



POWER NEEDLE

BACKGROUND: Controlling the power needle is critical to any hydroelectric plant with an impulse turbine configuration. Operating head ranges are between 20-2000 meters where the water is converted to a high velocity jet stream when released from the nozzle's orifice. As part of the nozzle for an impulse turbine, the power needle controls the water jet that impinges on a series of buckets rotating the runner.

There are two types of impulse turbines, Pelton and Turgo. A Pelton turbine power needle is in-line with the buckets of the runner that splits the water jet in half for maximum efficiency. The water impinges on the buckets from an incline, releasing it to the other side of the buckets with a Turgo turbine. Orientation can either be vertical or horizontal. Single and multi-jet power needles can also be utilized for a system. A deflector or other method of redirecting the water jet can be used as both for more control and safety. The use of either turbines and configuration can vary depending on plant strategy.

KEY TO SUCCESS: High resolution power needle control is critical as this application regulates available water flow to the unit when in normal or islanded operation. A power needle works in conjunction with governing control, which is a separate function. If the generator/plant protection scheme detects low frequency, it activates the needle to recover frequency by opening the needle during system separation and load acceptance, i.e. more power to the turbine. The governor will then take over to maintain unit frequency.

ELECTRAULIC™ ACTUATION

PROBLEM: Some of the challenges that are encountered at a hydroelectric plant with an impulse turbine are related to reliability, environmental protection, and most importantly, safety. Changes in electric demand have caused plants to cycle more frequently throughout the day adding more stress to equipment, degrading the performance capabilities or disabling them all together. For some hydraulic power units (HPUs), the performance demand can reduce reliability, increasing potential contamination of the hydraulic fluid, that is a major contributor of failures. One method for mitigating hydraulic fluid contamination is to increase oil volumes to help reduce the concentration of particulates, entrained air, moisture, and degraded oil. While the solution of increasing oil volume reduces contamination in an HPU, the oil volume and the potential for oil spills increase as the trade off.

SOLUTION: When applied to a power needle application, a REXA Electraulic™ Actuator has the performance and reliability to safely regulate water flow during normal and islanded operation. A distinguishing factor is the true closed loop design of the Flow Match Valve (FMV) technology, raising the standard for hydraulic performance and capabilities. The REXA Actuator responds instantly, less than a second ($dT < 90mS$), to a signal change to reach target position. REXA provides two-speed functionality, fast opening for frequency recovery with slow opening during normal operation, and slow to close as a protective measure to prevent water hammer. Under varying load conditions, precise target position can be achieved when the water is going through the nozzle and without the oil quality affecting system capabilities. While advanced in design, its simplicity in hydraulic circuitry eliminates the need to maintain oil cleanliness and have large oil volumes (reduced by 95%) assuring the actuator maintains stability throughout operation. There is no oil sampling, testing, and maintenance required. With a rating of two million full stroke cycles (with cycle built in cycle counters) and 10 million dither cycles, downtime is reduced.



RESULT

Upgrading from an oil pressure system to REXA Electraulic™ Actuation to operate a power needle can provide immediate benefits for a hydroelectric plant. Savings can be realized from eliminating maintenance on oil and components like filters and conditioning systems. The added benefit associated with REXA's true closed loop system uses very little oil volumes to operate reducing environmental risk by a large margin. With REXA Electraulic™ Actuation, a power needle can be operated reliably while reducing as much environmental impact as possible.

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