

Boiler Header Integrity Program (BHIP)

BACKGROUND

As boiler headers age, they become more prone to cracking in their ligament and stub-tube weld area. Such cracking can lead to header or tube failures, which are costly.

In response to these problems, MIS developed the Boiler Header Integrity Program (BHIP), whose main goal is the evaluation and monitoring of such cracking for failure mitigation. The scope of this study included cracking in the stubweld region (which despite its economic impact has received very little attention) and the ligament areas (which has been extensively studied by other researchers).

DISCUSSION

Three-dimensional finite element and fracture mechanics models of two header types were developed for calculating stresses and crack tip parameters in critical areas of the boiler header under plant operating conditions (*Fig. 1*). For the ligament area, the analyses concentrated on fast steam transients and differential adjacent tube temperatures that are present during plant operation.

The stubweld area was studied using detailed three-dimensional modeling of the cracks along the heat

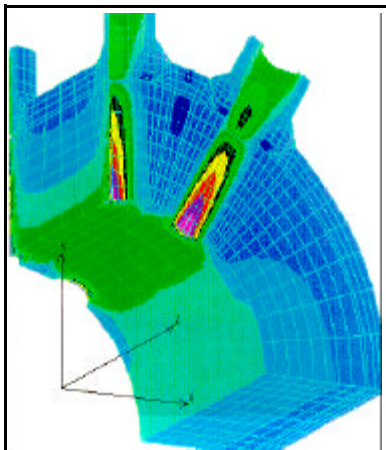


Figure 1. Stress contour plot for a type-1 boiler header

affected zone and calculating crack tip parameters, such as K_I , J-integral, and C^* , under a variety of loading conditions, including pressure, steam transients, and tube loading. The effects of material creep properties mismatch between the weld and the

base metal, ligament cracks, and oxide wedging were also studied.

CONCLUSION

This study showed that with fast steam transients or differential steam temperatures in adjacent tubes, the ligament area of the boiler header is severely loaded, it can accumulate damage and cracking, and it will eventually fail. The differential tube temperature effect is ignored by most commercially available software for ligament evaluation. The importance of considering the operating condition in each tube is shown in *Fig. 2*.

Continuous monitoring of steam temperatures in each tube may not be feasible from an economical or a technical point of view. Thus, MIS is developing an alternative approach for condition assessment of the ligaments.

MIS has made significant progress toward

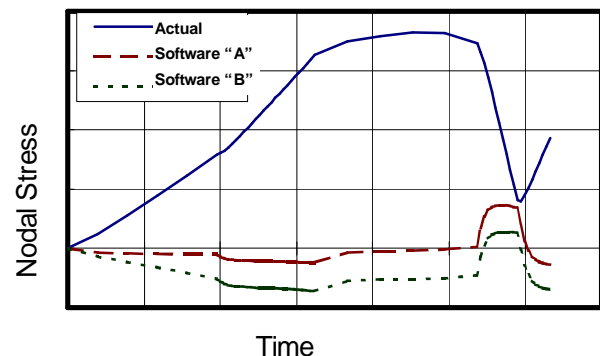


Figure 2. Comparison of predicted stresses (commercial software A and B) vs. actual conditions

identifying the root cause of both the internal and external stubweld cracking, such as proving that normal operating conditions do not impact stubweld cracking.

Further research in the area of boiler header integrity will identify the root causes of ligament and stubweld cracking to devise a proper maintenance program for damaged headers.