Pumps used during tunnel construction: Long service life is crucial

"Years of reliability is our first priority," according to engineer Albert Feisst, the director of liquid engineering who is responsible for all pumps used in Herrenknecht AG tunnel boring machines. Headquartered in southwest Germany, Herrenknecht is a global market leader in its industry. For more than 30 years, pumps from Allweiler AG have played a key role in these machines. Some tunnel boring machines are the size of a house and contain nearly every type of pump manufactured by Allweiler AG.

Robust screw pumps

Screw pumps of the "SNS" and "SNF" series carry feed oil for the entire hydraulic system at a pressure of 25 to 50 bar. They lubricate the gearboxes with low-viscosity oil (up to approximately 460 mm^2/sec) at pressures up to 60 bar. Pumps of the "Trilub“ series are used in the hydraulic system's cooling circuit and as filter pumps alongside units of the “SNS” and “SNF” series. These pumps operate at pressures of approximately 16 bar. All of these pumps have proven their durability and longevity in dozens of cases. "These pumps often stay in service for two to three years without maintenance. During this time we will use them in four or five of our machines," according to Mr. Feisst. Individualized, highly precise configuration of the pumps by the manufacturer is a key aspect of achieving such tremendous durability.

In addition, these pumps are very insensitive to disturbances. It is not uncommon for chips to enter the gear oil the first time a machine is started and during the gearbox's run-in phase. It is essential that this not lead to disturbances in the pump. Screw pumps have also proven to be extremely reliable when temporarily operated under cavitation and aeration conditions.

“Trilub” pumps are characterized by a very long service life in the mid-pressure range. "These pumps are designed in a way that give them a very good price/performance ratio," according to Mr. Feisst. Pumps designed for higher pressure have a pressure relief valve for additional safety. This helps avoid excessive pressure conditions and damage to the overall system. Additional pressure-maintaining and control valves keep system pressure steady as consumption fluctuates. Piston-based pilot control of the valves results in very small hysteresis values and therefore fine control over the pumps. An optional control-oil filter prevents foreign objects from clogging the control nozzles and contaminating the valves. Finally, solenoid valves and controllers allow the operator to preselect several different system pressures and start the pumps in an unpressurized condition. This makes it possible to have virtually pressure-free circulation and operation, such as when starting the pump or when the system stops for a short period of time.

Progressing cavity pumps for ground conditioning

Without progressing cavity pumps from Allweiler, it would not be possible to remove ground from in front of the drilling heads (the “heading face”) and stabilizing the tunnel would be difficult. Progressing cavity pumps of the “ANBP” series pump tenside, which generates foam for keeping dust down and for lubricating the cutting tools.

Injection of tenside foam produces the best results, especially with non-cohesive, water-permeable ground. Proportioning pumps in foam systems move the required basic materials (tenside dissolved in water and polymers). These progressing cavity pumps operate in a pressure range of up to 16 bar. A very steep performance curve is required so the pump will proportion liquids very precisely even when capacity and speed are low. Proportioning accuracy must be independent of pressure, which commonly varies from almost 0 to 6 bar. Multi-stage progressing cavity pumps have proven their value in these situations. They ensure the required proportioning accuracy across a wide range of capacities, from about 5% to 80% of the maximum design value. Herrenknecht uses primarily pumps of the "ADBP” series with maximum pressure of 16 bar and capacity of between 0.2 and 2.5 liters per minute.

Progressing cavity pumps for stabilization

The tunnel boring machine uses steel-reinforced concrete profiles, known as "tubbing" in order to stabilize the tunnel walls in newly dug sections. The space between the ground and the tubbing is then filled with mortar and compacted. A special bi-component mortar used for this purpose consists of a bentonite-cement suspension (the "A component”) and an accelerator (“B component”). Progressing cavity pumps of the “AE-H” series pump this bentonite-cement suspension. These pumps fill the empty spaces with pressures of up to 20 bar and a capacity of up to 120 liters per minute. To ensure that the suspension quickly cures and hardens, progressing cavity pumps of the “AE-H” series add the “B” component (the accelerator) to the discharge side of the bentonite suspension pump. Since there may be no contact with the ambient atmosphere, the mechanical seals on these pumps are secured with a pressureless quench with a hydraulic seal. On the pumps for the "A" component, a gland packing with sealing water seals the shaft.

All pumps utilize frequency converters (“FC”) to operate across a wide control range. These devices precisely adjust capacity to the oversized drives. Generally speaking, all pumps and drives used in the tunnel boring machines are dimensioned so that the pumps' performance will never be exhausted during normal operations. “We work under difficult conditions deep underground, so we always give ourselves plenty of reserves," according to Mr. Feisst. The optimized FC controllers enable the pumps to deliver good efficiency with low energy costs even when working below their performance limits.

Finally, Allweiler centrifugal pumps of the “NB” and “NT” series move water at high pressure. With the exception of peristaltic pumps, Herrenknecht uses every pump type manufactured by Allweiler. Instead of peristaltic pumps, Herrenknecht prefers piston pumps. Similar to their experiences with Allweiler, the company has been using this design successfully for decades. "Although peristaltic pumps in some ways have a superior design, we simply have not had enough experience using them," according to Mr. Feisst.

Global, individual, and flexible

The long service life and tremendous reliability of Allweiler pumps are major reasons why Herrenknecht has such an intensive relationship with this manufacturer. Allweiler’s global presence is another factor. Herrenknecht tunnel boring machines are in operation around the world, so having rapid access to local support is critically important. Allweiler is able to meet this requirement with approximately 100 subsidiaries and partners around the globe.

