Material Integrity Solutions, Inc.

PROJECT BULLETIN

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Design Improvement for a new Coal Charring Reactor

BACKGROUND

The designer/manufacturer of a proprietary coal charring process unit hired MIS to evaluate their design for mechanical and thermally induced stresses. MIS performed finite element analysis to determine temperature and stress profiles. We recommended changes to design details and material selection to improve the operating life and reduce the material cost for the unit.

DISCUSSION

Many inefficiencies exist in traditional batch processes for producing char and coke and recovering volatile products from coal. Our client was engaged to design and manufacture the commercial scale version of a new, continuous process, coal charring unit.

In this process, dehydrated powdered coal is introduced at one end of a double-screw-conveyor reactor. Process heat comes from gas burner exhaust passing through the central shafts of the screw conveyor and reactor housing. The mixing action and surface area of the spiral conveyor enhance heat transfer. As the coal is heated, it transitions through a plastic phase releasing its volatile components, then discharged as solid char.

Our client performed an initial design and analysis of the reactor. MIS checked the design and material specification by:

- Identifying first the operating and boundary conditions, and then defining the loads for the reactor rotor.
- Developing finite element models to represent global and local response of the rotor to various operating conditions of the system.

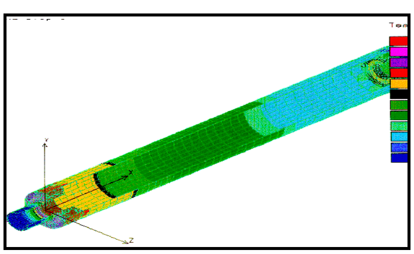

Figure 1: Rotor temperature contour.

- Performing heat transfer analyses of global (*Fig. 1*) and local models, using closed form and finite element methods, to estimate rotor temperature during various operating conditions.
- Performing time history stress analysis for the global and local (*Fig. 2*) rotor models to estimate operating stresses in the reactor's rotor.

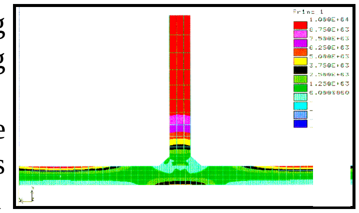

Figure 2: Local stress model.

- Evaluating stress and temperature from operating conditions against material creep and fatigue properties.
- Reviewing changes to operating practices, such as start-up and shut-down procedures, for their effect on rotor life.

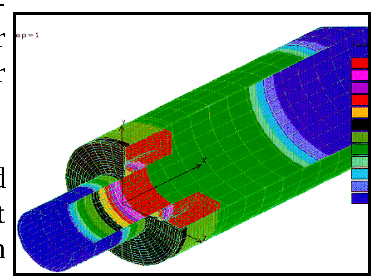

Figure 3: Plot showing acceptable stresses with design change.

The analyses identified areas in the rotor that would experience high stresses leading to premature failure. MIS was able to propose design changes to reduce operating stresses to acceptable levels (*Fig. 3*).

MIS identified changes in materials, mechanical and process design, and operating procedures that could produce substantial cost savings as well as improved rotor life.

CONCLUSION

Our expertise in failure prevention and stress and fracture mechanics analyses helped identify problem areas and cost effective solutions for the proposed reactor design. MIS also provided guidance for development of life-extending operating procedures. Results from our analyses may also enable the client to realize solutions to problems with similar designs.