Question 51: In your experience, what are the implications on coker heater run length and coke drum operations with the following feedstock quality: Contaminants (Na, Ca), low saturates or high asphaltenes, crude compatibility, solvent deasphalt (SDA) pitch, low asphaltenes and high saturates?

Frank Tracy (ConocoPhillips)

I will first speak to the heater run length portion of the question and then to the coke drum operations portion of the question.

Heater Run Length

There are at least three main mechanisms under which the heater tubes become fouled:

•Inorganic material deposition or precipitation,

•Rapid asphaltene precipitation,

•Coke formation

All of these may contribute to chronic heater fouling. We link acute episodes of rapid fouling with the first two mechanisms.

1) We will begin with inorganic materials. Inorganic fouling more typically occurs in the upper radiant or even the lower convection section of the heater. These materials may be inherent in the crude or may be introduced during production, transportation or upstream processing of the oil prior to its arrival at the coker. Suspended solids in the oil are often a source of these inorganic materials.

The sodium and calcium noted in the question are certainly two that are common problems. 15-20 ppm sodium has long been the industry rule of thumb for a maximum limit for sodium in coke feed and one we use internally. Of course, we would like to see values below this range. Crude unit caustic injection for chloride control will contribute to the vacuum resid sodium load.

Silicon is an inorganic which has caused significant problems in at least three of our cokers. Silicon has been identified with certain crudes with the source most commonly being silicates and silica (quartz). Additionally, silicon-based anti-foam is suspected as a foulant in at least one case.

Iron is another inorganic we have seen cause heater tube fouling. Iron sulfides and other iron compounds enter with the crude and are not effectively removed in the desalter and end up in the feed to the coker.

There are other inorganics associated with fouling coker heater tubes and include aluminum and magnesium (associated with silicates) and barium. However, in our experience, these are less prevalent than the four previously mentioned.

Inorganic deposits often do not lend themselves to removal using online spalling or steam air decoking, and consequently, pigging must be used.

Ideally inorganic materials should be managed and minimized upstream of the coker. This may involve desalter operation, managing crude unit caustic injection, and addressing issues with crude suppliers. In addition, other streams fed to the coker such as FCC slurry oil and refinery slop oil can contain inorganic materials that may be detrimental to coker heater run length.

2) Asphaltene deposition is a second mechanism to watch for. We have experienced rapid, episodic fouling events due to asphaltene precipitation. This tends to occur in the upper radiant or lower convection section. It is sometimes linked to highly paraffinic resids or when the feed is a resid hydrocracker bottoms or deasphalter pitch stream.

Within COP we use asphaltene stability and proprietary coking propensity testing to evaluate feed stocks and identify and address problems with feeds or feed compatibility. ConocoPhillips proprietary Distillate Recycle technology, which recycles coker distillate through the furnace and coke drums, can also improve asphaltene stability.

3) Coke formation, the traditional heater tube fouling mechanism, is the third mechanism. The heaviest coke formation usually occurs in the lower radiant section where temperatures are the hottest. Turbulence and high velocity can be used to minimize the time any molecule is at the interface with the hot tube and are utilized to minimize coking. Velocity steam is used for this purpose. Distillate Recycle technology can also be used for this purpose, plus there is a yield benefit as well.

Drum Operations

Let’s shift to the second part of the question, which was how these factors effect drum operations.

Inorganic contaminants don’t have much impact on drum operations. However, for anode cokers, there could be coke quality implications with most of these contaminants.

Different feed stocks can have an impact on coke drum operation. The top of the coke bed has had the least amount of time to complete the coking reaction. If you have a less reactive feed stock, such as a hydrocracker bottoms stream, then that material in the top of the bed will be less converted to coke and more like tar than a traditional vac resid feed. This material is more likely to plug flow channels in the top of the bed and be less effectively quenched, which may result in more hot spots and blow outs.

We believe an increase in the amount of resid hydrocracker bottoms being fed to two of our cokers to be the reason for increased blowouts and have limited the amount of this material to help address this issue. We have also raised coke drum temperature to help complete the coking reaction.

Ralph Goodrich (KBC Advanced Technologies, Inc.)

With contaminates such as sodium and other salts the heater fouling is accelerated. This generally is related to a desalter upset or poor desalter operations. In extreme cases a desalter upset can cause the delayed coker to foul in a few days or less.

Caustic injection is a common practice to mitigate chloride corrosion problems in the crude tower and overhead system. However, the resulting sodium in coker feed can accelerate fouling in the delayed coker heater and should therefore be kept below 15 ppm. Thus, the caustic injection rates should be carefully monitored and kept to a minimum or eliminated if possible. Solids in the feed to the coker can also cause rapid fouling. For example, in some locations in Canada, the solids content is as high as 2 wt%. These extreme levels of solids will tend to cause fouling in the coker heater (the upper radiant and lower convection sections), fouling in the coke drum overhead vapor line, and main fractionator flash zone section.

High asphaltenes in the feed will also increase the furnace fouling rate. Furthermore, the high asphaltene content will tend to produce a shot coke, which in turn can cause drum cooling problems and high drum thermal stresses, ultimately resulting in drum cracks. Finally, there are definitely crude compatibility issues to be aware of. Dissimilar crude and resulting coker feeds can result in difficulties in drum cooling and hot spots - foaming can be an issue as well. Some of these problems with dissimilar coker feeds can be addressed with procedural changes but at some point, limiting the offending crude is the only economic choice. In general, to avoid these problems, keep the feeds to coker as similar as possible, i.e., do not mix highly asphaltenic feeds with highly paraffinic feeds.

Tags

Chlorides

Corrosion

Delayed Coking

Desalting

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