Despite a standardized design, each tunnel boring machine is individually adapted to the job at hand. This makes customized pumping solutions and the ability to handle special situations particularly important. In fact, Allweiler has proven to be incredibly flexible and competent in situations like these. According to Albert Feisst: "Allweiler is the best supplier we have when it comes to service and customized solutions."

Requirements

Delivery of highly durable pumps with global support for use in tunnel boring machines.

Solution

Allweiler screw, centrifugal, and progressing cavity pumps.

Result

Allweiler pumps are at the core of every tunnel boring machine produced by Herrenknecht, the global market leader.

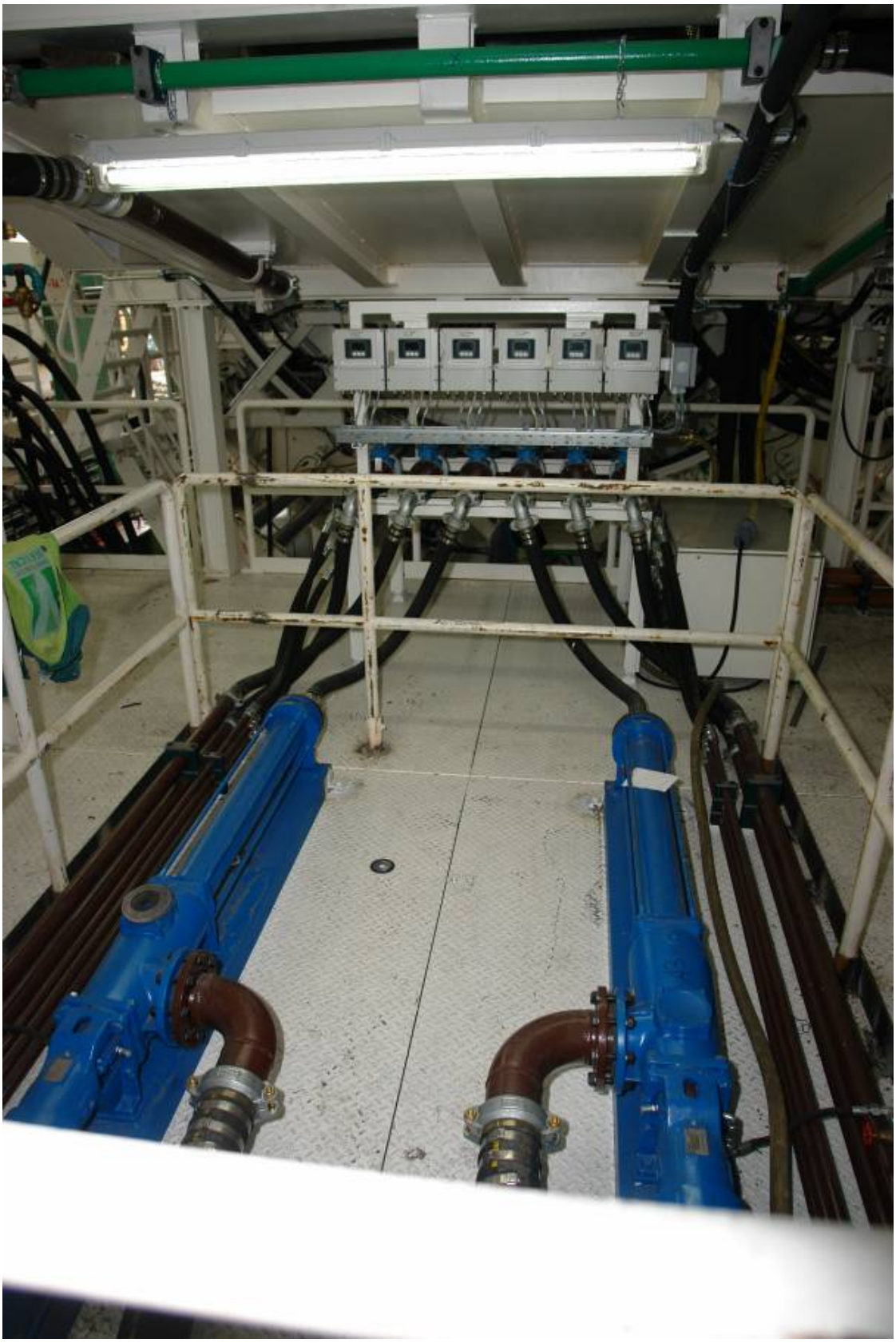
Engineer Albert Feisst is the director of fluid engineering for traffic tunneling at Herrenknecht AG.

Allweiler screw pump of the “SN” series, used as filter oil and cooling system pump.

Allweiler centrifugal pumps of the “NB” series, used as water pumps.

Allweiler progressing cavity pump of the “AE-H” series, used as a bentonite pump.

Allweiler progressing cavity pumps of the “AEB-H” series, used as proportioning pumps with a quench for accelerator.



Allweiler progressing cavity pump of the “AE-H” series, used as bentonite pumps for injecting the ring-gap mortar.

The lower half of the drilling head on a Herrenknecht machine under construction.

Allweiler progressing cavity pumps of the “AEB-H” series, used as proportioning pumps with quench.

Founded in 1860, **Allweiler AG** is the oldest German pump manufacturer and market and technology leader in the areas of ship-building, power generation and special industrial applications. Its product portfolio includes centrifugal pumps, propeller pumps, screw pumps, progressing cavity pumps, hose pumps and macerators as well as complete pump systems. Allweiler AG owns a foundry and manufactures its own stators. The company also produces ready-to-use fuel skids, lube-oil skids, and rinsing-water facilities. Allweiler AG has its main German headquarters in Radolfzell on Lake Constance as well as a major production site in Bottrop, Germany. Allweiler AG has been part of the Colfax Corporation since 1998.

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