Question 65: Discuss operating conditions and economic drivers to produce maximum diesel from the coker.

MAYO (CITGO Petroleum Corporation)

When your margins indicate the need to pull more diesel, you have two options: You can check the top of your tower, or you can adjust overhead temperatures and fractionations to confirm that you are pushing the maximum amount of heavy naphtha down into the diesel. The pitfall to avoid is cooling it off too much and worrying about salting on the top of the tower. You can get aggressive but be careful with regard to salting.

And then on the bottom end, a lot of us have fallen into the pitfall of trying to extend heater decokes, such as overuse of your heavy coker gas oil pumparound trying to recover as much of that preheat in order to raise coil inlet temperatures. Sometimes you do not let enough diesel traffic up the tower. So, the two modes you really need to watch are overcooling and overuse of that lower pumparound.

WATTS (LyondellBasell Industries)

I see a lot of similarities with what we do at the refinery. We obviously take a holistic approach to optimizing diesel on our refinery with the goal of pushing to a frontend distillation limit or flash limit; and on the backend, to push the 90% point or final boiling point limit. So, the streams we put in front of the diesel treaters are coming off of the crude units and the cokers. Then, we pulled a diesel stream off of one of our cat feed hydrotreaters. We found that the worst quality streams, in terms of ability to treat, on our diesel treaters are the light vacuum gas oil off of our heavy sour crude unit: the 636 diesel off the cat feed hydrotreater that is been hydrotreated. And then, the third would be the coker streams.

In terms of undercutting on the front end, typically the downgrade between coker-like gas oil and coker naphtha is a lot greater than what you see on the crude units. So, we are going to drive to either a temperature limit or a frontend distillation limit.

WILLIAM (BILL) HURT (Keystone Engineering Inc.)

What is your lowest operating pressure that had been maintained in your fractionator overhead?

MAYO (CITGO Petroleum Corporation)

For the coker fractionator in decoke mode, when we are running a side down for one of our smaller cokers, we can run down into the 10 psig (pounds per square inch gauge) range. But with normal operating conditions, the mid-20s is typically the average operating pressure.

MEL LARSON (KBC Advanced Technologies, Inc.)

There are some coker fractionators that do not have an intermediate pumparound, as there is on the light distillate section. Has anyone considered adding that so you could get the lift and not have to use as much at the bottom of the pumparound? Secondly, has anyone looked at coker naphtha fractionation on the backend to avoid the problem of salt deposition at the top of the tower while still optimizing the cutpoint? There are places around the world where we have seen both. Has anyone considered that as a revamp option to maximize flexibility and operation here in the States?

MAYO (CITGO Petroleum Corporation)

To respond to your first comment, that opportunity absolutely exists at our facility right now. One of our cokers has the pumparounds in the heavy gas oil and light gas oil circuits and just a draw for the blended oil (kerosene). For the other coker, we just have a draw on the light coker gas oil. And absolutely, if we are having any flooding issues at the top, any heat we allow up into that section will compound the issue. So an additional pumparound would absolutely help us in that situation.

WATTS (LyondellBasell Industries)

We looked at different projects on the pumparound. I am not that familiar with them, but I know we are – as are most refineries – looking at ways to shove more diesel into treaters. I would say that we do face issues when we shift to a two-drum operation on the cokers with basically being at minimum pumparounds and removing too much heat.

GARY HAWKINS (Emerson Process Management)

Consider the coker as two sections: the coke drums and heaters section and the fractionation and vapor recovery section. For the coke drums and heaters section, maximum throughput is achieved by optimizing the coke drum cycle; basically, taking advantage of as much of the drum capacity as possible without risking foaming in the transfer piping to the fractionator. Benefits can also be achieved by maximizing the efficiency of the fire heater operation. But the coker fractionator is unique amongst the fractionators in refineries (crude, vacuum, FCC and hydrocracker being the others) in that the feed to the column takes an upset in vapor flow every time the drums switch. This is an excellent application for multivariable predictive control targeted specifically for optimal fractionator control through the “bumps” of coke drum switching.

SRINI SRIVATSAN (Amec Foster Wheeler)

Usually maximizing C5+ liquid yields also maximize revenue to a refiner. However, if the HCGO is not going to be a downstream conversion unit, it is possible to have a large differential in the pricing between LCGO (light coker gas oil) and HCGO (heavy coker gas oil), with LCGO being priced at a premium. The economic driver to produce maximum diesel from the coker then depends on differential pricing between LCGO and HCGO.

Typically, delayed coking units (DCU) designed for maximizing C5 + liquid yields are designed for low pressure and ultra-low recycling. Amec Foster Wheeler has several units operating at coke drum pressures of 1.05 kg/cm2 (kilograms per square centimeter), which is the equivalent of 15 psig (pounds per square inch gauge), and a throughput ratio of 1.05 that make an HCGO product suitable for further processing in downstream hydrocracker units. While units can be designed for zero recycle (1.0 TPR) to further maximize C5+ liquid yields, it is to be noted that this increased liquid yields is mainly from the production of an extra heavy coker gas oil (XHCGO) stream or combined HCGO, if XHCGO is not drawn as a separate product. One has to carefully evaluate the quality of XHCGO or the combined HCGO product produced and the ability of the downstream processing unit to handle the product in this case. The contaminant levels – such as (nickel + vanadium), Conradson carbon, and C7 insolubles – in the combined HCGO stream, in a true "zero" recycle operation, can be 2.5 to 4 times higher than one operated at 5% recycle.

If producing diesel (LCGO) is the only objective, higher operating pressures favor the production of diesel material (LCGO). Based on the pricing differential between LCGO and HCGO, an optimum pressure can be selected that maximizes refinery margins.

BRENT MAYO (CITGO Petroleum Corporation)

When margins encourage diesel yield over naphtha, operating conditions that help improve diesel recovery are:

1. Adjusting pumparounds above the diesel section of the tower to improve fractionation (reductions in tower overhead temperature can result in salt deposition at too low of temperatures) and

2. Avoiding over-use (as a preheat benefit) of lower pumparounds to allow increased vapor traffic higher up the column [ensure piping and equipment can handle increased draw temperatures MAWT (maximum allowable working temperature) and thermal expansion]. Also, ensure that changes to the diesel final boiling point are within allowable range for downstream units.

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