Effects of suspended sediment on Pelton turbine wear and efficiency

Wysswasser (left), as an example of a mountain stream carrying suspended sediment from a glaciated catchment area

Natural rivers may transport leaves and driftwood, gravel, sand and suspended mineral particles. Handling the so called “solid load” is a challenge for hydro power engineers and hydro power plant operators.

Hydropower plants in the Alps are generally equipped with trash rakes as well as gravel and sand traps. At hydropower plants in which water from highly glaciated catchment areas, so called “glacier milk”, is used and the water is not stored in lakes where also fine particles could settle, the turbine water may contain suspended mineral particles of considerable concentration. These may damage the turbines. At a head of 500 m for example, inside a Pelton turbine, the veloc-ity of the jet towards the runner is about 360 km/h. Especially the hard particles, e.g. quartz, cause wear on turbine parts, what is also called hydro-abrasive erosion. Nowa-days the problem of hydro-abrasive wear gets more important, as sediment yield tends to increase with higher variability of meteoroligical events, the energy efficiency shall be increased and the hydro power plants are expected to be operated in a sustainable way.

When investigating hydro-abrasive wear, a major challange is that suspended load varies strongly through the year. Thus, a continuous monitoring of suspended sediment concentration and particle size distribution is required. Up to now, particle size distribution could only be obtained by analyzing bottled samples in a laboratory. In this research project, an in-situ laser diffractometer is used at the Fieschertal hydropower plant in upper Valais, Switzerland. This device allows measuring continually suspended sediment concentration and particle size distribution.

The investigation of suspended particles in the water of a hydropower plant together with periodical inspection of the turbines and monitoring of their efficiency shall contribute to enhance the understanding and the ability to model hydro-abrasive wear. This serves as a basis for further improving the layout and design of hydropower plants and their components (e.g. desilting facilities, turbines), their instrumentation and operation.

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