Tube to Tubesheet Design

For High Pressure High Temperature Heat Recovery Systems

Not again! That same old inlet tubesheet joint is cracked at the weld where the tube intersects the inlet tubesheet. Typically in process systems there are high temperature and pressure heat recovery systems. For example in an ethylene plant, cracked gas is produced resulting from a reaction within a furnace and upon exiting the furnace the gas must be quenched quickly. Normally a heat exchanger called a transfer line exchanger will handle this application. Hot gas enters the inlet through the tubes and is quenched. High pressure steam is produced on the shell side. One of the most critical areas of design is the inlet tubesheet.

Many designs on the market have a weld at the tube to tubesheet intersection on the hot gas face. Weld integrity and residual stresses may be an issue and limit the design. There are erosion related issues due to the velocity of particles hitting the joint in question. It is also essential that the waterside cool the inlet tubesheet. Most often the waterflow is governed by a thermosyphon type system. So how do you insure that the joint will withstand the design conditions?

Well, a good methodology is as follows:
1. Execute a thermosyphon analysis to determine the waterflow through the shell side. A two-phase flow model with slip conditions will achieve the best results.
2. Perform a computational fluid dynamics (CFD) model of the gas inlet.
3. Likewise conduct a CFD of the waterside.
4. Calculate relevant heat transfer coefficients. A local gas side CFD model is helpful in establishing accurate film coefficients due to entry effects.
5. Perform a finite element (FE) heat transfer analysis of the inlet tubesheet.
6. FE stress analysis – Although a linear elastic model may do the trick, many times a non-linear plastic model will achieve better results. The residual weld stress can be a player, and also an accurate geometric model of the weld is important.
7. Code assessment
One design available on the marketplace takes the weld away from the critical area. This design is shown below, both the tube to tubesheet joint and tubesheet itself.

Cliff’s Notes:

Hope everyone had good holidays as things are busting loose this year. OLMI is the designer of the tube to tubesheet joint as mentioned above. Below is a press release of January 7, 2003 I thought we would repeat in this newsletter.

“Effective January 1, 2003 BORSIG Technologies, Inc., will operate under its trade name KnightHawk Engineering. While we are still the same legal entity, the name KnightHawk Engineering better represents who we are and our mission.

Effective December 31, 2002 BTI, as a consequence of BORSIG GmbH’s Insolvency (Old BORSIG), KnightHawk is no longer the manufacturer’s representative for BORSIG GmbH in Berlin Germany. We wish all our former colleagues at BORSIG the very best. However, KnightHawk Engineering is still working on the BORSIG Pelletizing Die, a product developed jointly by BORSIG and KnightHawk.

WE ARE PLEASED TO ANNOUNCE that KnightHawk Engineering is the manufacturer’s representative for OLMI S.p.A. (www.olmi.it) for their United States and Canada Territory. OLMI supplies heat recovery systems including specialized heat exchangers and pressure vessels. We are pleased to offer OLMI’s competitive products to the industry. OLMI was founded in 1933, is a growing and dynamic company that is willing to go the "extra mile" for its customers. Together we have plans to make OLMI the number 1 supplier of TLE’s and SLE’s for the process industry.

KnightHawk Engineering had a profitable year in 2002 and we look forward to success in 2003. We appreciate the continued support of our clients who have faith in KnightHawk.”

As I am certain everyone is aware of the Columbia disaster. We live and work in the NASA community…, our kids knew and went to school with several of the astronaut’s kids. My neighbor down the street is an astronaut and we joyfully watched his missions in the past including take off. This has devastated our community. Our thoughts and prayers go out for the Columbia astronauts and their families.

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