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FEEDWATER HEATER TUBE TO TUBESHEET JOINTS

The intent of this "Tech Sheet" is to serve as a guideline for users to apply (if not already agreed with customer) the type of tube to tubesheet joint for the feedwater heaters for power plants.

Feedwater heaters used in power plants differ from other shell and tube exchangers in many ways. One of the main differences is the fluids that flow on shell and tube sides. The shell side fluid is turbine extraction steam and drains formed by this steam. In some power plants, boiler quality drains from other sources are also introduced into the shell. On tube side, the fluid is feedwater – which originates from steam from the boiler flowing through the turbine and condensing in the condenser and pumped back to the boiler through string(s) of feedwater heaters. Pumping is normally done in two stages and therefore the feedwater heaters are termed as low pressure heaters and high pressure heaters.

Typically, in low pressure heaters the tube side design pressure ranges from 300 psig to 1200 psig and for high pressure heaters it is 2000 psig to over 5000 psig. The operating pressure on tube side is about 70 – 80% of the design pressure. The shell side design pressure for low pressure heaters range from 50 psig to 150 psig with operating pressure from 5 psia to 120 psia. The shell side design pressure for high pressure heaters range from 300 psig to 1500 psig, with operating pressure from 225 psia to 1300 psia. A few power plants have feedwater heaters with design/operating pressure ranges in between the range for low and high pressure heaters indicated above. Such heaters are termed as intermediate pressure heaters.

The pressure differential between shell side and tube side is significantly high for the high pressure heaters and therefore has a higher potential for a tube to tubesheet joint leak with a slight deformation of the tube to tubesheet joint (TTJ). A leaking TTJ will cause feedwater from tube side to enter the shell side and results in shell liquid level rise and may result in the heater being taken out of service. A good TTJ therefore is very important for proper operation of the feedwater heater.

Tube to tubesheet joint types are:

1. Expanded only
2. Welded and Expanded

The tube expansion processes are roller, hydraulic, and explosive. For low pressure heater application, expanded only TTJ has been observed to be very reliable and TTJ weld may not be required. Therefore, users are cautioned not to indiscriminately specify welded TTJ, as this will impact heater cost due to various associated costs e.g.:

1. Tubesheet to be clad/overlayed with a compatible material for welding similar materials.
2. Machining of tubesheet after clad/overlay.
3. Non Destructive Examination of weld overlay.
4. Heat treatment after clad/overlay (when required).
5. Use increased nominal plate thickness to provide machining allowance due to tubesheet bowing for thin tubesheets.

While the expanded only TTJ is good for the typical operating/design pressures commonly seen in the low pressure heaters, for the high pressure heaters this may be supported with weld.

Expanded tube joints can be full-depth for extra strength and crevice corrosion avoidance.
Also for heaters that experience frequent load transients, the TTJ is a critical joint. In such heaters welded and expanded TTJ increases reliability.

Seal / strength weld and size shall be in accordance with applicable Code.
For heaters that are more likely for tube inlet/outlet end erosion due to feedwater velocity, welded TTJ may improve the problem.

In summary, the following guidelines can be used to determine when to consider TTJ welds:

1. For intermediate and high pressure heaters;
2. For heaters in solar power plants that are subjected to daily load transients;
3. For heaters that are not base load i.e., those heaters that experience frequent load transients unlike the base load ones;
4. For heaters those are more prone for tube inlet/outlet end erosion due to feedwater velocity.