## Question 26: How do you monitor furnace convection section fouling? What mitigation steps do you implement?

**MICHAEL KIMBRELL** (Becht Engineering)

Monitoring the flue gas temperature leaving the process convection section is a simple method of tracking the heat transfer in the convection section. The excess air needs to be taken into consideration as a higher O2 concentration will shift heat transfer into the convection section and causes the total quantity of flue gas to increase. Another simple method is to check the crossover temperature (process convection section outlet) with the convection section inlet temperature and track the delta temperature across the convection section. This delta can be corrected for flow by multiplying that delta temperature value by the ratio of the current flow rate divided by the design flow rate and then raising that ratio to the 0.8 power. Turbulent flow heat transfer coefficient inside tubes is proportional to the velocity raised to the 0.8 power.

It is a common practice to install tube metal thermocouples on the hottest convection section tube. The heat flux on these tubes is typically the highest in the heater and this high heat flux can cause deposition to occur inside the tube causing the tube temperature to increase. For long convection sections, more than 40 ft long, tube metal thermocouples should be installed at two separate locations.

A simple method to monitor the overall performance of the convection section is done by monitoring the flue gas temperature leaving the process convection section as a way of tracking the overall heat transfer in the convection section. The excess air needs to be taken into consideration as a higher O2 concentration will shift heat transfer into the convection section and that will cause the total quantity of flue gas to increase. Another simple method is to check the crossover temperature (process convection section outlet) with the convection section inlet temperature and track the delta temperature across the convection section. This delta can be corrected for flow by multiplying that delta temperature value by the ratio of the current flow rate divided by the design flow rate and then raising that ratio to the 0.8 power. Turbulent flow heat transfer coefficient inside tubes is proportional to the velocity raised to the 0.8 power.

**RICHARD TODD** (Norton Engineering)

There are several methods for estimating the extent of convection section fouling. The most direct method is measurement of flue gas stack temperature and comparing this result against an estimated value based on heater firing rate and excess air. The stack temperature correlation based on heater firing rate and excess air can be developed from a series of heater simulations with a clean convection section.

A second method for estimating convection section fouling will compare radiant and convection section heat pick-up over time. As the convection section fouls the fraction of heat pick-up in this area will

decrease causing firing rates to increase.

Fouling of external convection surfaces is a chronic condition which has no real cure. The best method for maintaining optimum performance over the long term is to eliminate the burning of liquid fuels and ensuring good combustion conditions in the firebox (proper excess air control and fuel air mixing). Depending on the number of tube rows in a convection bank, offline cleaning is very difficult unless inspection/cleaning doors are provided. Most modern convection sections do not include these doors so cleaning, even foam cleaning, has little or no impact on performance.

Cleaning of internal surfaces is best accomplished using pig cleaning techniques. There are many.

experienced companies offering pig coil cleaning services.

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