

Hydraulic solutions for solar thermal power plants

MechChem Africa talks to Jannie Botha (top right), HYDAC SA sales manager for power generation, and André Rodriguez (below right), sector manager for solar power at HYDAC International, about the unique hydraulic, lubrication and conditioning monitoring expertise and solutions the company offers for solar thermal power (CSP) plants.

In South Africa, we are involved with five operating solar thermal power plants,” begins Jannie Botha of HYDAC SA.

In addition, HYDAC services four parabolic trough CSP plants which all use molten salt, thermal oils, or water as the heat transfer medium. HYDAC has developed world-renowned expertise in the hydraulic systems used on these plants, with HYDAC International designing and manufacturing several auxiliary systems.

Solar thermal plants use concentrated solar energy to heat a transfer fluid, typically to temperatures up to 565 °C. This high-temperature fluid – usually thermal oils as well as molten salt – is then passed through a heat exchanger to create the high-pressure steam used to power a steam turbine, which is one of the critical areas where HYDAC technologies are being applied.

“The first key application we develop, install and maintain for solar thermal steam turbines is the lubrication and control oil system for the turbine shaft. Oil is continuously pumped through the turbine shaft both to keep the shaft and bearings cool and to keep the shaft spinning on an oil film. Any metal-to-metal contact between the shaft and bearings would result in a catastrophe,” says Botha.

André Rodriguez of HYDAC International explains further: “When starting a steam turbine, the shaft is resting in contact with its bearings, and it must first be lifted onto an oil film. For this, a jacking oil system is used to pump oil into the shaft bearings at high pressure – 160 to 210 bar – until the turbine is running at the required speed. The system then switches to pumping at a lower pressure of around two to six bar to maintain a constant flow of lubricating and



cooling oil. The same applies when stopping the turbine. Before starting to bring the speed down, the HP system must again be activated so that as the speed reduces, the shaft remains supported above the journal bearings,” he explains.

Turbine lubricating oil also needs to be continuously cooled, dewatered and cleaned. Jannie Botha explains: “A turbine running continuously at 3 000 rpm must always be protected by clean and dry oil. We at HYDAC are specialists in the efficient

removal of moisture from hydraulic and lubrication oil using our vacuum dewatering systems. As the lubricating oil flows between the tank and the turbine, it passes through a heat exchanger, which removes excess heat. Free or dissolved water and gases are then condensed out and removed under vacuum and the oil passes through an ultra-filtration circuit to ensure it is free of solid particles.

“We currently only need to change the oil once every five years or so, but because we continuously monitor the oil condition of each of the turbines we are supporting, we believe this could be stretched to once every 10 years,” suggests Botha, adding that while the systems were designed in Germany, HYDAC SA has been involved from the start and is now taking care of all the service and spare parts requirements, and extra value-added services such as oil condition monitoring.

Another critical HYDAC system supplied for the turbine-generators of solar thermal plants is the steam inlet control system for the steam turbine. “Steam turbines for power generation in South Africa must run at a constant speed of 3 000 rpm to deliver ac electricity into the grid at a fixed frequency of 50 Hz. But the load on the generator varies, so the amount of steam flowing through the turbine must be varied continuously,” Rodriguez outlines.

He says this system is compact in design and fully packed with HYDAC components. A hydraulic actuator’s positioning is controlled using proportional valve technology to adjust the opening of the steam valve to be able to close, open, or retain a set position. “These actuators are controlled with our high-pressure control oil units, which come with corresponding tools to be able to act to protect the turbine in emergency situations that might occur when the power or the pressure drops unintentionally,” he adds.

“There are three critical auxiliary systems for the steam turbines: the lubrication, cooling and jacking system, the inlet steam control system and the oil condition management system,” he notes.

