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Press
release

Voith Turbo:

April 27, 2004

**New Subsea Variable Speed Drive presented by
Voith**

Hydrodynamic variable-speed drives

Voith is the leading manufacturer of hydrodynamic variable-speed couplings, variable-speed transmission couplings and torque converters worldwide. They are used in power generation, in the oil and gas industry, the chemical industry, as well as for material handling. Voith hydrodynamic drives are in service under the toughest conditions around the world. These drives are installed in facilities ranging from production to transportation or processing. On offshore platforms, natural gas pipelines, crude oil and liquid pipelines, refineries, petrochemical plants and other industrial facilities, in the desert, or in arctic environments - Voith variable-speed drives are running 24 hours a day, 365 days per year.

Owing to their compact and robust design, hydrodynamic variable-speed drives allow energy and cost savings, higher flexibility, longer service life of machinery and motor, lower maintenance, and applications in toughest conditions. Their output capacities range from 100 kW to 50,000 kW and speeds of up to 20,000 rpm.

New development for subsea applications

The number of onshore and offshore wells worldwide will soon be equal, with a tendency towards more offshore wells. Major activities are underway in the Gulf of Mexico, Brazil, the North Sea and West Africa. In the North Sea, there are numerous small oil fields spread over a large distance, which require pumping, whereas in the Mexican Gulf the pressure of the well is still high enough for transporting the oil to the platforms. In Brazil and West Africa, the pressure is not high enough in deeper water, which also requires pressure boosting, in order to achieve the growing objective of obtaining acceptable recoveries from subsea wells.

Options currently being considered are:

- Wellbore artificial lift (ESP, gas lift, etc.)
- Subsea separation & single-phase pumping
- Multiphase pumping

In order to cut down on additional platform equipment and also costs, the petroleum industry is planning to locate the pumps, i.e. multiphase or centrifugal pumps, on the sea bed, at depths between 600 m and 3000 m. Almost all recent projects require variable-speed drives for subsea pumping applications, because of the fluctuations in well pressure and flow, as well as the different contents of oil, water and gas to be pumped.

For the drive and speed control of the underwater multiphase pumps, Voith designed a new subsea

variable-speed drive, which is located between a fixed-speed motor and the pump. The drive is designed to transmit up to 10 MW and is based on the hydrodynamic torque converter principle. The new drive concept offers significant capital cost savings and increased reliability compared to conventional variable-frequency drive systems.

Further advantages are

- Very high reliability and availability
- Low space requirements
- Low maintenance cost
- Easy to install
- Simple cable connection
- Unloaded start of motor
- Shock and vibration damping
- No overload of drive motor during operation
- No harmonics

Today, two pump principles are on the market, which Voith is targeting for its new variable-speed drive: twin screw pumps and rotodynamic pumps.

Test run of a prototype in the Voith test field

During the demonstration test run at the Voith factory in Crailsheim, Voith demonstrated the drive to a group of international specialists. The prototype was equipped with actuator, instrumentation and cooling system. The goal of the test run was to show and prove the function of the variable-speed drive, the instruments and the actuators, by simulating operating conditions of 1000 m water depth. Different speed-torque variations as well as subsea capabilities were successfully demonstrated by applying 100 bar water pressure to the housing, while transmitting 1800 kW of power at the input speed of 3600 rpm.

Contents of the test run:

1. Explanation of the test stand with prototype torque converter, mech.equipment components, sensors and data acquisition.
2. Recording of characteristic curve from $v = 0$ to 1 at $p_{\text{water}} = 100$ bar, $p_{\text{oil}} = 120$ bar at guide vane position 0%, 20%, 80% and 20% as reproducibility measurement, limited by temperature and output torque.
3. Characteristic curve evaluation offline at monitor.
4. Positioning and dynamics of guide vane position
 - Speed adjustment through guide vane positioning at constant load
 - Speed adjustment through guide vane positioning at variable load
5. Offline characteristic curve evaluation
6. Repetition of characteristic curve evaluation with $p_{\text{water}} = 100$ bar, $P_{\text{oil}} = 15$ bar.

Function , operating principle and design of the subsea variable-speed drive

The Voith subsea variable-speed drive operates between a constant speed motor and the pump. Voith torque converters are hydrodynamic transmission units that steplessly vary the torque

and speeds between their input and output shaft. The focal point of a hydrodynamic torque converter is a hydraulic circuit consisting of a pump, turbine and a guide wheel with adjustable guide vanes. The mechanical energy of the motor is converted into hydraulic energy through the pump wheel. In the turbine wheel, the same hydraulic energy is converted back into mechanical energy and transmitted to the output shaft. The adjustable guide vanes regulate the mass flow in this hydraulic circuit. With closed guide vanes (small mass flow) the power transmission is minimal; with the guide vanes fully open (large mass flow) it is maximal. Because of the change in the mass flow, the turbine wheel speed is variable and can be adjusted to match the different required speeds of the driven machine, e.g. a multiphase pump. Beside the speed, torque converters can also vary and even increase their output torque, which is especially used for starting, break-away or emergency conditions.

Voith Turbo, the specialist for hydrodynamic drive, coupling and braking systems for road, rail and industrial applications, as well as for ship propulsion systems is a Group Division of Voith.

Voith sets standards worldwide for papermaking technology, power transmission, energy technology, and industrial services. Voith was founded on January 1st, 1867. With annual sales of approximately Euro 3.1 billion, 24,000 employees and 180 locations worldwide, Voith is one of the largest family-owned companies in Europe.



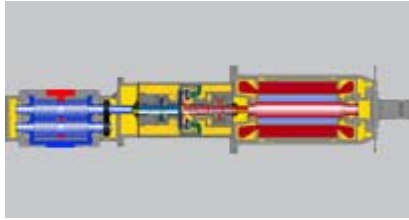
Prototype of Voith Subsea variable-speed drive at Voith test stand

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Prototype of Voith Subsea variable-speed drive at Voith test stand

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Sectional drawing of the Voith Subsea variable-speed drive

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Operating principle of a torque converter

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