Material Integrity Solutions, Inc.

PROJECT BULLETIN

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Causes and Behavior of Internal & External Stubweld Cracks

BACKGROUND

Stubweld cracking and its eventual failure can initiate and grow from the inside (*Internal*) or the outside (*External*) of the header (*Fig. 1*). A failure caused by either of these cases leads to plant shutdown and major repair cost. Despite the economic impact of stubweld failures, the initiation and propagation mechanisms of stubweld cracking have received very little attention up to now. This lack of research may be due to the difficulty in modeling and evaluating stubweld cracks and the belief that the economic consequences of stubweld failures are not as catastrophic as those of ligament failures, which has been the subject of much research.

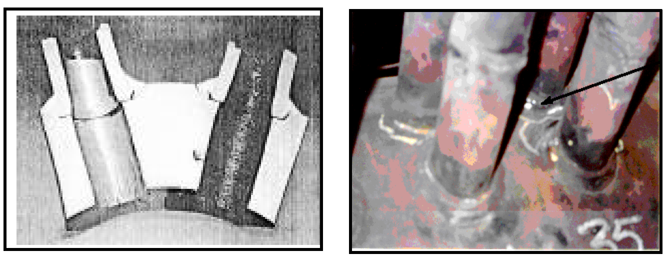

Figure 1: Internal (courtesy of EPRI) and External stubweld cracks

DISCUSSION

To decrease boiler header failures and reduce maintenance costs, MIS conducted a study to identify causes and behavior of internal and external stubweld cracks. For this purpose, detailed 3D finite element and fracture mechanics models of the header were developed (*Fig. 2*). These models were unique since they included the gap and the weld between the tube and the header for the first time. These models consider the effect of material mismatch between the weld and the base metals and allow for simulating 3D cracks of different sizes and shapes in the stubweld region. Crack behavior was studied under different loading conditions including thermal transients, pressure, tube external loading, and "oxide wedging". The effects of ligament cracks, external stubweld cracks on internal stubweld cracks, and vise versa were also studied. Stress and fracture mechanics analyses of two header types under normal plant operating conditions were used (*Fig. 3*) to study causes and behavior of stubweld cracks. This was achieved by simulating cracks of different sizes in the stubweld region and performing non-linear and creep heat transfer and stress analyses under various loading conditions.

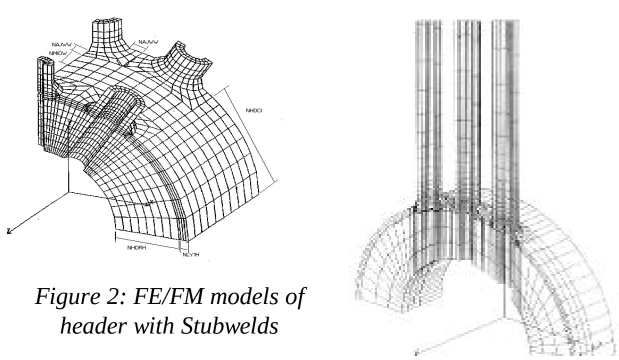

Figure 2: FE/FM models of header with Stubwelds

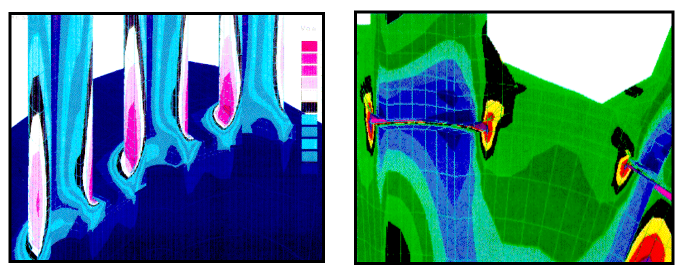

Figure 3: Stress contour plots of headers near stubweld region

CONCLUSION

In this study, MIS developed tools (including automatic 3D-FE/FM model generators) and methodology for detecting the root cause and behavior of stubweld cracking. This work showed that the "oxide wedging", tube loading, temperature differences between adjacent tubes, and thermal transients impact the internal and external stubweld cracking for the studied headers. Therefore remedial action could be planned for mitigation of such cracking leading to large savings in operation and maintenance cost. This set of tools can be used to quickly and accurately model almost any header and evaluate the effect of all operating conditions.