Conducting a restoration of a shell-and-tube exchanger

Thin-walled tube inserts and full tube liners

It is common knowledge that many heat exchanger tube failures occur within the first 6 in of the tube. Inlet end erosion, stress corrosion cracking and crevice corrosion are different types of failure mechanisms common in heat exchangers in the chemical industry.

In the past, the accepted repair for this localized tube damage had been 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 have long been sought including:

- Protecting damaged tube inlets.
- Restoring plugged leaking tubes to active service.
- Restoring original compressive strength to weakened 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 were introduced in 1976. They are inserted and then mechanically expanded into the existing tube ends.

Previous attempts to correct tube end erosion/corrosion have included the use of conventional ferrules made of metal, plastic or ceramic.

Such conventional ferrules are typically loose fitting and normally cemented or glued in place.

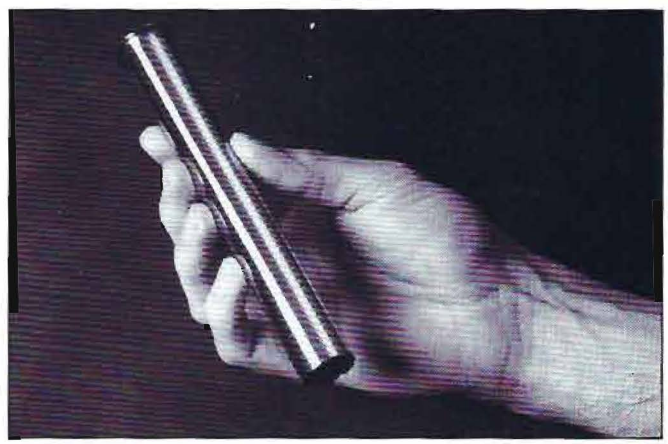
Unlike the tube end shield, ferrules cannot return plugged tubes to circulation and cannot restore tube-to-tubesheet joint strength. Because of their heavy wall, there is a severe flow reduction and, at the same time, a phenomenon known as end-step erosion is created.

In many cases the ferrules have cracked or come loose, and they cannot effectively be installed to the tube outlet ends.

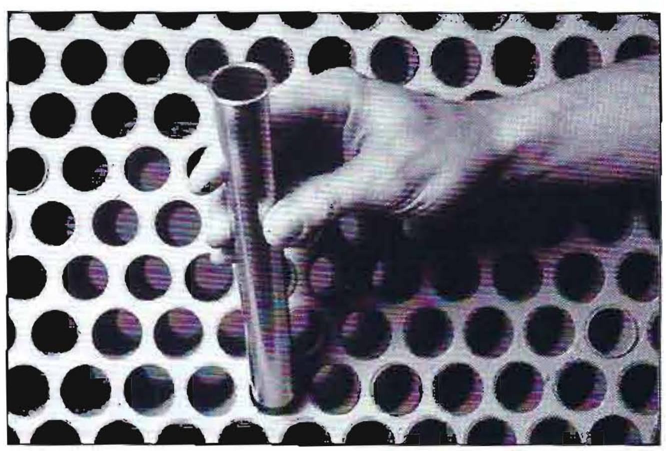
Choosing the proper shield alloy is critical in the case of tube inserts. Material can be selected from a range of different alloys. Selection is based on the existing tube material, the service of the heat exchanger and the cause of the tube failures. Options for shield material range from copper alloys (CuNi and brass) to stainless steel (austenitic, ferritic, duplex and superaustenitic), and include corrosion-resistant, nickel-based alloys (e.g., Alloy 400, Alloy C-276).

Tube shield installation

The installation process is carried out *in-situ* beginning with wire brushing tube's ID to allow for a pressure-tight seal. After the tubes are blown clear with compressed air, ID measurements are taken to determine expansion requirements. Shields are then inserted into each tube end. The flared end of the shield is



Thin-walled inserts address the problem of inlet erosion/corrosion damage to heat exchanger tubing.



Tube inserts slide directly into existing heat exchanger tubes.

expanded to a torque setting by use of a conventional tube expander, while the downstream end is expanded using a mechanical setting; avoiding any possibility of over-expansion. The final step is to flare the shields so they conform to the tubesheet profile.

Since 1976, more than 5 million shields have been installed worldwide.

Full-length tube liners

Based on the success of the shields for the repair of tube end damage, a similar repair technique was developed to restore tubes that had sustained damage over their entire length. This repair involves the installation of full-length tube liners. Due to ID pitting, OD grooving, full-length thinning and impingement damage, these tubes were plugged and no longer in service.

As the heat exchanger ages, the amount of plugged tubes begins to affect the efficiency of the unit and increases the flowrates in the remainder of the tubes. With 10% of the tubes plugged, historically the unit becomes a candidate for a full retube project.

In cases like this, the installation of full-length liners to repair the plugged tubes becomes an attractive alternative. By restoring the plugged tubes to duty, years of additional service can be provided.

Tube lining installation

The process of tube lining begins with the tube plugs being removed and the tubes prepared with a thorough cleaning. Cleaning methods include wire brush, bristle brush, metal-tube scrapers and hydroblasting. Tubes are cleaned of debris and the liner (a thin-walled tube) is installed.

A bleed chuck is clamped on one end and the pumping chuck is placed on the other end. The tube is filled with water and the air is bled out. The chucks seal the tube and the hydroexpansion pump pressurizes the water in the tube.

As the pump reaches the yield point of the material, the liner begins to expand. When the liner has achieved a metal-to-metal fit within the damaged tube, it is allowed to remain pressurized for a short period of time. Pressure is then released and the tube is allowed to drain.

The expanded liner is cut off and milled flush to the tubesheet. The liners are then roller expanded into the tubesheets to a set wall-reduction specification. The previously plugged and condemned tubes are now restored and returned to circulation.

■ To receive more information on heat exchanger tube restoration—CTI Industries Inc., Stratford, CT.

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