Fitness-for-Assessment of Regeneration Gas Heaters

Client Confidential

Oil and Gas

The Problem

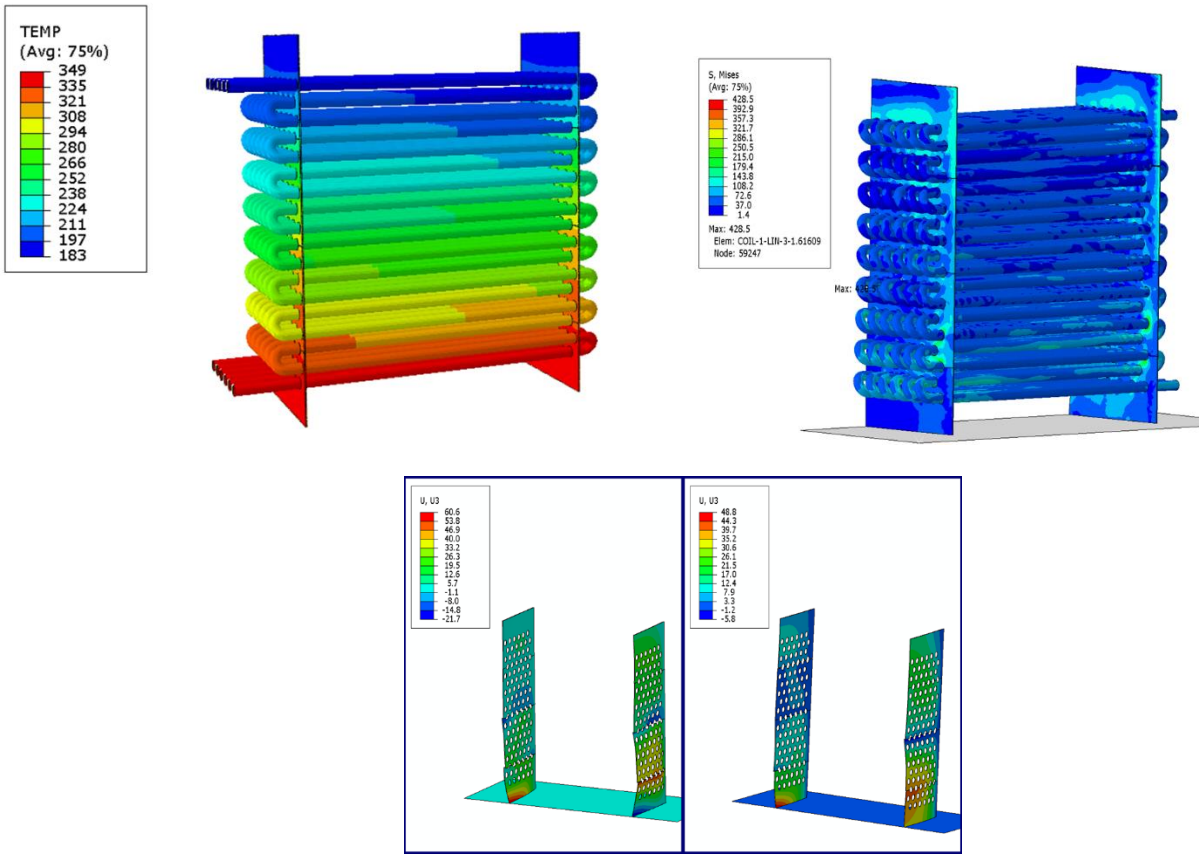
Regeneration heaters in our client's facility consist of process gas tube bundles heated up via ignited fuel gas flowing over the outside of the bundle. The tube bundles are supported in a fabricated convection box by four 12mm thick tube sheets at each side of the box. These tube sheets were initially fixed to the convection box by a bolted arrangement, which led to shearing of several fixing bolts on the bottom tube sheets and cracking of the tube sheet itself. The support design was subsequently changed and guide clips are now utilised to retain the tube sheets in position. Sufficient clearance has been allowed for thermal expansion. Our client wanted to determine the fatigue life of the tube bundles with the new support design.

Our Approach

A series of 3D linear elastic finite element analyses were performed to demonstrate fitness-for-purpose against the design by analysis criteria of PD 5500. The fatigue life of the vessel under anticipated normal operating conditions was determined. The FE predicted stresses were used as input to a fracture mechanics assessment of the critical defect size and anticipated fatigue crack growth rate and upper bound crack growth rates for CLSCC. The results from these analyses were used to determine the level of reliability for the proposed design of the vessel.

Outcome

The fatigue assessment of the regeneration heater tube coils predicts a limiting fatigue life of 70064 cycles, which is 8.3 times the postulated 8450 start-up cycles in 25 years. Using a safety factor of 10 on the design fatigue life of the tube coils, an inspection period of 20 years was calculated. The analysis predicts bulging of the bottom most tube sheet under both bolted and guide clip support arrangements. Although the use of guide clips is predicted to reduce bulging, detailed analysis of the support arrangement could be undertaken to further improve the support design.



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