THIELSCH ENGINEERING

High-Temperature Headers

Failures in Superheater and Reheat Outlet headers are relatively infrequent. Unfortunately, when a failure does occur in these components, the necessary repairs may require several weeks to complete. Due to the substantial costs associated with any forced outage, it is imperative to perform routine inspections of headers. In this manner, conditions with the potential to result in failures can be identified, monitored, and addressed before they fail during service resulting in a forced outage.

The root cause of failures in high-temperature headers can be caused by any one or a combination of the following four factors:

1. Design Deficiencies
2. Manufacturing or Material Defects
3. Fabrication or Erection Defects
4. Service-Related Deterioration

In more than 2,500 high-temperature headers that Thielsch Engineering has inspected, the vast majority of failures are the result of Service-Related Deterioration either acting alone or in conjunction with the other three factors. In all instances, Thielsch Engineering has developed and implemented repair procedures that have returned these components back to safe and reliable service.

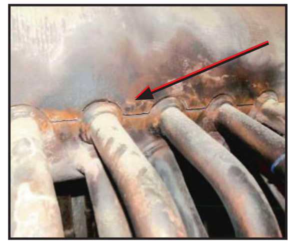
The principal types of Service-Related Deterioration mechanisms encountered in high-temperature headers are creep, fatigue, creep-fatigue, microstructural changes, and applied bending stresses. The location and characteristics of the damage can vary. However, they predominantly fall within the following terms:

Header Component Location	Deterioration Mechanism
Outlet Saddle Connection Weld	Creep Cavitation
Inside Diameter ligament Cracking	Thermal Fatigue
Longitudinal Seam Weld Cracking	Creep Cavitation in HAZ and Weld Metal
Circumferential Girth Weld Cracking	Creep Cavitation/Bending Stress
Header-To-Tube Stub Cracking – Tube Side	Bending Stress
Header-To-Tube Stub Cracking – Header Side	Creep Cavitation/Weld Defect

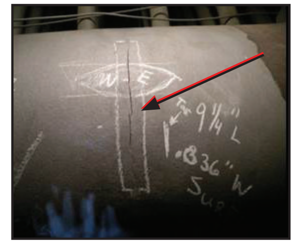
(cont.)

Ligament Cracking (ID)

Tube Side Cracking



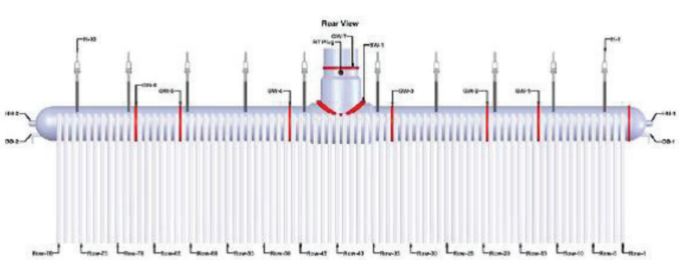
Seam Weld Cracking



Header Body
Girth Weld Cracking

Each of the damage mechanisms described can be identified long before throughwall failures and/or leaks occur by conducting a thorough condition assessment program. Such a program will involve nondestructive examinations and metallurgical evaluations that include:

- External visual examination of the header body-terminal tube assembly and hanger support components
- Magnetic particle examination of the outside diameter welds
- Internal borescopic examination of tube bore ligament field
- Ultrasonic linear phased-array and time of flight volumetric examinations of all circumferential girth welds and longitudinal seam welds (these examinations may also be performed in the sizing of internal ligament field cracking)
- Removal of replication foil impressions to provide metallurgical creep evaluation and remaining useful life estimates
- Hardness testing of all replication sites in order to identify thermal softening
- Diametric creep swell measurements
- Macroetching to delineate the heat-affected zones of undocumented longitudinal seam welds



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