Variable Speed Drives
for Combined Cycle Power Plants
Voith Turbo’s proven technology in combined cycle plants

Speed variation produces significant energy savings and efficiency improvement in combined cycle power plants, in cogeneration plants as well as in repowering projects.

Voith variable speed and geared variable speed turbo couplings enable the reliable and economic speed control of HP/IP boiler feed pumps. In addition, Voith torque converters are very reliably and efficiently used as gas turbine starting devices in advanced combined cycle power plants.
Energy reduction and performance improvement of boiler feed pumps

In combined cycle power plants, experience shows that every boiler – including heat recovery boilers – has to fulfill a so-called test point, thus ensuring the safety of the equipment at overload conditions.

The operating point of a pump results from the intersection of pump characteristic curve with the systems resistance curve. Other operating points may be obtained by increasing the systems head loss by throttling. In addition to the head loss the pump efficiency decreases significantly when operating at lower flow rates.

A much more economical way to control the pump flow is to change its speed, resulting in different pump characteristic curves that match the systems unthrottled resistance curve.

The use of a variable speed coupling allows reducing the speed of the boiler feed pump for overload as well as for the speed of base load conditions and also for partial load. This results in significant savings of auxiliary energy. The pump can be operated close to its optimum efficiency over the whole speed range.

When using speed regulation additional cost savings can be achieved by selection of a less expensive recirculation control flow valve and a 100% control valve (small differential pressure).

Service life of a power plant is about 30 years. Nobody can predict fuel and gas prices as well as load patterns over this period of time. Flexibility is a key issue for today’s advanced power station technology. The operation of boiler feed pumps, should be flexible too. This can only be achieved by variable speed operation of pumps.

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**Cost comparison Throttle Control versus Variable Speed Turbo Couplings**

<table>
<thead>
<tr>
<th>3 x 50% Boiler Feed Pumps</th>
<th>Throttle Control</th>
<th>Turbo Couplings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating points</td>
<td>425 MW Test Block</td>
<td>425 MW Test Block</td>
</tr>
<tr>
<td>Operating hours [h/yr]</td>
<td>7,990</td>
<td>10</td>
</tr>
<tr>
<td>Flow [kg/s]</td>
<td>62.70</td>
<td>78.38</td>
</tr>
<tr>
<td>Head [bar]</td>
<td>131.99</td>
<td>115.21</td>
</tr>
<tr>
<td>Feedwater density [kg/m³]</td>
<td>925.87</td>
<td>925.87</td>
</tr>
<tr>
<td>Pump efficiency [%]</td>
<td>78.96</td>
<td>80.00</td>
</tr>
<tr>
<td>Pump speed [rpm]</td>
<td>2,980</td>
<td>2,980</td>
</tr>
<tr>
<td>Absorbed power [kW]</td>
<td>1,132</td>
<td>1,219</td>
</tr>
<tr>
<td>Slip losses [kW]</td>
<td>–</td>
<td>157</td>
</tr>
<tr>
<td>Mechanical losses [kW]</td>
<td>–</td>
<td>12</td>
</tr>
<tr>
<td>Total power [kW]</td>
<td>2 x 1,132</td>
<td>2 x 1,219</td>
</tr>
<tr>
<td>Energy per year [kWh]</td>
<td>18,089,360</td>
<td>24,380</td>
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<tr>
<td>Total energy per year [kWh]</td>
<td>18,113,740</td>
<td>15,366,340</td>
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<tr>
<td>Energy cost 1 kWh: $0.0407</td>
<td>737,229</td>
<td>625,410</td>
</tr>
</tbody>
</table>

Savings: $111,819

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Example of power comparison between throttle control and variable speed coupling.

Example: Cost return studies have shown that amortisation time by speed variation is usually between 6 and 20 month.
Variable speed and geared variable speed turbo couplings

Variable speed turbo couplings for 50% HP/IP boiler feed pumps (3 x 50%)

Variable speed turbo couplings are fluid couplings, connecting the motor with the boiler feed pump. They enable stepless speed control of the pump. Hydrodynamic couplings provide wear free power transmission and vibration damping between input and output. Other benefits include exceptional reliability and availability, smooth acceleration of pump and long service life. All these features result in a more efficient and reliable operation of the pump.

Geared variable speed turbo couplings for 100% HP/IP boiler feed pumps (2 x 100%)

For higher power ranges geared variable speed turbo couplings are used. Input powers of 10,000 kW and speeds up to 6,000 rpm are possible.

Based on their robust design a reliability of 99.8% can be achieved in combination with a squirrel cage motor. Low operating and maintenance costs, high control accuracy and low energy consumption are additional benefits for operators.
Torque converters for starting and turning of gas turbines

Due to its torque-speed characteristic the Voith torque converter is just the right device for starting gas turbines. A high breakaway and acceleration torque is available for start-up of the gas turbine into the self-sustaining speed range.

Hydrodynamic torque converters adapt themselves easily and precisely to the gas turbine requirements. Optimal start-up is guaranteed by adjustable guide vanes and custom tuned hydraulic circuits.

High start-up reliability is secured with Voith. The system availability is over 99.9%.

The torque converter is drainable, eliminating the need of a clutch for disconnection of the starter from the turbine. Torsional vibration is no subject in hydrodynamic power transmission.

Turning Gear

For slow roll requirements of the turbines a turning gear can be attached on the torque converter output, achieving a space saving economical unit.

Complete start-up devices

Torque converter, motor, oil supply and base frame are assembled into a complete drive unit and hence offer the advantages of a complete delivery package from one single source, e. g. reduced number of interfaces, minimized space requirements and project responsibility in one hand.