Acoustic steam leak detection system raises boiler uptime

Stephen Scholtz (right) of RTS Engineering and Neil Robinson (left) of Procon Engineering talk about their boiler tube leak detection system and its role in improving the performance and uptime of steam boilers, especially those in the Eskom fleet.

"RTS has partnered with UK-based Procon Engineering since the 1990s to advance the use of Procon's early warning boiler tube leak detection system," begins project engineer Stephen Scholtz of RTS Africa. "The focus of this solution is to avoid unscheduled outages, reduce secondary damage to steam boilers and to secure personal safety by preventing catastrophic failures," he says.

The detection system is based on the use of acoustic and structure-borne sensors to pick up changes in airborne acoustic and vibration signals within working boilers. "In essence we are listening to the sounds that the boiler creates: using strategically placed open pathway microphones to detect airborne (audio) signals and structure-borne vibration sensors, were applicable. "The structure-borne sensors are attached to the outside shell of the boiler near the lower furnace area, where accumulated ash tends to block tubes and attenuate the sound signal. Here, the boiler shell acts as a diaphragm transmitting the sound from inside the boiler to the system," he explains, adding that the acoustic microphones are used higher up, on the end of wave-guide air tubes that are bolted onto a flange on an entry point of the shell.

"Having been in use for 20 to 25 years, this hardware is tried and tested, but the software has recently gone through a significant upgrade that has increased efficiency and bandwidth, now delivering better detection efficiency and accuracy," Stephen Scholtz points out. "By detecting frequencies across a wider spectrum, detection probability improves significantly, while improved analytics enables us to track, trend and identify healthy operating conditions and the early onset of leaks," he explains.

"This enables us to isolate the signal emitted from each individual sensor, from which we can develop a signature of a healthy operating boiler going back several years," continues Neil Robinson of Procon Engineering.

"We can use these signatures to help us to understand how the boiler operates under different load conditions and at different times of operation. Most impor-

Procon's early warning boiler tube leak detection system is based on the use of acoustic and structure-borne sensors to pick up operational changes within working boilers.

tantly, we can detect when a steam pipe first begins to leak and alert the customer to investigate further to determine the precise location," explains Robinson.

At the time of writing, Stephen Scholtz points out that South Africa had enjoyed 162 days free of load shedding. "A large part of the reason for this is a renewed maintenance mindset from ESKOM, with management prioritising reducing unplanned outages above everything else. To properly do this, Eskom and its service providers need to plan in advance, set budgets aside and implement new technologies to make these plants more efficient, economical and reliable.

"Most notably, this work is now being planned with foresight, rather than having to continually react to unplanned outages," he explains, adding that the Procon acoustic steam leak detection system is becoming a key part of identifying and pinpointing critical maintenance needs in advance of unforeseen and far more expensive boiler breakdowns. "This solution helps to stop the firefighting, which benefits all of us," he adds.

Turning attention back to how the system works, Robinson says: "Like any monitoring system, the longer it's running, the better the quality and accuracy the information. Because we can now develop trends, we track how each boiler is preforming compared to its 'normal' base-line condition. We can set alarms based on anything abnormal and we can filter out all of background noise to home in on the critical areas of the boiler, most notably boiler pipes and tubes.

"If the system sees a new spike, it immediately triggers an alarm to alert operators that something needs to be looked at. Then the software analysis kicks in to identify where the problem is and what it might be. Because a number of sensors will pick up the problem from different places around the boiler shell, by triangulation and from an analysis of the different signal levels coming from different sensors, we are also able to pinpoint the location of the problem.

So instead of having to inspect an entire boiler for the leak, this system enables a maintenance plan to be put together that specifies where the problem is, what type of tube is leaking, how best to get into the boiler to repair it, and the urgency: the boiler may be able to be operating for a time until a planned shutdown can be arranged, for example.

"Anywhere between 5 and 35 sensors can be used to protect a steam boiler. We are currently using 32 sensors to reliably monitor every tube on one of the Eskom boilers, perhaps 27 acoustic microphone's and five structure-borne sensors. Acoustics tends to be more accurate, but with ash build up at the bottom of the boilers, the ash clogs the guide tubes bringing the sound waves to the microphones, causing muffling. Hence the use of the structure-borne sensors in these areas," he explains.

In terms of installation, Scholtz says that the structure-borne sensors are simply mounted onto the boiler shell, while for the microphones have wave-guides, the boiler operators will generally install an access flange through the shell. "We then bolt our wave-guide assembly onto that flange to give us a continuous air path between the pipes and tubes inside the boiler and our microphone on the outside end," says Stephen Scholtz.

"An early warning of a small boiler tube leak can prevent expensive secondary damage and unscheduled outages. And we know from experience that increasing boiler availability by just one day will more than cover the cost of a leak detection system," he concludes.

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Acoustic microphones are used higher up, on the end of wave-guide air tubes that are bolted onto a flange on an entry point of the shell. An optional soot blower system can also be installed to keep acoustic waveguides clear of ash build-up.