
Question 49: What criteria do you use to predict coke drum hot spots (leading to blowouts) during the cutting cycle? How do you modify your standard cutting procedure if you anticipate hot spots?

Gary Gianzon (Marathon Petroleum Company)

Coke drum hot spots can be difficult, if not impossible, to predict but there are operating practices that can help minimize the occurrence of coke drum hot spots/blowouts. The operating practices are as follows:

1. Set a target and monitor the coke drum inlet temperature. It is a guide to understanding the actual condition of feed to the drum. High furnace outlet/coke drum inlet temperature improves coke porosity. Our experience indicates that raising the temperature a few degrees can make a huge impact on reducing blowouts/hot drums.
2. Maintain forward flow of steam/water in the drum while transitioning to water quenching.
3. Develop a quench ramp program that fits your specific unit. Initial water rate should be low and gradually increase at a set interval. Pressure override is needed to prevent over-pressuring of the drum during quench.
4. Install a “totalizer” that measures the total volume of water used during water quench and provide guidelines on minimum water usage during drum quench. Low water usage can indicate water has channeled through the coke bed.
5. Install a “totalizer” that measures the total volume of sour water produced during quenching and provide guidelines on minimum sour water make from the blowdown settling drum.
6. Ensure that all the coke drum skin temperatures are below target before draining water out of the drum.
7. Fill the drum with water above the coke bed to the High-level shutoff switch. This ensures that the coke bed as well as the drum metal has been cooled.
8. Install and use controlled back pressure quench either by raising the quench drum settling drum pressure or through a back pressure controller.

If a hot spot is encountered while drilling the pilot hole, our coke cutter follows the “decoking hot spot” procedure to minimize/reduce coke emissions during decoking. Here are the excerpts from our decoking for hot spot procedure:

1. Follow normal procedure for drilling of pilot hole, noting all areas of emissions.
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2. De-coke the drum in 5 ft. increments versus 10 ft. during normal cutting procedure.
 3. If emissions are encountered, raise the drill steam and allow water to run until emission is diminished

Rajkumar Ghosh (Indian Oil Corporation)

Coke drum hot spots refer to a situation where some part of the Coke bed remain hot, while the other parts get quenched. As soon as this hot part of the coke bed comes in contact with coke cutting water during drilling or cutting operation, it results in sudden vaporization and steam blowout. In our cokers, we have sometimes experienced very hot drums which resulted in blowout during cutting cycle and also observed red hot coke coming out of the drum along with coke cutting water.

Hot drums typically occur because of partially coked hydrocarbon resid collapsing at the top of the coke bed after drum switch and encasing the 800°F hot coke. This pitch type resid prevents quenching some part of the coke bed within the coke drum. When high pressure coke cutting water hits the unquenched part of the bed, the water explosively vaporizes, pressurizing the coke drum and lifting coke out of the coke drum. Hot drums can also occur in the lower portion of the coke bed for variety of reasons viz., poor coke drum warm-up, resid is poorly coked due to low temperatures, formation of large amount of shot coke (which cannot be avoided if feed is of quality that leads to shot coke), shorter cycle length with less quenching duration or improper steaming leading to channeling during water cooling.

Following guidelines are used for predicting coke drum hot spot:

1. Correlating the amount of quench water collected in the blowdown system can help predicting hot spot. Sour water production for 28 ft diameter coke drum is estimated to be 208 m³ /hr based on heat balance. Unusual reduction in sour water generation (below 70%) is a key indicator to poor quench and possible hot spot.
2. Premature water level buildup in the drum during water cooling step indicates less vaporization of water, thereby pointing to inadequate cooling and possibilities of hotspot. Less than normal water consumption could be another key indicator to hot spot.
3. longer time required for depressurization of coke drum after coke bed is filled with water also indicates improper cooling and possibilities of hot spot.
4. Any disturbance or interruption in a particular Coke Drum cycle is a precursor for Hot Spot. Short duration heater tripping, momentary loss of feed to heater/ coke Drum, variations in coke drum inlet temperature and variation in feed quality during the course of coke drum filling are some of the reasons for hot spot in coke bed.

Precautions like drum partial fill & drain, water-over or soaking can be employed to mitigate hot spots.

The frequency and severity of hot spots can be reduced by:

a. Increased COT near the end of cycle helps reducing quantity of uncoked resid at the top of the drum. This is also part of the action for reducing coke VCM.

b. Maintaining adequate Steam Stripping. The rate of steam and the duration of stripping will allow the coking reactions to complete since steam does not greatly cool the coke bed (it is actually heated as it moves through the bed). Higher steam rates will keep flow channels open and reduce channeling in the coke bed.

c. Ensuring that the Coke bed is positively submerged under water towards the completion of quench cycle. Coke drum skin temperatures are closely monitored for:

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c. Ensuring that the Coke bed is positively submerged under water towards the completion of quench cycle. Coke drum skin temperatures are closely monitored for this purpose. Reliable coke drum level indicators play a crucial role. In case hot spot is anticipated, the coke bed should be allowed to soak for at least an hour before going ahead for draining activity.

As per our experience, steam blow-outs generally happen during the initial pilot hole drill of the coke bed. If it is predicted that the coke drum may have hot spots, we go slow to drill the pilot hole @2-3 fpm for such types of drums against normal of 5-8 fpm. During cutting operation, if the operator spots more than normal amount of steam coming out from the reactor, the drill stem is taken up by about 1 meter from that point and left there for 10- 15 minutes for cooling of that region.

Eberhard Lucke (Commonwealth E&C)

I don't know of any criteria that can be applied to predict hot spots during the cutting cycle. Typically refiners apply certain measures during the quench cycle to potentially identify irregularities like potential hot spots. They monitor drum temperatures and drum pressure to manipulate the quench rate controller. Some operations also use a totalizer for quench water used to fill up the drum to compare to historical data for normal operation. I don't see any benefit in adjusting your cutting procedure when knowing about a hot spot. The bigger concern is to make sure that no operations personnel (or other personnel) is in the vicinity of the top head opening during these critical stages of the drum operation. Also, consider installing a top head system that includes a containment dome with a vent connection to a safe place to minimize the hazard of hitting a hot spot during quenching or cutting.

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