Listening for the Faint Sounds of Boiler Leaks Helps Avert Shutdowns

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Listen to your plant boiler; it has important things to say. Acoustic monitoring (listening) systems (AMS) provide an early warning of potentially serious problems, saving thousands of dollars by averting shutdowns at power stations, pulp and paper mills, chemical plants and other industrial facilities.

AMS technology can detect faint, previously unheard sounds or vibrations from leaks in pressurized (primarily steam) systems, such as boilers or their auxiliary equipment. The systems then alert operators by a flashing red bar on a monitor, allowing the plant to fix problems before they become unmanageable. Advanced software also allows plants to analyze the acoustic data and identify trends which often vitally affect plant operation.

The most advanced acoustic monitoring systems use solid metal "metalborne" waveguides, or sounding rods, which are spot-welded to various locations on the boiler's casings and tube membranes. The solid waveguides, which don't penetrate the boiler wall, are as much as three times more sensitive to steam noises than older hollow-metal (airborne) waveguides. They are usually 3/8-in. in diameter, stainless steel, and about 15-in. long.

The solid waveguides can be located almost anywhere on the boiler, including lower furnace water walls, rather than being limited to existing openings. They can't plug up with ash, which reduces system maintenance, and they can detect leak noises which travel through boiler gases and fused metal pathways.

Metalborne waveguides can detect sounds of leaks from a superheater, economizer or other source inside the boiler. The leaks produce acoustic wavefronts which travel through the gases inside the boiler and hit the boiler wall or a sound-collecting steel plate attached to the waveguide. As the wall or plate vibrates, a piezoelectric sensor, stud-mounted on the end of the waveguide, also vibrates. This produces a change in voltage. The AMS system amplifies, filters and analyzes that voltage, converts it to a decibel level, and sounds an alarm if the signal is above a

preset threshold for more than a certain time.

The rods also detect physical vibrations from leaks, like those that occur in water walls and leak toward the inside or outside of the boiler. In these cases, the "metalborne" vibrations travel across the boiler tubes and membranes, reach the sensor, and are likewise converted to voltages, amplified, filtered and analyzed.

The system uses a high-temperature coaxial cable which carries the voltage signals to a preamplifier near the boiler. Another coax then carries the signals to the system's processing chassis, which includes amplifier/filters and a PC data logger. Signals are amplified and filtered in the frequency band between 1.7 kHz and 12 kHz. This bandwidth provides the greatest difference between the leak signal and normal background noise.

The PC stores one signal from each sensor every 20 seconds. Signal amplitude appears in bar graph form on a VGA color monitor in the control or other equipment room. Maintenance personnel watch the screens during every shift. The bar is green, with baseline height of approximately 86dB for normal background noise. However, if the signal reaches an alarm threshold (typically 92dB for abnormal noise), the bar turns yellow. If the signal remains above the threshold for a pre-set time (usually 10 or 15 minutes), the bar turns red. This time delay prevents false alarms during normal boiler operations, such as soot blowing. When the bar turns red, an alarm sounds and a warning light flashes in the control room. Maintenance personnel can view a wide range of information on the CPU unit display. This includes raw spectra waveforms and voltage trends for each sensor.

Advanced AMS systems using solid waveguides can simultaneously monitor up to 192 sensors on as many as eight boilers. A boiler can have between 12 and 49 sensors, depending on its size and operating pressure.

AMS systems save thousands of dollars by alerting maintenance personnel days or weeks before leaks develop into more serious problems. They are also far more reliable than the usual approach of maintenance personnel simply listening for leaks, or making periodic vibration checks.

The trend data which the AMS software provides appears instantly on operator screens, showing exactly what has been happening. Operators can then analyze these trend charts to pin down the exact problem. AMS systems can be connected to the manufacturer's office via modem, so the company can provide 24-hour surveillance, examine problems, provide reports, recommend solutions and fine-tune instrumentation. The system can also connect to a plant's distributed control system via serial or hard-wired connection, which allows users to build their own graphics screens.

The newest acoustic monitoring systems use the basic software and monitoring equipment but reduce installation costs by daisy-chaining signals from one sensor to the next, then sending them to the central processing unit (CPU) on an RS485-shielded twisted-pair cable, rather than using separate cables from each sensor to the CPU. This cable configuration can reduce installation costs by as much

as $10,000 for a 24-sensor system.

The acoustic monitoring field is now booming because industries need to ensure continuous operation to maintain productivity in today's highly competitive market. In the years ahead, AMS systems will provide more information, to many more plant personnel, for reliable fail-safe operations.