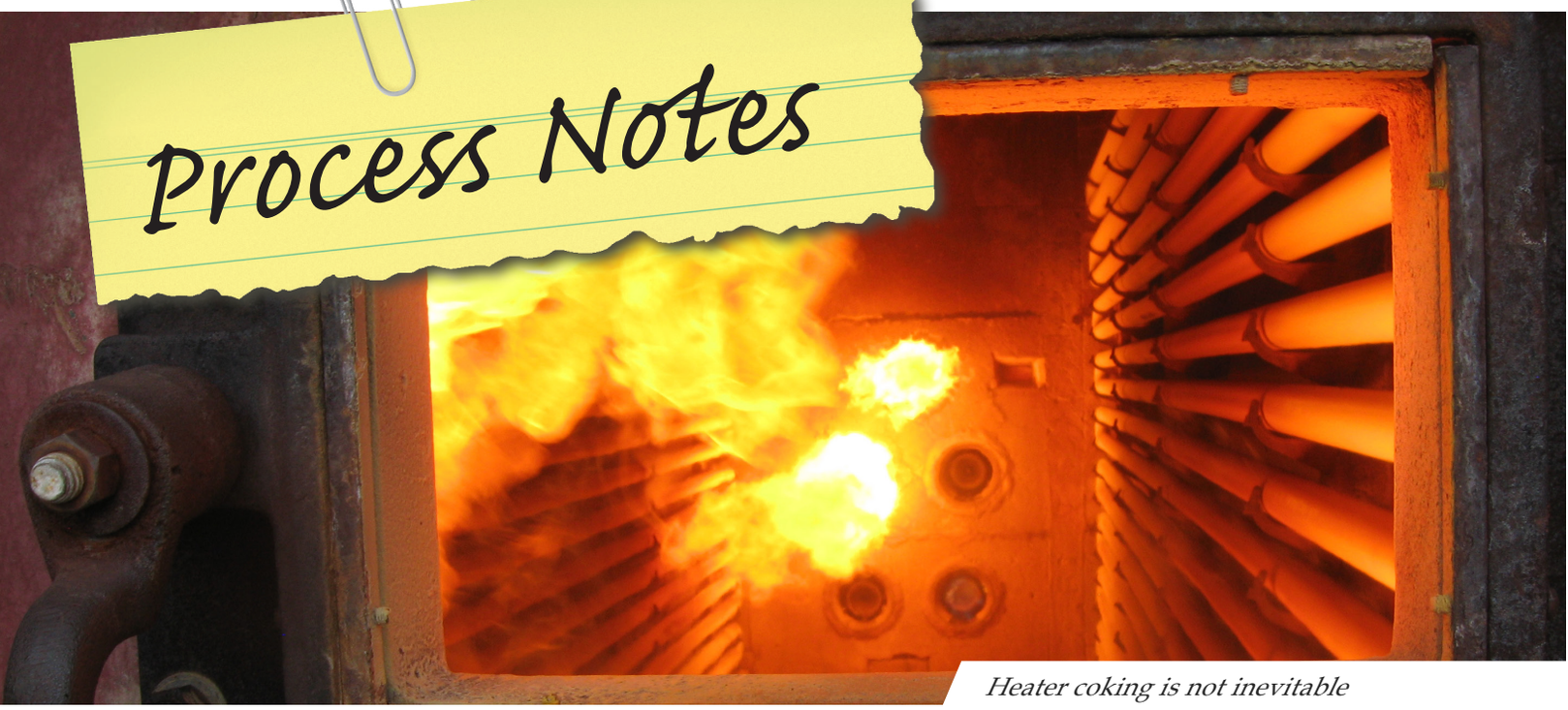

Heater coking is not inevitable

Avoid Fired Heater Coking

For many refiners, heater coking in Crude and Vacuum Distillation Units (CDU/VDUs) is a common occurrence. Many units around the world are shut down every two years, every year, or even every six months to deal with chronic heater coking. However, with the right design features driven by a solid understanding of heater coking mechanisms, fired heater run length can be extended beyond five years, even with relatively challenging crudes.

The two primary drivers of heater tube coking in CDU/VDU services are oil film temperature and residence time. Secondary factors such as crude coking tendency, solids content, and blend instability can further accelerate heater tube coking. So, which heater design parameters will maximize heater run length and avoid shutdowns for high heater tube metal temperature or high heater pass pressure drop?

Mass flux is king

Mass flux ($lb/s/ft^2$ or $kg/s/m^2$) is found by dividing the mass flow through a heater tube by the tube's cross-sectional area. High mass flux begets high velocity and suppresses coking in several important ways. First, high mass flux means that the fluid moves through the tube faster, minimizing residence time. Second, high velocity results in high heat transfer coefficient, which minimizes internal oil film temperature. Finally, high mass flux creates high wall shear inside the tube, minimizing build-up of solids or asphaltenes.

Heat flux can surprise

Heat flux ($BTU/hr/ft^2$ or $kcal/hr/m^2$) measures the amount of heat absorbed through a given outside surface area of a heater tube. High heat flux raises tube metal temperature and causes high oil film temperature inside the tube. Popular fired heater design programs use a well-stirred firebox model and calculate peak heat flux by applying a simple multiplier to the average heat flux. In reality, heater design parameters such as firebox height/width ratio, burner type, burner sizing, burner placement, and air/flue gas flow patterns can result in actual peak heat fluxes that are much higher than the "calculated" peak heat flux on the heater datasheet. Localized areas with very high heat flux will coke and suffer from high tube metal temperature.

Of course there are many other variables that must be considered, such as pass arrangement, vertical or horizontal tubes, cylindrical or box or cabin, coil steam, etc. Problems stemming from blend instability are becoming more common as refiners are increasingly mixing light shale crudes with heavy crudes. As the crude begins to vaporize, asphaltenes can precipitate out of unstable mixtures and coat the heater tubes, forming coke and creating hot spots.

Even with challenging crudes, refiners have achieved Crude Heater and Vacuum Heater run length goals through careful design and respect for the basics of coking. Contact Process Consulting Services, Inc. to learn more.

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