Progressive Cavity Pumps Reduce Costs for Digesting Residual Sludge:

Lower energy and maintenance costs while simultaneously reducing downtime

Operators looking for the most reliable, low-maintenance and efficient solution for discharging digested residual sludge at a sewage plant in Germany recently began a comparison of an inclined conveyor versus four-stage progressive cavity pumps. The results show that use of the progressive cavity pumps helped the plant save significant amounts of energy and lower maintenance costs, while simultaneously reducing downtime compared to an inclined conveyor.

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Figure 1: Plant showing sludge silos.

Sewage Plant Looks for Cost Reduction and High Availability

The Duisburg-Kasslerfeld sewage plant serves a large catchment area in western Germany. Approximately 50 percent of the wastewater volume comes from households, with the remainder from a variety of industrial operations, including tank cleaning, beverage production and the Duisburg zoo.

The sewage plant is designed for 450,000 resident equivalent units; its dry-weather inflow is approximately 1.3 cubic meters per second (m3/s) and rainy-weather inflow is up to 4.1 m3/s. In recent years, the plant operator replaced the chambered filter presses with two centrifuges. Following this upgrade the operator had to determine the best possible methods for discharging the dewatered sludge. The

operator decided to compare reliability and economic efficiency of two methods: a centrifuge with an inclined conveyor and a centrifuge with a progressive cavity pump. As the pump solution allowed for 24 hours per day operation, it would lower costs.

The residual is stored in two silos before being transported for incineration. **Figure 1** shows the two feed tubes that lead into the residual sludge silos. In the front silo, an inclined conveyor moves sludge from the top; in the rear silo, a pump moves it from the bottom.

Comparing Progressive Cavity Pump with Inclined Conveyor

Ruhrverband, the non-profit water management company that operates the plant, decided to test the performance of AE-RG series four-stage solid-substance progressive cavity pumps as the residual sludge discharge pump.

Ralf Wilms, Ruhrverband's regional operational group leader, notes, "We wanted to know whether a discharge pump would be a more economical and reliable solution than a conventional inclined conveyor."

The sludge contains approximately 25% dry substance, and the selected AE-RG four-stage progressive cavity pump has several design characteristics that ensure reliable continuous operation with such a high proportion of dry substances. Two force-feed screws arranged in parallel next to each other ensure continuous operation. A wide feed funnel that prevents bridging of the material is another important element to ensure movement of the sludge and disturbance-free operation of the plant. This special pump design does not require a bridge breaker, and the pump's design height is significantly smaller than similar pumps. Even when starting, there are no disturbances because the break-out torque (starting torque) is very low. The pump is controlled by a frequency converter and runs at 30 to 60 Hertz (Hz). The low rotational speed helps the pump achieve a long service life.

The pumps can move drained sludge with dry substance proportion of up to 45%. The two edge-to-edge feed or mixing screws in the feed funnel and the extra-long stuffing housing ensure reliable filling of the pumping elements without bridging or formation of deposits. **Figure 2** provides a look inside the pump.

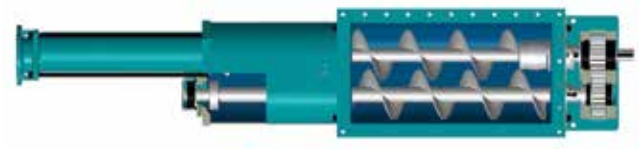

Figure 2: Allweiler AE-RG series progressive cavity pump.

Figure 3: Diagram showing parallel operation of the inclined conveyor (bottom, red zig-zag line) and the progressive cavity discharge pump (top, straight line).

Progressive Cavity Pump Wear and Maintenance Costs Lower than Inclined Conveyor

Since starting operations, the wear and associated maintenance costs for the four-stage progressive cavity pumps have been significantly lower than those of the conveyor. In addition, the pump requires approximately 4 to 5 kilowatt/hour (Kw/h) less energy than the conveyor. The pump moves a daily volume of approximately 55 m^3 of sludge with a dry substance proportion of approximately 25%. Pressure ranges from 4 to 9 bar (58-87 pounds per square inch (psi)). Maximum discharge pressure is about 20 bar (290 psi), so the plant's silo can be completely filled with no difficulty.

In addition to lower energy consumption, the plant has also reduced its spare parts and maintenance costs. As there is a large selection of rotors and stator elastomers operators can find the combination that best matches the pumped liquid's chemical and physical characteristics. This results in the longest possible service life; long maintenance intervals, minimal downtime and very reliable, continuous operations.

Figure 4: Four-stage solid-substance progressive cavity pump, used as a residual sludge discharge pump below the centrifuge.

The plant operator has found significant benefits from using original spare parts due to their significantly greater durability. Repair, assembly and technical consultation services have also proved valuable. In particular, if conditions in the plant change or if pumps will be used in other processes, the manufacturer recommends the materials that will have the longest service life and the configuration with the greatest efficiency.

For example, when a new flocculent is used, a durability test is conducted with several different elastomers to determine the mixture that is precisely adapted to the conditions. Getting the right combination of elastomers for the chemical and physical properties of the liquid is one of the consultation services that pays real dividends.

Proven Results

As of November 2018, the AE-RG pump on centrifuge 1 had been in operation for more than 20,000 hours. It had experienced one change of stator at approximately 9,300 operating hours and the first service at 16,000 hours. The pump on centrifuge 2 has been operating since January 2018 without maintenance and no failure in operation. The manufacturer anticipates that the pump will complete up to approx. 20,000 operating hours before needing overhaul. The progressive cavity pump has really proven itself.

About the Authors

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