Tube challenge

18 October 2010 | By David Wilson

A handheld testing tool uses a low-frequency acoustic pulse to enable plant operators to spot defects in heat-exchanger tubes.

Heat exchangers are widely used in numerous industries - they can be found in power stations, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage-treatment works.

Regularly inspecting the tubes inside such heat exchangers is vitally important to ensure that the units are performing optimally. Any flaws in such tubes - such as pitting of the tube walls, erosion, holes, blockages and bulges - can cause the heat exchangers to fail or work less efficiently. At the very least this can result in higher energy costs for plant operators, although it can also cause catastrophic failures that damage expensive equipment (such as turbine bearings) and require expensive and unexpected stoppages for repairs.

There are a number of systems that are used to perform such inspection functions, including eddy-current and ultrasonic probes, as well as video scanners. Unfortunately, all of these systems have their own set of drawbacks. While some, for example, are unable to access the complex tube configurations found inside some heat exchangers, others can only inspect tubes made from certain materials. More problematic is that they all rely on the expertise of trained technicians who must first traverse a probe through the tubes in the exchanger and then manually interpret the results from the data collected.

Worse yet, because such procedures tend to be slow - inspection times of about one minute per tube are often cited - the technicians who inspect such tubes often only have
time to inspect a small sample in any given exchanger - well under 10 per cent of deployed tubes in some cases - hoping that these sampled subsets accurately represent the functional integrity of all the heat-exchanger tubes.

Any flaws in such tubes – such as pitting, erosion, holes or bulges – can cause the heat exchanger to fail.

Ideally, of course, plant operators would prefer to test all the tubes in their heat exchangers, no matter how they are configured or what material they are made from. They would also like to reduce the amount of time-consuming human effort that is involved, while producing more objective, rather than subjective, reports on the condition of the tubes themselves.

Now, engineers at Leusden, Netherlands-based AcousticEye have developed a universal tube-testing solution that they claim can do just that. The acoustic system allows a technician to test any tube in any heat exchanger in less than 10 seconds, saving time and resources. Better yet, because it is a non-invasive procedure, it can navigate bends, coils, elbows and fittings without difficulty.

‘While standard inspection technologies are time consuming and require highly skilled professionals with years of education and a high level of certification, our product - the Dolphin 2000 - can be deployed after only a two-day training course,’ said Tal Pechter, chief executive officer at AcousticEye.

A 3D image highlights the type and location of each fault
The Dolphin 2000 system itself comprises a handheld probe that creates a low-frequency acoustic pulse from a loudspeaker that is injected down the tube. Any discontinuities in the cross-sectional area of the tube create reflections, which are then captured by a microphone on the probe, after which they are sent to an industrial laptop computer running software that automatically processes and interprets the signals using the company’s proprietary signal-processing algorithms.

Since the amplitude and shape of the reflections is determined by the characteristics of the discontinuities in the tube - the signature of a hole, for example, is markedly different from erosion or a blockage - the software can automatically analyse the signals and then generate a report to pinpoint the type, location and severity of every problem.

Pechter explained that, in use, a technician would first capture an image of the tubes in the heat exchanger, either from a CAD drawing of the exchanger, a schematic or from a handheld camera. Then, the inspection parameters associated with the schematic - including the length, outer diameter and wall thickness of the tubes - would be entered onto the system. Once completed, the end of the acoustic probe would then be fitted to the end of each tube in the exchanger through an adapter.

“While standard technologies are time consuming, our product can be deployed after just two days’ training”

TAL PECHTER, ACOUSTICEYE

After the data from each of the tubes had been captured by the probe, an operator would then set certain thresholds into the system. These not only enable the system to automatically eliminate any spurious background noise created in the reflected signal, but also allow the operator to flag the extent of common problems such as pitting, erosion, holes, blockages and bulges to whatever degree of precision is required.

’As an example, the software lets an operator define the threshold of wall loss percentage he wishes to see. He could set a parameter to flag up when a wall loss was above 20 per cent and increase that figure in steps of 10 per cent. In a similar fashion, a user can define whatever thresholds he likes for any of the typical faults that are likely to be found, and then the software will automatically display them on the screen,’ said Pechter.

The system software then produces a report that not only identifies the type of fault and which tube the fault has been found on, but also the location of that fault along its longitudinal axis. Not only that, but the software can also generate a visual representation of the entire heat exchanger and the pipes within it, displaying a three-dimensional colour-coded image of the heat exchanger highlighting the type and location of each fault.

AcousticEye’s Pechter explained that this feature can be especially useful for identifying where clusters of flaws may have occurred within a group of tubes within an exchanger, enabling an operator to make a valued judgement as to the reason that the flaws might have occurred in the first place.
Before any tubes in any heat exchanger are examined for flaws, they are cleaned to ensure that the results from any measurements will be accurate. Occasionally, however, tubes are not cleaned as efficiently as a plant operator might like, and here too, the AcousticEye system can help by indicating the amount of deposit left inside any of the tubes in a system, providing a degree of quality control to the cleaning process.

If the technology has a single drawback it is that it is unable to detect flaws on the outside of the pipes in an exchanger. Nevertheless, that hasn’t prevented the system from being employed successfully in numerous locations across the world, from a geo-thermal power plant in California to a nuclear facility in Russia.

And with an estimated 13 billion tubes inside heat exchangers across the world, of which less than 10 per cent are presently being inspected every year, it seems likely that the system will travel even further in the years to come.

**The key facts to take away from this article**

- Heat exchangers are widely used in a number of industries
- Regularly inspecting the tubes inside is vital to ensure performance
- The Dolphin 2000 system uses acoustic pulses to locate defects
- It also provides a degree of quality control to the tube-cleaning process

**Readers' comments (1)**

- Richard Derry | 20 Oct 2010 12:28 pm

  We (Rico Industrial Services Ltd) are the UK agent for the Acoustic Eye System. We have used it very successfully on condensers & heat exchangers in the power industry this year. This last month we had an extremely satisfying result in detecting a hole in a condenser tube that had been undectable using traditional eddy current methods and thus we able to plug up the leaking tube.

  Note: the system can definitely detect flaws on the inside on the tubes.

Unsuitable or offensive? Report this comment