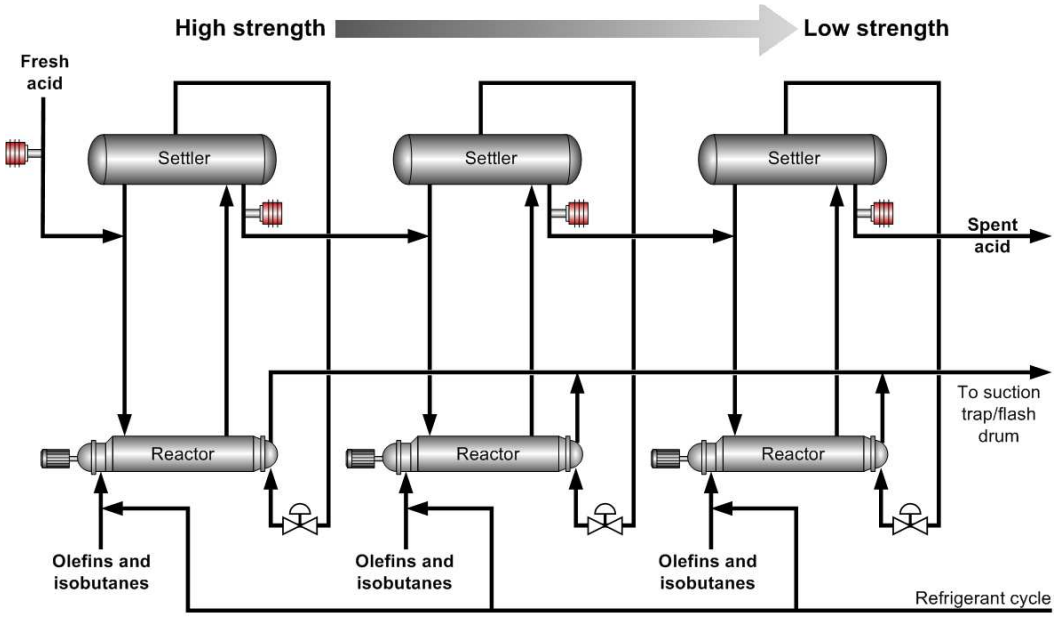
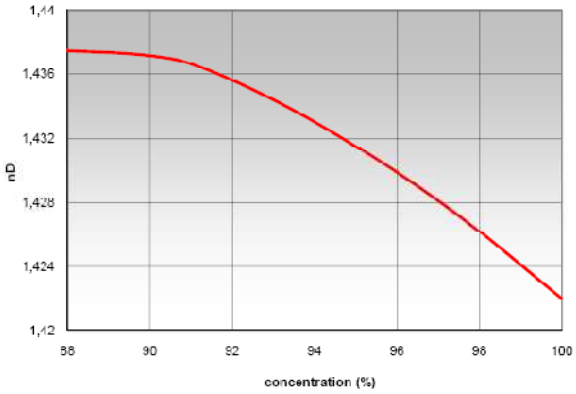


SULFURIC ACID, H_2SO_4

Typical end products

Alkylate (premium higher octane gasoline blending stock for motor fuel and aviation gasoline)

Chemical curve: Sulfuric acid 88 100 R.I. per Conc% b.w. at Ref. Temp. of 20°C



Introduction

Motor fuel alkylation using sulfuric acid (H_2SO_4) or liquid hydrofluoric acid (HF) is one of the oldest catalytic processes used in petroleum refining. The purpose of the alkylation is to improve motor and aviation gasoline properties (higher octane) with up to 90% lower emissions compared to conventional fuel usage.

The problem with HF is that the catalyst forms a hazardous air pollutant when released as a superheated liquid, while H_2SO_4 does not. Therefore nearly 90% of all alky units built since 1990 have adopted the H_2SO_4 technology.

The leading H_2SO_4 alky unit licensor, with a 90% share of the market, is DuPont (Stratco®). Another licensor is EMRE (Exxon Mobile Research Engineering, formerly K.W. Kellogg).

Application

In the process, isobutylene is alkylated with low molecular weight olefins (propylene, butylene and pentylene) in the presence of strong acid catalyst to form alkylate (the premium higher octane gasoline blending stock). The reaction is carried out at moderate temperatures in a two phase reaction. The phases separate spontaneously, so the acid phase is vigorously mixed with the hydrocarbon phase to form higher molecular weight isoparafinic compounds.

After the reactor, the mixture enters a separation vessel where the acid and hydrocarbon separate. The acid is then recycled back to the reactor.

Installation

The problem involved with the sulfuric acid iso-butylene alkylation process is that the sulfuric acid concentration is critical to complete consumption of the iso-butylene. A highly variable concentration of

the iso-butylene in the feed stock upsets the sulfuric acid content in the process.

It is important to determine the proper quantity of acid that will be fed into the process. This is achieved by combining routine sample titration analysis with continuous acid monitoring using the K-Patents Process Refractometer. Without this continuous real-time measurement, the operator would need to wait for a confirming titration result causing a delay in the implementation of any necessary adjustments to the acid flow.

The continuous monitoring removes the uncertainty involved between titration measurements. The K-Patents refractometer will indicate any gradual fluctuations in the acid flow, allowing precise control over efficient acid consumption and resulting in cost savings. It is also useful in preventing acid runaway, an unwanted situation commonly described as "wild acid".

Acid runaway may happen when the acid strength goes below 85-87%. As a consequence, the reactions between olefins and iso-butene turn into reactions of olefins only, producing polymers known as "acid sludge, ASO or red oil".

Due to their operating principle, the K-Patents refractometers are unaffected by acid soluble oil (ASO). The K-Patents refractometer indicates actual acid strength regardless of the amount of hydrocarbons present, which is essential when transferring acid emulsion. It is also an extremely useful tool in the real-time acid strength measurement process during agitated conditions.

The initial acid concentration is typically 85-100% and the temperature is 15℃ (59℉). The benefits of the K-Patents continuous monitoring system include substantial cost savings due to reduced acid consumption, and smooth alkylate production without acid runaways.

Instrumentation

The K-Patents Process Refractometer System for Alkylation Acid Measurement Consists of:

1. a) K-Patents Process Refractometer PR-23-AX/FM/CS to be used in hazardous locations in Zone 2.

or

   b) K-Patents Intrinsically Safe Process Refractometer PR-23-IA/IE/IF to be used in hazardous locations up to Zone 0.
2. Options:
   - 2.1. Customized spool piece for easy sensor installation
   - 2.2. EXd enclosure for easy isolator and transmitter mounting
   - 2.3. Parts for a start up
   - 2.4. Spare parts supplied for two years of operation
   - 2.5. Start up and commissioning service
3. User specified tests and documentation.

Hastelloy C-276 should be considered as the process wetted parts material when the acid piping flow velocity is at a maximum of 6 m/s (20 ft/s). Alloy 20 can be considered when acid piping flow velocity is at a maximum of 1.8 m/s (6 ft/s). However, it is the end user’s responsibility to specify the appropriate material, ensuring that it is satisfactory for the intended operating requirements.

Appropriate equipment with hazardous and intrinsic safety approvals are available when required.

Instrumentation	Description
	K-Patents Process Refractometer PR-23-GP is an industrial refractometer for large pipe sizes and tanks, cookers, reactors and kettles. Installation through a flange or clamp connection.
Area classification:	Intrinsic safety and hazardous area approvals available.
Measurement range:	Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 % by weight.