Water & wastewater

Operation under high pressure

When a Swiss energy company wanted to minimise the wear on hydraulic control valves in its hydroelectric power station caused by glaciers and suspended solids, it installed specially adapted automatic basket strainers designed for water pressures of up to 1,160 psi (80 bar).

The Kraftwerke Oberhasli AG power plant (KWO) can generate energy on demand at any time using water dammed in the Grimselsee, 1909 m above sea level. The Swiss energy company makes an important contribution to generating electricity and stabilising the grid in Switzerland and Europe from its hydroelectric power plants in the Grimsel area. In addition, reservoirs act as natural batteries in which energy can be stored in the form of water and later used to generate electricity.

However, the use of natural glacial run-off and rainwater poses the problem of suspended matter. The glacier is continuously eroding extremely fine stone particles from the mountains. These solids, derived from glacial abrasion, are transported by the runoff into the reservoir and collect there together with other suspended matter brought in by rainfall. These 25–200-micron (µm) particles pose a problem for the huge turbines in the KWO power plants, as they cause heavy wear of the slide valves. These valves use the pressure of the water to control the ball valves which, in turn, control the intake to the turbines. Due to the water's drop height of 670 m, very high pressures occur in the valves and their supply lines.

Heavy wear

Sand settling tanks are in place upstream, which prevent the entry of coarse particles into the control valves, however they have demonstrated only limited success. "Until now, the valves had to be cleaned and repaired by KWO every three to four months," explains Franz Christen, sales and technical manager at BT-Hydraulik AG, which was commissioned by KWO to find a solution to the problem.

In the past, the valves had to be completely replaced on a regular basis, but now they are no longer available on the market. To reduce or, ideally, eliminate costly and time-consuming repairs, the hydroelectric power plant operator was interested in finding a new solution. "The installation of larger settling tanks was not an option," continues Christen. "At water pressures of 870 psi (60 bar), 1,160 psi (80 bar) or even more than 1,450 psi (100 bar), very large, complex tanks would be needed. But that would not be feasible for economic and environmental reasons, and for lack of space. Converting to oil hydraulics was likewise not feasible for the same reasons." Therefore, KWO decided to install filter systems directly upstream of the control valves and turned to BT-Hydraulik, a leading company in the field of hydraulic drive technology.

Basket strainer

The experts from the Berne-based company advised KWO to use an automatic basket strainer. "Conventional filters clog up over time and need to be serviced and replaced at regular intervals," Christen

The Kraftwerke Oberhasli AG power plant (KWO) can generate energy on demand at any time using water dammed in the Grimselsee, 1909 m above sea level. (Image: Shutterstock)

The Eaton Model 2596 automatic self-cleaning strainer is designed for continuous, uninterrupted removal of entrained solids from liquids in pipeline systems.

explains. "An automatically self-cleaning filter is the more economical solution." The problem is that standard backwash filters are not designed for the high pressures in a hydroelectric power plant. BT-Hydraulik, together with Eaton, worked on refining the Eaton Model 2596 strainer. This motor-driven strainer provides continuous removal of solids from fluids in pipework systems - though only within a standard pressure range up to a maximum of 232 psi (16 bar). However, Eaton provides customization of this filter system to serve customer-specific applications.

A version of the Eaton Model 2596 automatic basket strainer was developed for KWO that is designed for pressures of up to 1,160 psi (80 bar). However, a variety of measures were required to make this possible. Firstly, in order to withstand the high pressures, Eaton modified the entire housing by increasing the wall thickness and making the cover considerably sturdier. In addition, the flushing arm drive shaft was sealed with a quadruple mechanical seal. "A particularly challenging problem was to find a filter element that offers the highest possible filter fineness that could also withstand the high pressures and was backwashable," says Christen.

A reinforced version of the DuraWedge filter elements proved to be the solution. It is made of V-shaped stainless steel wire profiles and even the standard version is capable of being used in demanding applications. After being further reinforced, the filter elements now can withstand the high pressures in the hydroelectric power plant, filtering out a large part of the suspended matter due to a filter fineness of 25 µm. "However, the system had to be additionally adjusted so that the screen baskets would not be deformed in the backwash phase," explains Christen. "A pressure reduction of 870 psi (60 bar) to the ambient pressure would have been problematic despite the reinforcement."

So far there are four high-pressure basket strainers being used in KWO's hydroelectric power plant. The basket strainers have also been adapted to the operating parameters used in the plant.
The connector size for two of the filters is 2 in and for the remaining two, the size is 3 in, with a flow rate of between 53–106 gallons per minute (gpm) or 200–400 litres per minute (lpm).

However, the design of the high-pressure strainer basket developed jointly by Eaton and BT-Hydraulik can also be adapted to other parameters, in line with whatever the application requires. The backwash is triggered by an Eaton control, and in KWO's case, it is whenever the differential pressure reaches 11.6 psi (0.8 bar). Alternatively, control using predetermined time intervals or permanent backwashing would also be feasible.

Cost reduction

Even though the test phase of the new filter system at KWO is scheduled to run for several years, initial results are already clear. "The results are very good," says KWO. "So far we have had no outages and the system perfectly meets our needs in terms of maintaining and cleaning the baskets." Especially when compared with the turbine lines where the sliding gate valves have not yet been retrofitted, it is clear that wear and tear has been significantly reduced, while the amount of maintenance required and the associated costs have been minimised by the high-pressure automatic basket strainer. ●

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Eaton Model 2596 automatic self-cleaning strainer (version for pressures up to 1,450 psi (100 bar).