Cracking in composite tubes (SA210 clad with 304L) used to fabricate primary air ports in kraft recovery boilers is a well-known but not well-understood problem for boiler operators. Unlike cracking in composite floor tubes, where the cracks terminate at the cladding/substrate interface, cracks in composite air port tubes sometimes penetrate into the carbon steel layer, which can lead to catastrophic in-service failure of the boiler. From the research performed on composite floor tubes, it is now commonly accepted that differences in the thermal expansion characteristics of the 304L and the SA210 combined with the elevated in-service operating temperature of the boilers can yield residual stresses sufficient to promote SCC in the 304L cladding. However, at present it is not known why the cracks sometimes penetrate into and propagate through the carbon steel layer in composite air port tubes. Further consideration of air port tubes and floor tubes reveals that both manufacturing processes and operating conditions experienced by each type of tubing are typically different. For example, the air port tubes are bent during manufacturing and can be exposed to localized frequent in-service thermal transients 100 degrees C above the nominal operating temperature.

In this study, some of the aforementioned manufacturing and operating variables will be investigated using X-ray diffraction and finite element modeling. In particular, residual stresses will be experimentally determined from three specimens:

1. a single bent composite tube (prior to welding) designed for a primary air port opening,
2. an "as manufactured" composite air port panel, and
3. an air port panel removed from service with cracking present.

The stress data from the first two experiments will be to characterize manufacturing contributions to residual stresses in the air port tubes. This data will be input into a 3-D finite element model that will be used to predict residual stresses in the air port tubes under various operating conditions. Finally, the FEM modeling results will then be compared to the stress values obtained from the air port panel removed from service.

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