Iguaçu Falls, the largest series of waterfalls on the planet.

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Hydroelectric Plant Benefits from Early Detection of Moisture in Oil

World's largest hydroelectric plant implemented real-time water-in-oil detection to increase availability of its generating units.

Itaipu Binacional, a partnership between Brazil and Paraguay on the border of the two countries, is the world's largest hydroelectric generating plant. Its development began in 1972, when engineers searched for the best location to build a power plant on the Paraná River, near the famous horseshoe-shaped Iguaçu Falls. The site selected for its potential high energy yield was a river stretch known as itaipu, guarani for "singing boulder".

The construction of the plant began in 1974, and the dam was completed in 1981 with 12.3 million cubic meters of concrete, 14-gate spillway, and with up to 40,000 workers on the job site at the peak of construction. Energy production began from the first turbines in 1984, reaching a production peak in 2008 of 94.7 billion kilowatt-hours with 20 generating units.

Fewer Unscheduled Shutdowns Increases Availability of Generating Units

Itaipu Binacional has 20 generating units that collectively produce nearly 20 percent of all energy consumed in Brazil and nearly 90 percent of energy consumed in Paraguay. Therefore it is no wonder that availability of generating units is a top priority for Itaipu. Specifically, Itaipu has been looking to improve the early detection of water contamination in the lubricant oil in the turbine bearings in its generating units.

Water contamination, especially free water, in lubricating oil causes numerous problems, including corrosion, loss of lubricating properties, machine malfunction, or automatic shutdown when water levels cause oil levels to exceed operating limits.

A non-operational unit can cause large financial losses, but availability is most important for Itaipu. If automatic shutdown of a unit were to occur for even a short time during peak hours, the consequences to the electrical system could be significant.

Real-time detection of water contamination allows preventative action to be taken quickly to avoid further problems, including automatic shutdown. If moisture levels in the oil reach alarm conditions,

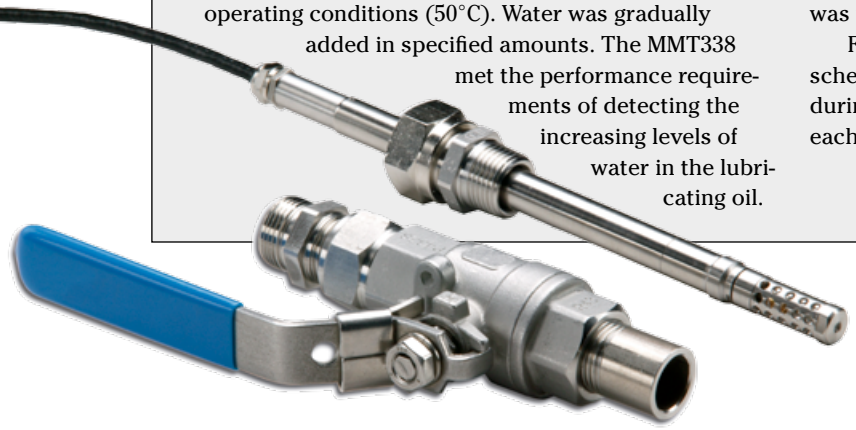
Extensive Lab and Operational Testing to Select a Sensor

In their quest to improve water-in-oil detection, Itaipu looked at humidity in oil sensors from several manufacturers. In the end, they chose Vaisala HUMICAP® Moisture and Temperature Transmitter for Oil MMT338, and developed a test protocol to see if the sensor's performance would meet their needs.

The first step was to test the sensor in a lab environment. The sensor was installed in a tank containing 50 liters of lubricating oil with temperatures held to normal operating conditions (50°C). Water was gradually added in specified amounts. The MMT338 met the performance requirements of detecting the increasing levels of water in the lubricating oil.

After satisfactory results of the lab test, the next step was to test the sensor under real-life conditions in an operational generating unit in the hydroelectric plant. This second test looked for false readings of moisture in oil (false alarms), indication of water saturation level before and after temperature changes, installation method of the sensor, and sensor performance when oil temperatures are lower and when temperatures are stabilized. After one year of operational testing, Vaisala's MMT338 was noted to perform to specifications.

Full operational implementation of the sensors is scheduled to begin in June 2010. Sensors will be installed during scheduled preventative maintenance windows in each of the 19 remaining turbines.



Itaipu's maintenance teams can look for the water leakage source in each of the four oil-water heat exchangers. Once the leaking heat exchanger is identified, it can be isolated to prevent further leakage.

Proactive Health Management of Assets

Real-time monitoring of moisture in lubricating, insulating, or cooling-agent oil used in turbines and transformers also allows for proactive health management of assets. Proactive maintenance not only reduces maintenance costs, but helps keep the assets running 24/7. In Itaipu's case, it has increased the availability of their turbines.

Water can cause corrosion, degrade insulating properties, and reduce dielectric strength. Adding moisture-in-oil sensors to the transformers means that problems can be detected early, and extreme cases such as arcing and short circuits can be avoided.

Next Step: Implementation

The project to improve early water-in-oil detection was led by Mr. Nilton S. Ramos Quoirin, Itaipu Electrical Engineer in Brazil, and Mr. Armando L. Ortiz Torres, Itaipu Electrical Engineer in Paraguay.

They looked at humidity in oil sensors from several manufacturers before deciding on Vaisala HUMICAP® Moisture and Temperature Transmitter for Oil MMT338. According to Mr. Quoirin, Vaisala's sensor had the necessary features, such as water activity measurement, alarm relay, 4–20 milliamp output, and an LCD display.

The MMT338 is specifically designed for early detection of moisture in oil in pipeline installations. It indicates the margin to saturation in oil in terms of water activity (aw), which as a parameter is independent of oil type, age and temperature. Additionally, it can also provide output in parts per million (ppm).

After extensive testing, Itaipu is now moving ahead with full operational installation of the MMT338.

"By detecting the presence of water at a very early stage, we are able to quickly find the water leakage source. Repair can be done while the generator is running. It is possible to take corrective measures before the water reaches an excessively high level and the generating unit is automatically shut down," says Quoirin, adding:

"The installation of the MMT338 sensor in the other turbines will contribute to minimize the forced unavailability of the power plant."