

Energy Oil & Gas

Gas/Electric Partnership Conference – February 10, 2011

High-Speed Motors and Drives

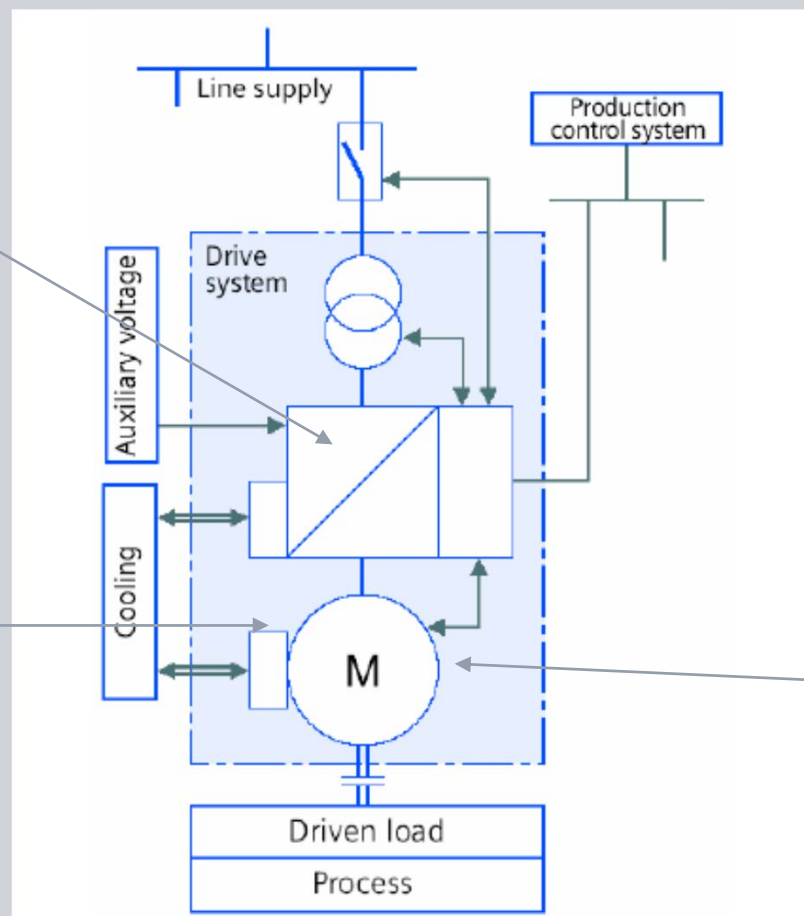
Presenter: Ingo Dieling



Components of a large drive system

Drive Topology
Semiconductors

Bearings:
Sleeve or
