High-megawatt Electric Drive Motors
High-megawatt Electric Drive Motors
Presentation Content

- Total cost of operation
- Large synchronous motors
- Starting methods
- High-megawatt compressor drives
- Very High Voltage motors
- References
- Summary
Total cost of operation (TCO)*

TCO includes:

- Purchase price
- Specifications
- Transportation
- Storage
- QA
- Reliability
- Electricity
- Repairs
- Administration
- Inventory
- etc

*Information provided by Machinemonitor based on survey of 6000 machines
Large Synchronous Motors

- 4-6 pole synchronous compressor motors
- 10 - 60 MW
- 3-150kV
- Efficiency >98%
- Direct on line or VSD/VFD applications

![Graph showing output vs. frame size for 6- and 4-pole motors]
Synchronous Motor Concept

- Features
  - High efficiency
  - Low inrush current
  - Variable power factor

- Rotor design characteristics
  - Salient solid rotor
  - Forged shaft for heavy duty service
  - Brushless exciter
Considerations when Selecting Starting Method

- Short circuit capacity on the network
- Maximum allowed voltage drop on the terminals during start
- Minimum starting torque to give a safe acceleration and synchronization for synchronous motors
- Maximum starting torque not to exceed the allowed shaft torque during start
Starting Methods:

- Direct on line starting
- Reactor starting
- Capacitor starting
- Reactor + capacitor starting
- Transformer starting

Frequency controlled starting

Bus voltage (p.u), Stator current (p.u), Excitation current (p.u), Active power (p.u), Reactive power (p.u)
High-megawatt Compressor Motors

- +40 years experience driving large compressors
- Adaptable for harsh environments Hot, Cold, Hazardous Area
- Water cooled or Air cooled
- Suitable for multiple compressor applications Gas injection, Pipeline, Air separation, Gas oil separation etc.
- Pf control for weak network
Very High Voltage Machines

Conventional

MW, Power
kV, Voltage

Cable
VHV Synchronous Machines - AMT

- Connection
  - Direct to high voltage grid
  - Variable speed with HVDC – light converter supply

- An innovation creating a brand new motor concept
  - Motorformer™: 5 - 50 MW
    - 20 - 70 kV

- Eliminates the need for a transformer
- Higher total efficiency
- Less space than conventional installation
# References

A selection of compressor motors >30MW.

<table>
<thead>
<tr>
<th>Customer</th>
<th>No</th>
<th>User country</th>
<th>Starting</th>
<th>MW</th>
<th>Industry</th>
<th>Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linde</td>
<td>2</td>
<td>UAE</td>
<td>Soft start</td>
<td>59</td>
<td>Air Separation</td>
<td>2010</td>
</tr>
<tr>
<td>Air Liquide</td>
<td>2</td>
<td>South Africa</td>
<td>Soft start</td>
<td>55</td>
<td>Air Separation</td>
<td>2001</td>
</tr>
<tr>
<td>Statoil</td>
<td>2</td>
<td>Norway</td>
<td>HVDC</td>
<td>44</td>
<td>COG</td>
<td>2008</td>
</tr>
<tr>
<td>Wuhan steel works</td>
<td>3</td>
<td>China</td>
<td>Soft start</td>
<td>42</td>
<td>Metal (Blower)</td>
<td>2003</td>
</tr>
<tr>
<td>Linde</td>
<td>2</td>
<td>UAE</td>
<td>Soft start</td>
<td>40</td>
<td>Air Separation</td>
<td>2010</td>
</tr>
<tr>
<td>JSW</td>
<td>3</td>
<td>India</td>
<td>Soft start</td>
<td>40</td>
<td>Metal (Blower)</td>
<td>2007</td>
</tr>
<tr>
<td>Air Liquide</td>
<td>1</td>
<td>Italy</td>
<td>Soft start</td>
<td>40</td>
<td>Air Separation</td>
<td>2008</td>
</tr>
<tr>
<td>NIGC</td>
<td>2</td>
<td>Saudi Arabia</td>
<td>Soft start</td>
<td>35</td>
<td>COG</td>
<td>2003</td>
</tr>
<tr>
<td>BP</td>
<td>2</td>
<td>Azerbadjan</td>
<td>DOL</td>
<td>33</td>
<td>COG</td>
<td>2002</td>
</tr>
<tr>
<td>In Salah</td>
<td>2</td>
<td>Algeria</td>
<td>VSD</td>
<td>12</td>
<td>CO2</td>
<td>2001</td>
</tr>
</tbody>
</table>
Summary

- Synchronous 4-6 pole high-megawatt motors are commonly used for large compressors in air separation and various gas compression applications.
- Highest installed power reference is 59 MW.
- SM motors are a proven reliable compressor drive technology.
- High efficiency is key to total cost optimization.
- Very high voltage is a new technology opportunity.
Power and productivity for a better world™