBT: 30MW

Thyristors: larger than 30MW
Induction Motors

5,500hp – 15,000rpm
20,000hp – 6,000rpm

Application-specific cooling (air-air, air-water, open)

Active magnetic bearings in a flange-type design

Induction motor with solid shaft

Stator – designed for drive converter operation

Self-ventilated with a shaft-mounted fan
Synchronous Motors

In Operation:

22,000hp – 6,600rpm
31,000hp – 6,300rpm
47,000hp – 5,040rpm
88,000hp – 3,780rpm

Active Magnetic Bearings

Sleeve Bearings
Induction Motor – Voltage Source Drive (IGBT)

In Operation:

Power: 4,500hp

Speed: 4,700 – 6300rpm

Active Magnetic Bearings

Air Cooled Perfect Harmony Drive

Application: Compressor – Refinery
Induction Motor – Voltage Source Drive (IGBT)

In Operation:

Power: 4,500hp

Speed: 4,700 – 6300rpm

Active Magnetic Bearings

Air Cooled Perfect Harmony Drive

Application: Compressor – Refinery
47,000hp Synchronous Motor – LCI (Thyristors)

40” Pipeline
Zeebrugge Compressor Station:
4 x 47,000hp Synchronous Motors
Length: 145 miles
Capacity: 2.4 Bcf/d
47,000hp Synchronous Motor – LCI (Thyristors)

Speed range: 2880 – 5040rpm
Sleeve bearings
TEWAC
47,000hp Drive – LCI (Thyristors)

Power Section: 48 Thyristors
12 pulse
Water cooled

Harmonic Filter: 3 tuning frequencies
47,000hp Drive – Converter Transformer – GIS Switchgear

Converter Transformer:
- Designed for outdoor installation
- Two secondary windings (12 pulse)
- Filter winding

GIS MV Switchgear
47,000hp Drive – Extended Scope

Extended scope:
- Water cooling system
- Cabling
- Transportation and Installation
- Commissioning
- Engineering
- Project Management
### 47,000hp Drive System – Technical Data

<table>
<thead>
<tr>
<th></th>
<th>Input Transformer</th>
<th>Harmonic Filter</th>
<th>Frequency Converter</th>
<th>Synchronous Motor</th>
<th>TOTAL EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
<td>47MVA</td>
<td>12MVar</td>
<td>35MW (motor power)</td>
<td>35MW</td>
<td></td>
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<tr>
<td><strong>Efficiency</strong></td>
<td>99.2%</td>
<td>99.7%</td>
<td>99%</td>
<td>98%</td>
<td>96%</td>
</tr>
<tr>
<td><strong>ONAN</strong></td>
<td>4 Winding</td>
<td>Filter and PF correction</td>
<td>12 pulse</td>
<td>Sleeve bearings</td>
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</tr>
<tr>
<td></td>
<td>Semi-Conductors</td>
<td>Redundancy</td>
<td>No. of Pulses</td>
<td>P.F Harmonic Filter</td>
<td>Output Frequency</td>
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</tr>
<tr>
<td>Multi Level PWM</td>
<td>LV IGBT</td>
<td>Cell bypass</td>
<td>18 – 36 pulse</td>
<td>0.95 Filter not required</td>
<td>Up to 330Hz (20,000rpm)</td>
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<tr>
<td>Perfect Harmony</td>
<td>HV IGBT</td>
<td></td>
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<tr>
<td>LCI</td>
<td>Thyristors N+1</td>
<td>N+1 Redundancy</td>
<td>12 pulse</td>
<td>Filter and p.f. correction required</td>
<td>Up to 120Hz (7,200rpm)</td>
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<td>Sinamics GL 150</td>
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</table>
Summary

Multi Level PWM Drive

Induction Motor with AMB or sleeve bearings

Available up to 15,000rpm (5,500hp)
Up to 6,000rpm (20,000hp)
Option for 40,000hp @ 6,000rpm

LCI drive

Synchronous Motor with AMB or sleeve bearings

Above 40,000hp
Summary - Benefits

- Best availability and reliability
- Wide speed control range without any noticeable power losses
- Low emission
  - significantly lower noise level compared to gas turbine
  - oil free when using active magnetic bearings
- Option for shaft mounted axial fans:
  - in many cases forced ventilation can be replaced by self cooling (shaft driven fans) while maintaining safe coast down regarding the cooling of magnetic bearings.
- Elimination of gearbox: less required space, less overall weight of drive line, less maintenance costs
- Retrofitting existing compressor stations that were operated with gas turbines
THANK YOU!