LOW HEAD TURBINES

Fit for the Future

When Austrian professor Viktor Kaplan (1876–1934) filed his essential patents for the eponymous turbine in 1912 and 1913, he opened the way for a new technology able to use low hydrostatic heads for power generation in an economically feasible way. Now, considering low-head applications automatically leads to discussion of Kaplan turbines, either horizontal or vertical.

Although there are not that many large-scale green field projects featuring Kaplan machines currently underway in Europe, there is nonetheless a huge potential for this turbine type in small hydro applications. With new requirements for grid control, increasing demands for ecological performance and minimizing fish injury rates in particular, the operators of existing low-head power plants are being driven toward equipment upgrades. Consequently it is vital this technology is continually developed to be fit for the needs of the 21st century and beyond. ANDRITZ – the worldwide leader in low head turbines – focused its research and development efforts on meeting these new demands at an early stage and thus has appropriate solutions in place.

CHANGING CONTROL REQUIREMENTS

Switching turbine regulation from level control to primary control introduces a significant change in the frequency of regulation movements by the runner and guide vane mechanisms. More regulation movements result in more load cycles for the affected parts and inevitably make fatigue a greater consideration.

ANDRITZ has developed tools to accurately assess the impact of changing operational requirements on fatigue and can therefore support energy producers in the diagnosis and assessment of the residual service life of turbine equipment.

DEMANDING ENVIRONMENTAL PERFORMANCE

The impact hydropower stations have on aquatic life has become a major issue for new hydropower plants and the refurbishment of existing hydraulic turbines. Increasing demands for environmental performance have prompted changes in the use of problematic substances such as lubricating oils, for example.

Development of oil-free solutions for Kaplan turbine runners was initiated many years ago and within the last 25 years ANDRITZ has recorded more than 200 references. These examples include oil-free Kaplan runners up to largest diameters, outputs and heads for these types of machines. Each one is the best possible solution for the given application. Instead of oil, the hub is filled with water together with corrosion inhibitors which are non-toxic and not hazardous to aquatic life.

FISH-FRIENDLY SOLUTIONS

From the first phases of considering plant design and layout or a refurbishment program, important parameters are set that have a major influence on both energetic and environmental performance. In particular, the hydraulic as well as the mechanical design of the turbines offers many opportunities to significantly and positively influence fish survival rates. In order to accurately assess different designs in terms of their fish mortality-related performance, comprehensive knowledge of injury mechanisms and their corresponding mitigation measures is necessary.

Since the 1990s, ANDRITZ has followed a combined design strategy to ensure high rates of fish survival. Different design features are possible, associated with the various injury mechanisms caused by the different stressors (measurable, physical qualities that can be linked to each injury mechanism). It is worth noting that the optimal choice of design parameters for fish survival might be slightly different from those design considerations in which maximizing energy production or minimizing costs are the only targets. Nonetheless, efficient operations and good fish survival rates are possible if the appropriate design considerations are made.

ANDRITZ uses a biological assessment tool supported by CFD to record the various stressors on a fish along its trajectory through an operating turbine. Based on in-depth knowledge of the stressor limits for injuries to various fish species, survival rates can be calculated with this assessment tool.

Viktor Kaplan's idea for a low head and efficient turbine emerged more than a century ago but, in light of changing environmental, economic and operational needs, this ingenious basic idea must evolve and change too. ANDRITZ strives to ensure that Kaplan's idea continues to advance and fulfill today's demanding requirements, making his legacy FIT FOR THE FUTURE.