PHORGOTTEN PHENOMENA

Condenser Tube Repairs Using Tube Inserts

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It is common knowledge that many heat exchanger (HX) tube failures occur within the first 6 in. (150 mm) of the bundle. Inlet-end erosion, stress corrosion cracking, and crevice corrosion are different types of failure mechanisms that are common in shell-and-tube HX.

In the past, the accepted repair for heat exchanger (HX) tube damage localized close to the inlet was full tube replacement or shortening of the tube bundle—despite the fact that more than 95% of its length usually remains undamaged. Either type of repair has proven extremely expensive and time consuming.

Accordingly, alternatives to full retubing repair long have been sought, including:

- Protecting damaged tube inlets.
- Restoring plugged leaking tubes to active service.
- Restoring original compressive strength to weakened tube-to-tubesheet joints.

An acceptable repair should be cost effective and extend the life of the existing equipment.

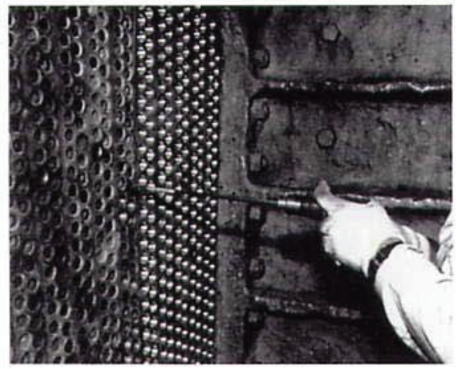
Tube Shields/ Thin-Walled Inserts

Metallic, thin-walled inserts or shields (Figure 1) were introduced in 1976. They are inserted and then expanded—either mechanically, hydraulically, or by a combination of the two—into the existing tube ends.

FIGURE 1

Thin-walled tube insert (shield).

FIGURE 2



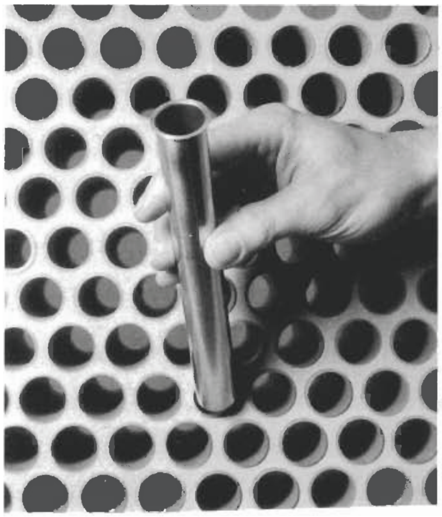
Tube ends are wire-brushed prior to installation of inserts.

Previous attempts to correct tube end erosion/corrosion have included the use of conventional ferrules made of plastic or ceramics. Such conventional ferrules typically are loose-fitting, and normally are cemented or glued in place.

Unlike the tube-end shield, ferrules cannot return plugged tubes to circulation and cannot restore tube-to-tubesheet joint strength. Because of their heavy wall, there is a severe flow reduction and, at the same time, the creation of a phenomenon known as end step erosion. In many cases, the ferrules have cracked or come loose, and they cannot effectively be installed to the tube outlet ends.

Choosing the proper alloy is critical in the case of tube inserts. Material can

FIGURE 3



Insert being placed in tube end.

FIGURE 4

Inserts being mechanically expanded into tube ends.

be chosen from a range of different alloys. Selection is based on the existing tube material, the service of the HX, and the cause of the tube failures. Typically, the shield alloy selected is superior, but galvanically compatible, to that of the existing tubes. Options for shield material range from copper-based alloys (Cu-Ni and brasses) to stainless steels (austenitic, ferritic, duplex, and superaustenitic) to nickel-based alloys (e.g., alloys 400, 600, and C-276 [UNS N0400, N06600, and N10276]). They also include alloys required for high-temperature service (e.g., type 310S [S31008]).

FIGURE 5

Tube bundle with inserts in place.

Tube Shield Installation

The installation process is carried out in situ beginning with wire brushing tube inside diameters (ID) to allow for a pressure-tight seal (Figure 2). After the tubes are blown clear with compressed air, ID measurements are taken to determine expansion requirements. Shields then are inserted into each tube end (Figure 3). The flared end of the shield is expanded (Figure 4) to a torque setting by use of a conventional tube expander. The downstream end is expanded using a mechanical setting, avoiding any possibility of overexpansion. The plant also has the option of hydraulically expanding the insert for its entire length, which normally is 6 to 12 in. (50 to 300 mm), but sometimes is as long as 9 ft (2.7 m). The final step is to flare the shields so that they conform to the tubesheet profile (Figure 5).

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