Active Magnetic



Type of Motor:
Induction or
Synchronous

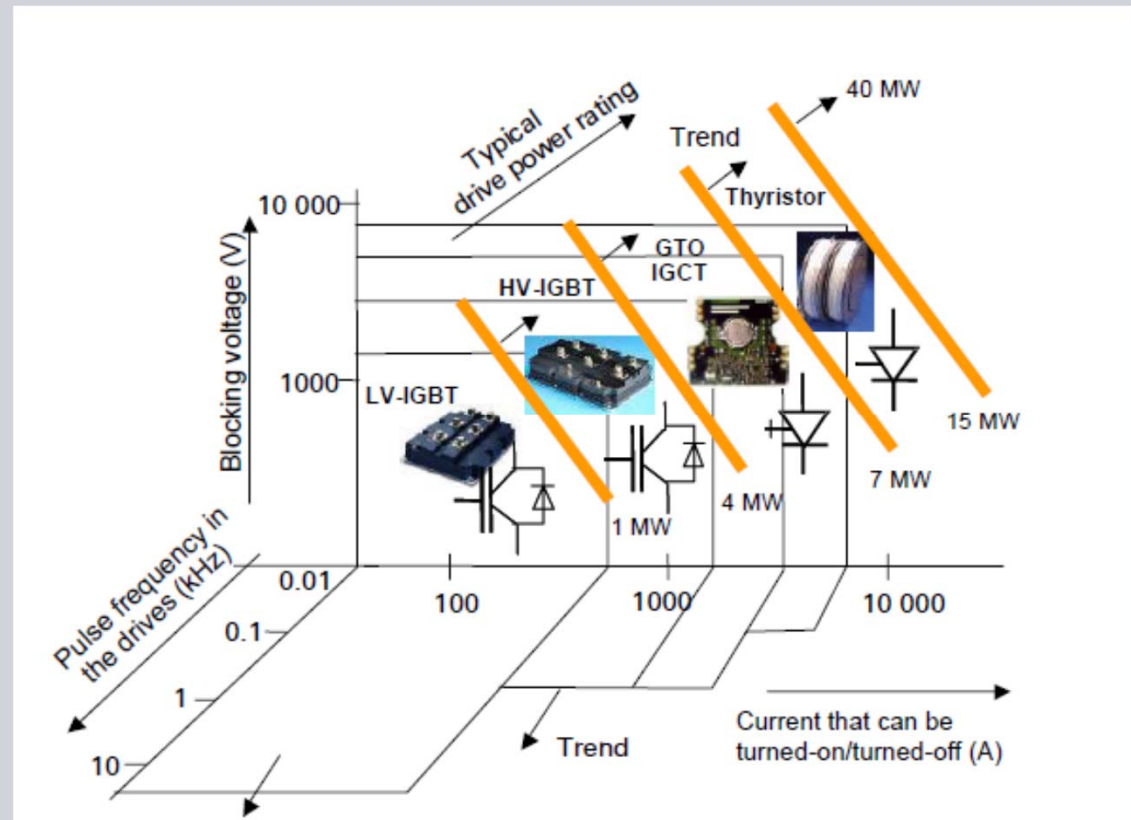
Power Semiconductors

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

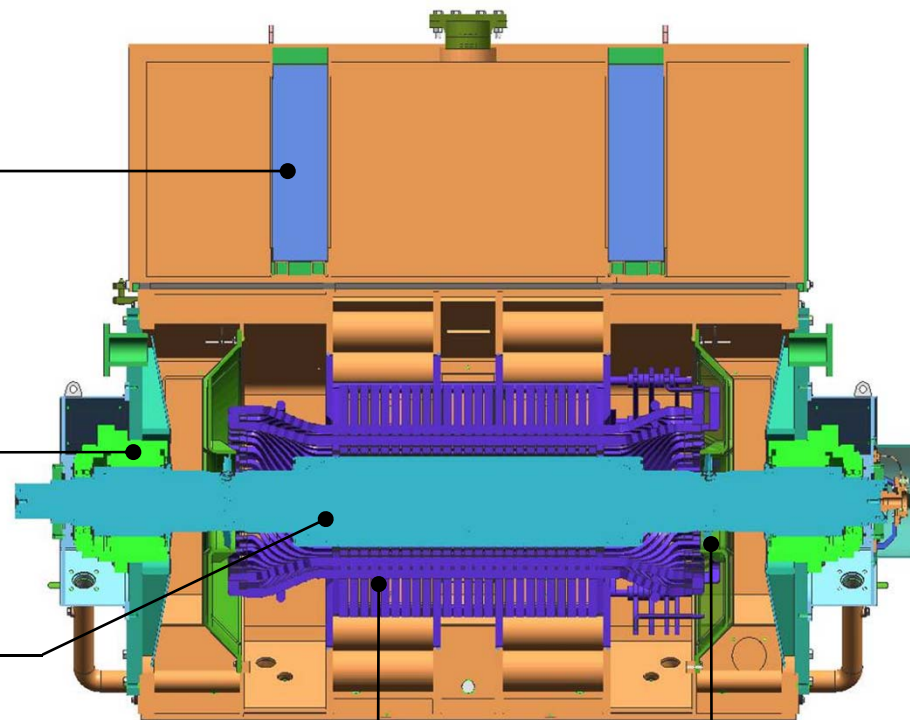
Application-specific cooling
(air-air, air-water, open)

