Refining

Micro Motion

EMERSON Process Management

Crude and Vacuum Distillation	Delayed Coker	Fluidized-bed Catalytic Cracker (FCC)	**Alkylation**	Hydrotreating	Hydrogen Plant	Blending

Alkylation is the fourth unit in this seven-step overview of Refining

Overview of Alkylation

The alkylation process in a refinery is often part of the same operating area as the FCC unit because the two units are closely linked. The primary function of the alkylation unit is to re-combine some of the smaller molecules formed via cracking in the FCC unit into the gasoline size range. Alkylation produces a very high quality gasoline blending component because it has a high octane rating, contains no benzene or other aromatics, no olefins, and little or no sulfur. It is a product very much in demand because of its “cleanliness”.

Alkylation is the reaction of low-molecular weight olefins with an isoparaffin to form higher-molecular-weight isoparaffins. The alkylation process takes place at low temperatures in the presence of either liquid sulfuric acid or hydrofluoric acid as the catalyst. Many licensors and engineering companies have been trying to develop an economical solid bed alkylation catalyst but there has been limited success.

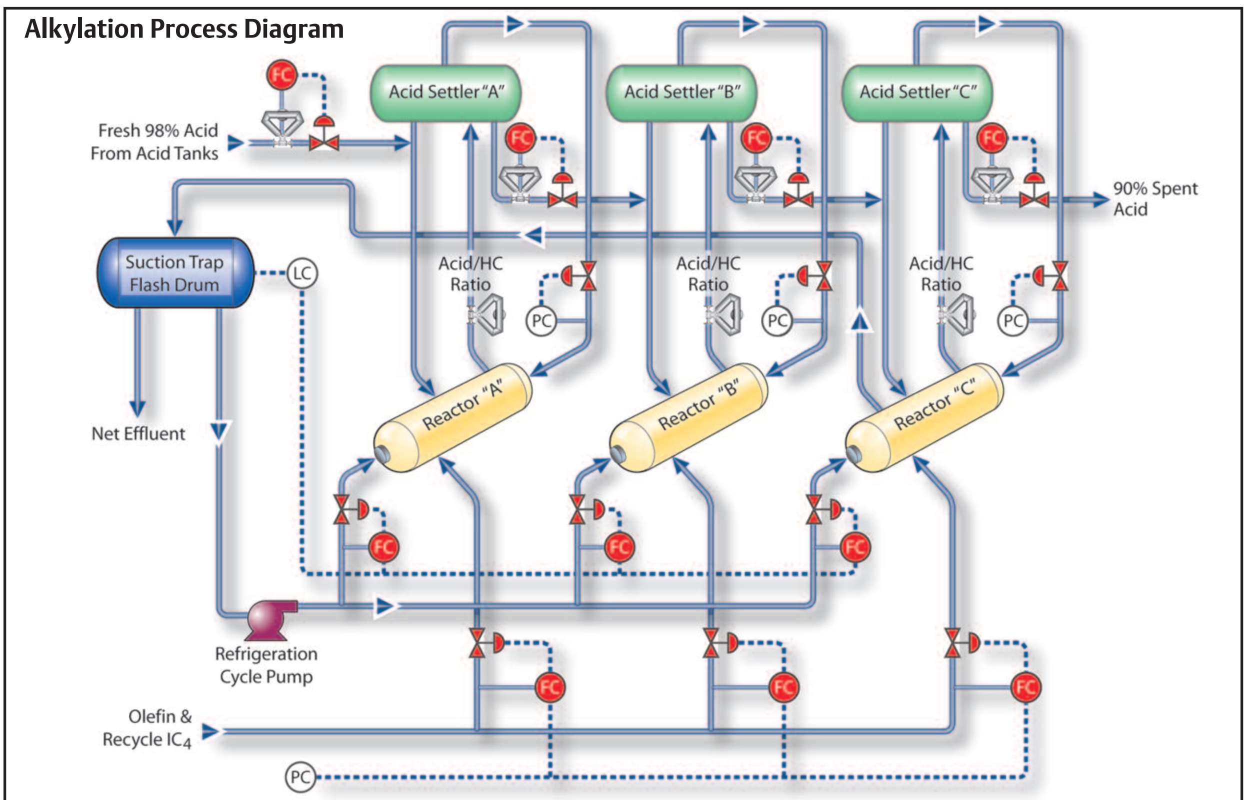
The two alkylation processes, hydrofluoric or sulfuric, are quite different. There are two primary licensors of the HF alkylation process, which are UOP and Phillips. Because of the dangers of exposure to HF acid, there are few if any new HF alkylation processes being built, but there are a large number of units running around the world. Because Micro Motion does not have metallurgy compatible with HF acid, we will concentrate mainly on the sulfuric acid alkylation process in this document.

