Sealing systems for hot oil pumps

In industrial heat generation, thermal oil has become a popular heat transfer medium. Compared to hot water systems, thermal oil can transfer higher temperatures at lower pressures. This means that hot oil systems allow a lower pressure rating. An electrical heater or burner heats up the oil, users consume the heat, and there is a circulation pump. The trouble-free operation depends primarily on a reliable circulation pump with a corresponding shaft sealing system. Every user of hot oil systems should be aware of the different sealing systems and pump concepts and their advantages. Using the cheapest pump solution often leads to high maintenance costs during operation.

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PUMP CONCEPTS
Low-cost pump concepts normally use standard foot-mounted ductile iron volute casings with a standard single mechanical seal that is separated from the hydraulic parts by an air-cooled intermediate casing. The temperature limit is typically 350°C. However, in applications above 320°C this standard foot-mounted casing can be overstressed and deformed by typically unknown forces and moments generated by the piping system during heating of the plant. For temperatures above 320°C (up to 400°C) a pumping concept based on the chemical standard pump hydraulics is often a better solution. The pump casings can be equipped with centerline mounting, the material can be improved to cast steel and different sealing systems can be used. When cast steel is used, it is also possible to use welded drain pipes which are getting more common nowadays (Figure 2).

SEALING SYSTEMS
Especially for low viscosity and high temperature synthetic oils (e.g. Dowtherm or Diphyl), sophisticated tandem seal arrangements or magnetic couplings are required. In Figure 3, an ideal tandem seal arrangement is shown. In order to minimize the influence of solids (such as cracking particles) on the seal lifetime, the seal face combination is SiC against SiC (silicium carbide is a very hard ceramic material), the bel lows are rotating in order to prevent clogging and the seal chamber is designed as large as possible to prevent the accumulation of solids. The two seals (on the product and atmosphere side) are lubricated by a pressureless air-cooled thermosiphon vessel which also prevents damage to the seals, even during dry running conditions. A constant lubrication and circulation flow is generated by a pump ring. Failure of the product seal can be detected by a level switch in the vessel and the atmosphere seal will prevent leakage. For applications above 350°C, it is possible to have additional water cooling with a cooling coil inside the thermosiphon vessel. Another reliable solution is shaft sealing by magnetic coupling, which is also air-cooled and is absolutely leak-free (Figure 4). The operating principle of the magnetic coupling is very easy. There are internal and external rotating magnets that are separated by a stationary containment shell. This special design separates the magnets with an air-cooled finned casing from the hot pump casing, which means that the magnets are running at a reduced temperature level (maximum 250°C). They are also additionally protected against solids because they are separated from the main circulation flow. Once again SiC against SiC is...
be achieved by combining several units in a battery, which also increases plant availability at the same time.

The circulation pumps of such a system are exposed to extraordinary conditions. At a temperature of 330°C, a flow of 530-630 m³/h against a head of 90 m must be circulated. The typical low-cost pump with a standard foot-mounted casing and a single mechanical seal (as described above) proved to be too weak for this kind of application. The low viscosity synthetic oil can additionally lead to leakage by the single mechanical seal. Therefore heavy duty pumps from Dickow Pumpen KG, a leading manufacturer of hot oil pumps, were selected. A robust design with centreline mounted cast-steel casings and a tandem seal arrangement were selected as the sealing system (see also Figures 2 and 3).

The first installed pumps have been running for over two years now without any problems (Figure 1). In the meantime Bertrams have obtained several orders for similar polyester plants in China and over twenty Dickow pumps have now been installed. All the pumps are in operation and running successfully.

How can you select the right pump and sealing system? Unfortunately, there are no fixed temperature limits, it also depends on the piping and pump size, etc. In regions above 320°C and when using synthetic oils, it is strongly recommended to carefully examine the pump and seal design. When comparing double seal systems and magnetic couplings the latter is not always more expensive. In regions up to 55 kW the initial costs of magnetic coupled pumps are even lower, for larger motors however (and therefore larger couplings), the double seal systems look more attractive. The longest meantime between failure (up to ten years) can only be reached with a proper magnetic coupled pump.

**FIELD EXPERIENCE/APPLICATION**

In 2002 Bertrams Heatec, a leading company in heat transfer plants, located in Muttenz in Switzerland awarded contracts for several heat transfer systems with multiple heaters for polyester plants in China. The heaters had a capacity of 14-16 MW. The selected heat transfer agent was synthetic Dowtherm A. Every heater generated about 157,600 kg/h vapour with a temperature of 337°C and a pressure of 3.5 bar. Process heating using thermal fluids in the vapour phase (flash system or secondary vaporizer) makes it possible to distribute a constant supply of heat uniformly to several users. The capacities range from 100 kW up to about 45 MW per heater, thus covering a broad spectrum of heating requirements. Even larger capacities can be achieved by combining several units in a battery, which also increases plant availability at the same time.

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