KNIGHTHAWK TECH NOTES

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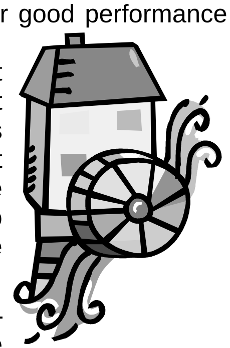
September, 2007 **Issue 07.02**

"Let it Syphon "

There is a new project on the books to install a waste heat boiler (WHB) in a process system. The waste heat boiler is a replacement for a current design that has been in operation since you were born. Like most plants, your facility wants to increase capacity. The WHB has hot process gas on the tube side and water on the shell side. The plant sees an opportunity to save a few bucks by using the existing steam drum with associated risers and downcomers. The Engineering Manager asks you to see that the existing risers, downcomers, and steam drum will work. In your research, you find that the circulation is driven by what is called a "thermosyphon" action. Also spelled "thermosiphon," as well as a few other ways.

A thermosyphon (TS) is simply the natural circulation of a system. In the case above, the WHB heats the water and causes the density of the fluid in the risers to be less than the density in the downcomers. The difference in density will cause the fluid to circulate. When designing systems such as the one mentioned above, there are a few considerations.

1. Steam Drum internals – The steam drum size and hardware are critical. Normally, the internals consist of riser inlet, downcomer outlet, demister pads, standpipes, steam outlets, boiler feedwater injection, and level control instrumentation. The hardware must be designed properly for the steam drum to operate effectively. The amount of steam generated must be replaced by the boiler feedwater. There is also, the ever contant question of boiler feedwater temperature. Sometimes it is simply dictated by what the process can provide. If the boiler feedwater is too cool, this may cause excessive subcooling that could affect the heat transfer at the downcomer inlet to the shell. The optimum heat transfer occurs when good nucleate boiling is present.
2. Pressure drop in risers and downcomers – The pressure drop is critical in the risers and downcomer. Too much pressure drop can lead to thermodynamic instability. Boiling in the risers requires pressure drop theory that will address "two phase flow with slip conditions". Simply put: this means that the bubbles in the risers greatly increase the pressure drop due to increased volumetric flow and friction. Don't let this bite you.
3. Location of downcomers and risers – Location of risers and downcomers in the shell are important for good performance and reliability. Careful attention must be taken for the hot inlet tubesheet. It is important that bubbles not be trapped, leading to overheating of the inlet tubesheet.



4. Circulation Ratio – This is one of the most important parameters in WHB design. The circulation ratio (CR) is the ratio of the mass flow rate of water circulating to the steam generated. A good design will have a CR greater than 20:1. It is general industry practice to have a CR greater than 15:1. A very low CR can lead to thermodynamic instability and overheating of the inlet tubesheet.
5. Water flow at hot gas inlet tubesheet – The water flow across the backside of the inlet tubesheet should be great enough to sweep particles and bubbles away. This depends on the WHB design, but in general, a good number is 2 ft/sec for bulk water flow velocity.
6. Water quality – Poor water quality leads to poor heat transfer due to corrosion. A good water treatment program must be in place for a boiler.
7. Thermodynamic Stability – This is normally caused by too low of a CR or improperly sized risers and downcomers. But this is also a situation where pressure pulses are generated as the system goes on or off line to the utility. This can cause high pressure pulsations that can lead to what is called "flash off" and adequate heat transfer is lost.

All work performed should be reviewed and approved by a professional engineer that is competent in this field.

Cliff's Notes:

KnightHawk has worked with complex thermosyphon systems for 15 years and has developed its own, proprietary thermosyphon computer program that is one of the most advanced in existence. KHE's program has all the physics and considers in detail, two phase flow effects. KHE regularly performs design audits of thermosyphon systems. Give us a call and let us discuss your thermsyphon system challenges and let us show you how we can help.

Summer is over and the kids are back to school. I hope everyone had a great summer. Football has started and everyone is gearing up for another big season. With the new quarterback maybe the Texans will have a better year than the Astros have had.

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KnightHawk Project Update

- Fitness for Service Waste Heat Boiler – Petrochemical
- Rod Mill Failure Analysis – Gasification Power
- Thermosyphon Analysis - Petrochemical
- Pump Metallurgical Assessment – Off shore - Africa
- Waste Water Treatment System Design Audit – Offshore
- Waste Heat Boiler Fit-For-Service – Petrochemical – Middle East
- 15 MW Compressor Audit – Petrochemical - Asia
- Refinery Settling Vessel - Petrochemical
- Desuperheater CFD - Power
- Material Handling Audit – Offshore
- Compressor Vibration – Petrochemical
- Vessel Fluid Dynamics – Petrochemical
- Gasifier Failure Analysis – Petrochemical
- Steam Turbine Failure - Power
- Structural Dynamics - Power
- CFD of Exchanger - Petrochemical
- CFD of Pumps - Petrochemical
- CFD Review of Ethylene TLE - Petrochemical
- 3-D CFD model of Polymer Pump – Petrochemical
- Pump Skid Design – Off Shore
- Rotordynamics – Off Shore
- Waste Heat Boiler Failure Analysis – Petrochemical
- Level 3 Waste Heat Boiler Fit For Service – Petrochemical
- Turbine Generator Wreck – Power
- Polymer Heat Exchanger – Petrochemical
- Ethylene Crack Gas Cooler – Fit For Service – Petrochemical
- Heat Exchanger Vibration – Petrochemical
- Structural Vibration – Petrochemical
- BFW Pump System Vibration Study - Petrochemical
- Inlet Cone Design for TLE's – Petrochemical
- Integral Gar Compressor Failure Analysis – Petrochemical