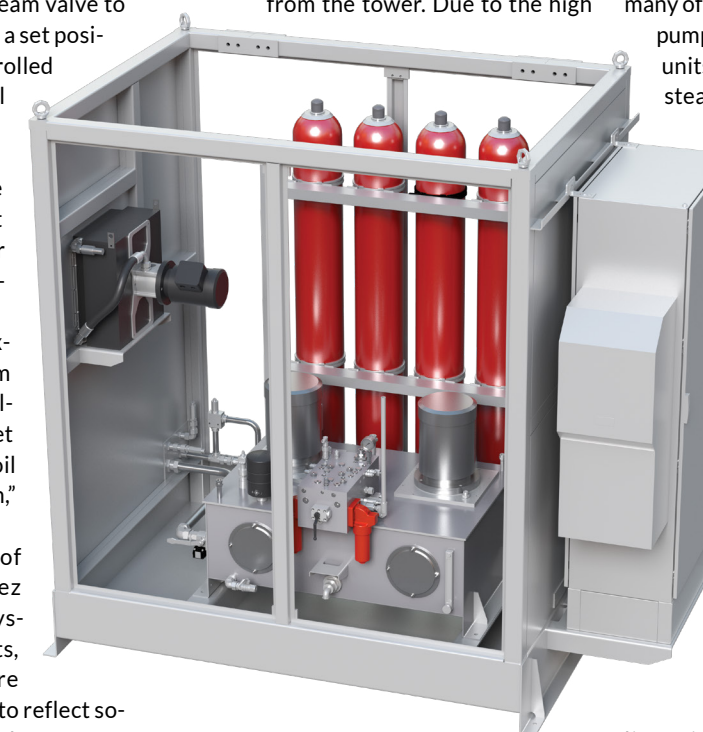
Moving to some balance of plant applications, Rodriguez highlights HYDAC support systems for the solar tracking units, where hydraulic cylinders are used to position the heliostats to reflect solar radiation directly onto the solar tower or the receiver heat pipe of a parabolic trough. “These hydraulic cylinders control the angle of the mirrors all day, supporting the heavy

structures and slowly and accurately following the sun. A parabolic trough might be 100 m long. It is heavy and requires an accurate control system and a high-power density, so hydraulics are ideal,” he says.

Rodriguez highlights the role of accumulators in the control system of the heliostat and trough positioners: “This is unique to HYDAC’s design. It provides much better protection from motor overloads, which can easily occur. The hydraulic motors on competing units without accumulators might have to start every 10 to 15 seconds to keep positional accuracy, but with the actuation pressure coming from an accumulator, our motors need only start every 10 minutes or so to maintain the drive pressure needed to move the tracking cylinders. And when a quick response is needed, during a hailstorm for example, the actuation pressure needed is instantly available from the accumulator,” he explains.

On power towers, he says, high-density molten salt is pumped all the way up to the top of the 250 m tower, where it is heated to 565 °C or so before being pumped down again. “HYDAC has delivered a remarkably interesting molten salt downcomer system to regulate the pressure of the molten salt in the pipe. The solution involves three cylinders, two being operated at any time and one spare, along with two separate valve control units with large accumulator volumes and a complete control cabinet.

“The cylinders are controlling the flow and pressure of the molten salts coming from the tower. Due to the high



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A HYDAC FluidAqua Mobil FAM 5 vacuum dewatering unit for dewatering, degassing and filtering hydraulic and lubrication fluids.

pressure this is a critical application, which therefore includes a redundancy concept to ensure the system can continue to function in all scenarios. HYDAC accumulators make certain that the valves can be moved into safety position, even without electricity. HYDAC delivers this as a complete system, including the electrical controls, cylinders and more, which makes us stand out from the competition,” Rodriguez explains.

HYDAC also supplies other auxiliary systems such as cooling, seal oil or balance of plant products. Pointing to another example, he says: “The pumps transporting the heat transfer fluid through the systems require reliable lubrication, cooling and sealing systems. Solar thermal power plants use many of HYDAC’s hydraulic products; at the pumps, at the tower, on the solar tracking units and mirrors and, critically, on the steam turbine. All these products must work for the plant to produce power reliably.

“We are global leaders in the supply of HYDAC systems and the components that go into them. We have quality hydraulic components, system designs, knowledge, and if you look at our subsidiaries such as HYDAC SA, we have passed on the knowledge of these systems and how to maintain them properly. It is globally unique to have a supplier that not only delivers the systems but can deliver most components from OEM manufacture, and ensure highest yields and availability for these solar applications.

“Our South African office, I believe, is now a centre of excellence for HYDAC Solar Thermal Power solutions,” Andre Rodriguez concludes.

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Solar thermal plants use concentrated solar energy to heat a transfer fluid, typically to temperatures up to 565°C. HYDAC SA service four of the parabolic trough CSP plants in South Africa.