ALKYCLEAN—A true solid acid gasoline alkylation process

ALKYCLEAN is a low-risk alkylation process, using an environmentally friendly zeolite catalyst, which has proven to be a reliable alternative for existing liquid acid technologies. A 10 bpsd demonstration unit has operated successfully for almost three years utilizing this technology.

The advantages of alkylates

Alkylate is valued as a blending component in the gasoline pool because it has no olefins or aromatic compounds, a low sulfur content, a limited heavy end, and relatively high research and motor octane numbers. All of these traits contribute to the production of environmentally "clean" gasoline, providing a strong incentive for refiners to produce alkylates.

With an alkylation unit, the refiner can optimize FCC unit operations for higher conversions. The lighter fraction, butanes and olefins, is then used to produce alkylate. Alternatively, the extra propylene produced at the higher FCC conversions can be used as a high-value petrochemical. The combined alkylation and FCC gasoline fraction will not only be larger, but will also have improved properties, such as a lower heavy end fraction.

Some significant drawbacks

These economic and environmental advantages have led to substantial growth in alkylation capacity in recent decades. But existing sulfuric and hydrofluoric (HF) acid based technologies posed some significant disadvantages.

HF is extremely toxic and corrosive. Experiments in the Nevada desert have shown that a lethal dose of HF aerosol can be present even eight kilometers from the point of emission. To minimize risk, HF alkylation requires complex safety procedures and equipment. Although risks can be limited, the effects of any accident could be dramatic, a risk that has brought the acceptance of new HF units under severe scrutiny.

Sulfuric acid is less dangerous than HF, but toxic sulfur oxide gas can be formed by the oxidation of hydrocarbons. In addition to this operational risk, the amount of acid needed is high—about 100 kg of sulfuric acid per ton of alkylate produced. This results in additional environmental and safety risks related to installing acid regeneration facilities or transporting large quantities of the acid, all of which has an impact on operating economics. And with both technologies, corrosion prevention necessitates expensive construction materials and relatively high maintenance costs.

The search for a solid solution

All the risks associated with liquid acid alkylation technologies have inspired many attempts to develop a true solid acid catalyst and process. All of these efforts have failed, until now. Albemarle, ABB Lummus Global and Neste Oil introduce ALKYCLEAN, a genuinely innovative alkylation process. ALKYCLEAN was developed and proven at a demonstration plant constructed and operated by Neste Oil in Finland. This unit has a capacity of approximately 10 bpsd and operates on the same feedstocks Neste uses in its existing alkylation unit. Besides proving the technology and catalyst on a commercial scale, the project also generated the key know-how required for the smooth construction and operation of commercial plants.

The advantages of ALKYCLEAN

The ALKYCLEAN process offers many unique advantages:

- Alkylate octanes comparable to the liquid acid processes
- Competitive plant investment and production costs
- The potential for economic retrofitting and de-bottlenecking of existing liquid acid units
- Reduced sensitivity to changes in C_4 olefin composition of feedstocks
- Elimination of heavy hydrocarbon by-product (ASO) production
- Elimination of reactor refrigeration and alloy construction material requirements
- Reduced maintenance, monitoring and insurance costs
- Elimination of corrosive/toxic liquid acid consumption and associated safety and environmental concerns

Table 1 provides a more detailed comparison of the new ALKYCLEAN process with existing liquid acid technologies (see page 12).

Contact: Edwin van Rooijen
Email: edwin.vanrooijen@albemarle.com

ALKYCLEAN

Continued from page 11

ALKYCLEAN comparison with liquid acid technologies			
Parameter	**Modern sulfric acid technology**	**Modern hydrofluoric acid technology**	**ALKYCLEAN**
Base condition	C_4=feedstock	C_4=feedstock	C_4=feedstock
Product RON	95	95	95
Product MON	Base	Base or better	Base or better
Alkylate yield	Base	Base	Base
Total installed cost, ISBL	Base	85% of base	90% of base
Total installed cost, including OSBL (regeneration facilities, and/or safety installations)	Base	70% of base	50% of base
ASO yield	Base	Less	None
Equipment maintenance	High	High	Much lower
Corrosion problems	Yes	Yes	None
Reliability and on stream factor	Base	Base	Higher
Turnarounds frequency / duration	Varies / longer	Varies / longer	Match FCC or better / shorter
Safety	**Unit specific safety precautions as well as transport precautions**	**Very specific safety precautions required that extend throughout refinery**	**No special precautions other than those for any refinery process unit.**
Catalyst	**H_2SO_4**	**HF**	**Zeolite**
Environmental	**Significant waste streams generated**	**Significant waste streams generated**	**No emissions to air, water, or ground**

Table 1: Detailed comparison of the new ALKYCLEAN process with existing liquid acid technologies