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In the competitive electric power generation market, attention must be given to improving condenser operating efficiency. Steam turbines cannot attain their specified performance without an efficient condenser. Tube leaks that affect condenser performance are critical. Most condenser tubes are designed to last at least 30 years. Unfortunately, normal plant operation, changes in water chemistry, and other circumstances often create a shorter life for tubes. Most condensers are overbuilt to allow for a certain percentage of tubes to be plugged when a leak is detected.

In the past, Seminole Electric , headquartered in Tampa, FL, like other utilities, used methods including pasting wet newspapers against tube sheets, spraying thick foam, or using saran wrap to locate condenser tube leaks. These methods were slow, required multiple experienced operators at inconveniencing hours (plants can typically be brought to a partial load only during the midnight shift), and worse, were often ineffective.

By using a ruggedized portable ultrasonic leak detector, Brian Thorp, predictive maintenance (PdM) technician for Seminole Electric, has been able to provide quick leak detection and repair on an aging steam condenser, allowing the utility to provide maximum power during high demand periods.

Ultrasonic technology

Ultrasonic leak detectors work like simple microphones that are sensitive to high-frequency sounds ranging from 20-100 kHz. In comparison, most humans can hear at most 17-19 kHz.

Using a sensitive piezoelectric crystal element as a sensor, minute high-frequency sound waves excite or "flex" the crystal, creating an electrical pulse that is amplified and then heterodyned, or translated, into an audible frequency that the technician can hear through a pair of noise reduction headphones.

As a leak passes from a high pressure to a low pressure, it creates turbulence. The turbulence generates a high- frequency sound component, which is detected by the piezoelectric element, allowing the technician to guide the instrument to the loudest point in order to pinpoint the leak.

Several ultrasonic detectors use parabolic or elliptical reflectors to enhance and concentrate the leak signal, which can be useful when detecting small leaks or scanning at a great distance.

Effects of tube leaks

The condenser is the largest heat exchanger in the condensate/feedwater network. It is located under the steam turbine generator. When the steam exits the turbine, it is passed over cool pipes (cooled by river water) that condense it to liquid water. The purified water is pumped back to the boiler to be heated to steam again. The same purified water is boiled and condensed over and over.

Keeping the condenser tubes from leaking the river water into the steam or clean side of the condenser is a key to achieving optimum performance. Fresh water leaking into the purified system can wreak havoc by causing corrosion throughout the system and can significantly reduce operating life if not rapidly addressed.

Leak detection in condensers

The Seminole Electric plant condensers contain 44,000 one-in. tubes per unit and feature a split design, with eight water boxes or two loops. This allows the plant to isolate one loop or four water boxes while running at a partial load. Isolating a section of the condenser allows Thorp to drain the cooling water and enter the water boxes while the plant is still operating. Because the turbine is still operating, a vacuum is present on the steam side of the condenser tube. This vacuum creates a pressure differential that sucks air into the tube leak site. As the air enters the leak site, it creates a minute turbulence, which generates a high-frequency signal. The ultrasonic leak detector quickly detects and pinpoints leaking tubes, allowing them to be plugged.

Operations know when a leak is severe enough to warrant attention by sensitive sodium parts per billion (ppb) counters in the condensate pump discharge system. The sodium counter display is checked by operators on their rounds.

Ultrasonic leak detection

Seminole originally tried an older airborne ultrasound detector. The unit tested was not designed for the high humidity environment that is present in steam condensers. It soon ceased to function as moisture built up in the circuit but not before what was thought to be a tube leak was heard. Unable to complete the ultrasonic test at that time, the usual

time-consuming methods were used to solve the immediate problem; however, the PdM department was convinced it should learn more about high-frequency ultrasonic detectors that were designed for harsh environments.

Thorp's research led him to SDT North America, Cobourg, ON, where he found the company's 170M, an instrument that is sealed to IP65 (ensuring it will function in wet environments) and includes a flexible extension wand to extend the reach of the leak detection sensor.

Thorp soon discovered that online steam condensers offer abundant ultrasonic signals to compete with the leak signal. To solve this problem, he holds the instrument a few feet from the tube sheet and scans the entire area. If a noisy area is found it is noted. He then switches to an extended flexible sensor and scans tube to tube. If the sound signal on the digital dBVU meter or sound in the headset does not change from tube to tube, a leak is unlikely. This is particularly true of tubes located on the outer edges of the tube sheet, as these tubes are more likely to have noisy steam flowing over their o.d. surfaces.

If a significant signal change occurs, a leak is suspected. If the leak is in the tube, the difference will be heard at the tube opening. If the noise level is heard on the tube sheet, the area is blocked to eliminate reflected noise. A concentrator cone with an opening of 1/8 in. is placed on the flexible extended sensor and is held almost on the tube sheet surface. It is then moved around the tube to tube sheet fit or the plug previously installed in the tube. During this process the small area of the 1 in. tube that is leaking can be pinpointed and repaired.

After using the ultrasonic detector for a while, Thorp attended a 21/2 day Level 1 training course. He returned from that training confident that he would expand the use of the ultrasonic detector to detecting problems with coal conveyors, bearings, compressed air leaks, and other problems that commonly occur in a power generating station.

Benefits

Seminole Electric realized several intangible savings from improvements in water cleanliness and reliability related to the ultrasonic leak detection project. Reduced water chemical cleanings mean reduced costs and a reduction in tube leakage also means less corrosion.

Also, working in water boxes at operating power plants can be unpleasant, with an ambient temperature of 100-105 F and a 99.99 percent relative humidity. Using ultrasonic leak detectors has allowed Seminole's maintenance personnel to get into the water box, find the leak, and get out quickly.

Thorp reports a quick return on investment for the ultrasonic detector and has attracted the attention and support of top company management based on the results to date.

His advice to others considering ultrasound is to use as many technologies as are available to solve problems, as no one technology can supply all the answers. He is confident that ultrasound will remain an important inspection tool for Seminole Electric. **MT**

Seminole Electric

Seminole Electric is a generation and transmission cooperative headquartered in Tampa, FL. It provides bulk supplies of electricity and wholesale energy services to 10 cooperatives located throughout peninsular Florida. More than 1.5 million individuals and businesses in 45 counties rely on Seminole and its members for electric service. Seminole's primary generating facility is located on the St. Johns River in Putnam County, FL, about 50 miles south of Jacksonville. This 1300 MW station has two 650 MW generating units. The plant's water hyperbolic cooling towers (450 ft tall and 400 ft across) and 675 ft stack are visible from miles away. This plant generates electric energy from coal. Its output is distributed across transmission lines to Seminole's member distribution systems that, in turn, deliver electricity to individuals and businesses—about 10 percent of Florida's population.

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