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)

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Active Magnetic Bearings

Air Cooled Perfect Harmony Drive

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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

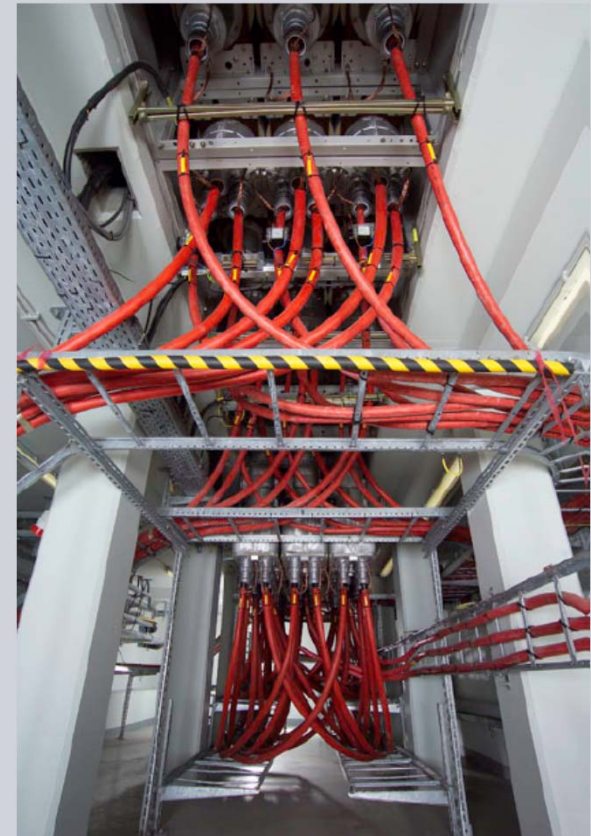
GIS MV Switchgear



47,000hp Drive – Extended Scope

Extended scope:

- Water cooling system
- Cabling
- Transportation and Installation
- Commissioning
- Engineering
- Project Management



47,000hp Drive System – Technical Data

	Input Transformer	Harmonic Filter	Frequency Converter	Synchronous Motor	TOTAL EFFICIENCY
Power	47MVA	12MVar	35MW (motor power)	35MW	
Efficiency	99.2%	99.7%	99%	98%	96%
	ONAN 4 Winding	Filter and PF correction	12 pulse	Sleeve bearings	

Summary

	Semi-Conductors	Redundancy	No. of Pulses	P.F Harmonic Filter	Output Frequency	Cooling	Motor
Multi Level PWM Perfect Harmony	LV IGBT HV IGBT	Cell bypass	18 – 36 pulse	0.95 Filter not required	Up to 330Hz (20,000rpm)	Air cooled up to 8,000hp Water cooled	Induction or Synchronous
LCI Sinamics GL 150	Thyristors	N+1 Redundancy	12 pulse	Filter and p.f. correction required	Up to 120Hz (7,200rpm)	Water cooled	Synchronous

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



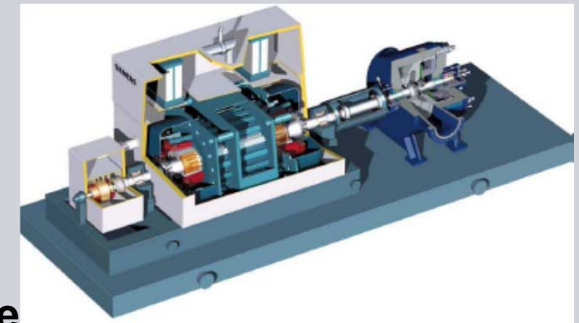
Synchronous Motor with AMB or sleeve bearings



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**



High Speed Motor Session

THANK YOU!

