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PROCESS INSTRUMENTATION

Power generation efficiency **boosted up** by clamp-on flow meters

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Energy storage facility uses SITRANS FS230 ultrasonic clamp-on flow meter to maximize efficiency of turbines

When an energy storage facility in New York, USA was looking for a way to improve the efficiency of their power generating turbines they did not have many options to choose from. Because of the sheer size, the space limitations and performance requirements of the application, the only option was to install a SITRANS FS230 clamp-on ultrasonic flow meter from Siemens. Several competitors had tried to accommodate the special application requirements, but they had not been able to come up with a viable solution. Once Siemens won the project it took some additional time to complete, the reason being that the meter had to be custom tailored specifically to the application.

Background

The plant, which is a recharge type system, supplies over a million kilowatts of energy during peak demand periods by cycling water between two reservoirs. One is at the top of a mountain the other is at the base with approximately 1500 ft (467 m) between them; a height difference several times that of Niagara Falls.

During periods of peak demand the water is routed from the upper to the lower reservoir making the turbines produce power through gravitational forces only. When the demand for water is low, the water is pumped back uphill using the turbines and generators as pumps.

In order to improve the performance of the turbine it was necessary to monitor the output efficiency by measuring certain aspects of the application, such as flow and pressure. These values are used to calculate the turbine performance enabling plant operators to monitor the entire process and to detect any trends and track changes over time. To obtain the accurate results to provide an exact picture of the turbine's performance, highly accurate (± 1%) metering devices were needed. And this is where the FS230 came in.

Non-intrusive transducers are mounted on the four foot section of pipe with magnetic assemblies before the transition of the full bore ball valve to the turbine.

The challenge

One of the major issues at the energy facility was the installation itself. Because of the way it was configured with water flowing to the turbine during the day and water being pumped back up to the reservoir at night, the solution had to take this bi-directional flow into account. In addition, the pipe diameter was so large and the pressures so high that only one flow technology was deemed fit for the job: ultrasonic clamp-on flow measurement. Although an ultrasonic insert type meter was also considered it was ultimately disregarded for two reasons: the fear of leaks and the need to entirely drain the upper reservoir. Because this had never been done before, it was decided not to pursue this option.

Although the clamp-on flow meter FS230 was the most optimum choice for this installation there were still several problems to overcome:

- The penstock piping was very large with an outer diameter of 113" (2,87 m) and a 1.313" (33,35 mm) steel walled pipe. In addition, it was only partially accessible through a small maintenance vault.
- The distance from where the penstock entered the vault to the transition of the full bore ball valve was only 4 ft (1,22 m).
- The flow velocity was very high at ± 50 ft/s (15,24 m/s) making measurement extremely challenging.
- The flow was bi-directional with the metering location only a few feet downstream of the turbine when it was in pump mode. This resulted in a very poor flow profile and severe flow turbulence making measurements a challenge to read.

The solution

After a good bit of extensive research, Siemens developed a non-intrusive solution based on the FS230 clamp-on flow meter that lived up to all of the customer's requirements:

- Specialized shallow path ultrasonic transducers were developed for the FS230 that could operate in reflect mode with a minimal linear distance of pipe. Paired with the custom flow computing software the flow meter was able to read signals that were previously most challenging.
- The position of the gate valve, upstream of the turbine, was transmitted as an analog output to the meter and used to calculate a ball park figure of the flow rate, leaving the meter to compute a higher resolution measurement of the actual flow. This increased the meter's ability to accurately measure the flow with an accuracy of ± 1% by improving the correlation of the upstream and downstream ultrasonic signals.
- Magnetic assemblies were configured to mount the transducers tightly to the pipe in the very small space available. The geometry of the vault simply prevented the use of full circumference mounting straps.
- A control routine was implemented to continuously adapt to the changing application based on the operating conditions.

So, even though the odds were tough, Siemens designed a solution that overcame all obstacles and achieved or exceeded all of the required performance criteria.

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