SULFURIC ACID ALKYLATION

How do you run the alkylation unit safely while still meeting production goals?

Although there is very little commercial data available, a runaway can occur within a few hours. Therefore, a lab analysis that is completed once during an eight hour time period would not be frequent enough to indicate an acid runaway.

Glen Liolios, STRATCO. "Acid Runaways in a Sulfuric Acid Alkylation Unit". http://www2.dupont.com/Clean_Technologies/es_MX/assets/downloads/AcidRunaway2001.pdf

What if...

- You could **avoid acid runaway**?
- You could **minimize acid consumption**?
- You could **maximize production** of high-quality alkylate?

The sulfuric acid alkylation unit produces high-value alkylate. It is no surprise, then, that maintaining a high level of production is a key unit metric. However, increased production must be balanced with product quality, acid consumption, and employee safety. These are all competing objectives, and it is your job to balance these demands and constraints to optimize the unit.

Process engineers we talk to tell us about sulfuric acid alkylation unit challenges like these:

"Acid runaway must be avoided."

Safe operations is the top priority at every unit in the refinery. At the alkylation unit, a major safety concern is avoiding acid runaway, caused by acid concentrations that are too low. Acid samples are taken every shift and measured in the lab via titration to ensure the concentration remains above 87wt%. But this leaves 8 hours between sampling, allowing time for acid strength to decrease to potentially dangerously low levels.

"I'm challenged to minimize acid consumption."

Sulfuric acid is a major cost of the alkylation unit, so you want to minimize acid consumption. This is difficult given the need to avoid acid runaway- you want to lower the final acid concentration, but only to 89-90wt%. Steady operations and gradual changes to the acid flow rate are critical to low acid use, but this proves difficult in practice. Since acid samples are taken once per shift, a low result can cause quick compensation. Acid flow is increased because the consequences of acid runaway far outweigh the cost of high acid use. However, this can increase acid consumption needlessly. You'd like a way to continuously monitor acid strength to avoid these sudden reactionary changes to acid flow.

"It's difficult to maximize high quality alkylate production with all of the processing constraints."

Alkylate is a high quality, high value gasoline blending component, so maximizing the throughput of the alky unit is important to refinery economics. But running the unit harder decreases product quality. One way to ensure quality is to maintain the correct acid to hydrocarbon ratio inside the reactor, but this is difficult using the sightglass.

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SULFURIC ACID ALKYLATION

AVOID ACID RUNAWAY

Micro Motion Coriolis flowmeters measure both flow rate and density. Density can be correlated to acid strength, providing a continuous measurement between lab titrations. Coriolis meters on the interstage acid lines enable monitoring throughout the process. An upset in the first or second reactor may take hours before it can be detected in the final settler, but the change in density provides early detection of the problem. A Coriolis meter on the fresh acid line provides an alarm if the feed tank is inadvertently switched, for example, from fresh to either spent or swing tanks. Finally, in-situ Smart Meter Verification monitors for corrosion wear in the meter, giving you confidence in the meter performance, and providing insight into the process.

MINIMIZE ACID CONSUMPTION

When an acid sample comes back with a low concentration, another sample is immediately taken and checked. However, acid flow is usually increased to be on the safe side until the lab result comes back. If the result is normal, the immediate concern has passed, but oftentimes acid flow is not reduced back to the prior level. Even if it is, the sudden changes in acid flow upset the balance in the system, and lead to increased acid use. Using the density output of Micro Motion Coriolis meters to continuously monitor acid strength prevents this 'panic' between titration measurements. Real-time data also promotes gradual changes in flow control, which reduces acid consumption.

IMPROVE ALKYLATE QUALITY

Maintaining the correct acid to hydrocarbon ratio in the reactor ensures an acid-continuous emulsion, improving product quality. The emulsion is typically monitored with the ratio sightglass, but it is difficult to obtain reliable measurements, if this is monitored at all. Installing a Micro Motion Coriolis meter in parallel with the existing ratio glass provides an online density measurement, which is correlated to the acid to hydrocarbon ratio. This provides accurate, real-time data that can be used to ensure the proper ratio is maintained. The Coriolis meter does not monitor emulsion tightness, so the ratio glass can be maintained for this purpose.

A refinery installed Micro Motion Coriolis meters on the sulfuric acid lines in an alkylation unit to infer acid strength. This provided real-time continuous acid strength data, safeguarding against acid runaway, and enabling reduced acid consumption. The acid concentration leaving the system improved from 94wt% to 90wt%.

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