The primary sulfuric acid alkylation technology is Dupont™ STRATCO® Effluent-Refrigerated Alkylation technology. The plants include the following sections:

- feed treating
- reaction section
- refrigeration section
- effluent treating
- fractionation

The units are designed to process a mixture of propylene, butylenes, and amylenes. There are a number of different configurations, but there are generally between three and six Contactor™ and acid settler combinations. The feed streams generally flow through one Contactor™, with three to six operating in parallel, while the acid streams flow in series from the first Contactor™ to the last. The alkylation reaction takes place in the Contactor™, and that mixture flows to an acid settler, where the acid and hydrocarbon separate.

Alkylation Process Diagram



Customer Challenges

The acid cost is the highest cost of operating the alkylation unit, amounting to 50% of the overall operating expenses so there is a big driver to try to reduce acid consumption. Reducing the concentration at which the acid is spent by 1% reduces acid costs by 10%. Other drivers include optimizing throughput since alkylate is such a crucial component to the gasoline pool. Minimizing unit upsets and preventing unplanned shutdowns is also critical.

Another important process variable is the acid/hydrocarbon ratio in the Contactor™. This ratio is traditionally measured with a sightglass, by occasionally circulating through the sightglass and then blocking it in to visually inspect the ratio. The problem with this approach is that the sightglass often gets plugged and difficult to see through, so the operators neglect this measurement.

Customer Process Challenge #1 – Monitoring Acid Strength and Flow

Challenge: Maintaining the target acid concentration level is important to refiners both from an economic as well as a safety aspect. If the acid level drops too low, there is a danger of running into an acid runaway situation, where reactions get out of control, acid is rapidly consumed, and the plant will have a major shutdown costing millions of dollars.

On the other hand, maintaining the acid concentration too high costs the refiner a lot of money in acid costs. Maintaining the acid concentration at a specific level is therefore critical. The traditional approach to maintaining the acid concentration is by manual sampling.

The interstage acid flow rate is often also a challenge. Because of the erosive nature of the acid and the desire to keep the pressure drop low, the flow rates through all the piping in the plant are kept below 3 ft/s (1 m/s). The optimal velocity for a mag meter is around 30 ft/s, so reliable measurement is challenging.

Customer Process Challenge #2 – Monitoring Acid/HC Ratio Control

Challenge: Mixing and emulsion characteristics inside the Contactor™ are monitored using the acid/HC ratio. An acid-continuous emulsion is desirable, indicated by an acid/HC ratio in the range of 45-60%. Below this acid/HC ratio, a hydrocarbon-continuous emulsion exists resulting in poor product quality and potentially leading to an acid runaway. It is important to monitor this ratio but, because of the difficulty of getting a reliable measurement with the standard sightglass method, the ratio is often not carefully monitored.

Improving Efficiency	Recommended Product Solution
Customer Challenge #1 - Monitoring Acid Strength and Flow	**Micro Motion ELITE CMF200 and ELITE CMF300**
Control Point Challenge: Maintaning proper acid strength and acid flow rates. **Solution:** Micro Motion highly accurate density measurements can be correlated to the acid strength, giving the refiner continuous on-line measurement of acid strength. This allows better control of the spending strength, resulting in significant savings from reduced acid usage. Acid flow rate control between reactor stages is also improved since Coriolis meters have such high turndown, they still get accurate flow at greatly reduced flow rates. **Competing Technology:** Mag meters and lab sampling for acid strength	**Application** Interstage and spent acid strength 
Customer Challenge #2 - Monitoring Acid/HC Ratio Control	**Micro Motion ELITE CMF100**
Control Point Challenge: Acid/ HC ratio control **Solution:** By measuring the density of the emulsion with Micro Motion Coriolis meters, the acid/HC ratio can be determined. Continuous on-line measurement of this ratio ensures emulsion characteristics in the Contactor™ and alerts operations instantly in the event of an emulsion inversion. **Competing Technology:** Ratio glass to visually inspect the level.