

TECHNIQUES FOR MODELING THERMAL AND MECHANICAL STRESSES GENERATED IN CATALYTIC CRACKER AND COKE DRUM HOT BOXES

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ABSTRACT

Consideration of heat transfer loading between surfaces during transient and steady state conditions is required when analyzing vessels that involve secondary stresses and low cycle fatigue. Some of the higher stresses occur in enclosed, non-insulated air space regions, referred to as a hot box, between a supporting skirt (or shell) and a vessel. Hot boxes are critical parts of vessel designs in catalytic crackers and delayed coke drums. In coke drum cycles, the sudden heating of the vessel generates significant bending stresses in the skirt, and radiation heat transfer causes a greater area of skirt to be heated when compared to conduction alone. This heat must be removed during the cooling transient or the hot expanded skirt will be pulled by the contracting vessel, resulting in large bending stresses. It is the experiences of the authors that failures to calculate the transient temperatures in the components often underestimate fatigue stresses.

Some of the important elements associated with modeling thermal stresses in hot boxes include using appropriate boundary conditions, radiation and convection conditions, pressure end loads, and conductivities for the insulation materials. This paper emphasizes the importance of performing detailed sensitivity analyses when unknown thermal or mechanical loading conditions exist. Examples include the effects of convection properties within the hotbox and conditions associated with transient loads. Discussions are also provided on the potential geometric issues associated with the use of axisymmetric finite element models. Additionally, this paper discusses the importance of making field measurements to enhance modeling assumptions. Discussions will be provided on the best methods for acquiring field data and the techniques routinely employed by Stress Engineering Services, Inc.

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