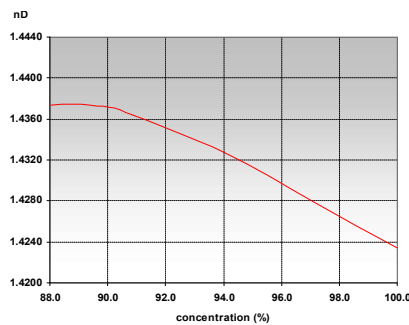


SULFURIC ACID, H₂SO₄

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 wt.-% at T_{REF} of 20°C



Introduction

Motor fuel alkylation using sulfuric acid (H₂SO₄) 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 H₂SO₄ does not. Therefore nearly 90% of all alky units built since 1990 have adopted the H₂SO₄ technology.

The leading H₂SO₄ 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, isobutane 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 catalyst (sulfuric acid) allows carrying out the two-phase reaction at moderate temperatures. The phases separate spontaneously, so the acid phase is vigorously mixed with the hydrocarbon phase to form higher molecular weight isoparaffinic 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.

Instrumentation and Installation

K-Patents General Type Probe Process Refractometer PR-43-GP is installed after the settlers to monitor continuously and in real-time the concentration of acid in the process.

The concentration of sulfuric acid is critical to achieve the complete consumption of the isobutane. A highly variable concentration of the isobutane 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 by K-Patents Process Refractometers. Real-time measurements reduce the need for sampling and lab analyses that cause delay in the implementation of any necessary adjustments to the acid flow.

Continuous monitoring removes the uncertainty involved between titration measurements. K-Patents refractometers 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 result, the reactions between olefins and isobutane turn into reactions of olefins only, producing polymers known as "acid sludge, ASO or red oil".

K-Patents refractometers are not affected by acid soluble oil (ASO). The PR-43-GP 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°C (59°F). 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.

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

1. K-Patents Process Refractometer PR-43 for hazardous locations in Zone 2.
or
K-Patents PR-43 Intrinsically Safe model for installations in hazardous locations up to Zone 0.
2. Optional parts:
 - 2.1. Different flow cell options 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.

Alloy C-276 / ASTM C276 should be considered as 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 responsibility of the end user to specify the appropriate material, ensuring that it is satisfactory for the intended operating requirements.

Non-incentive (Ex n) and intrinsic safety (Ex ia) approvals available for hazardous area installations.

Instrumentation



Description

K-Patents Process Refractometer PR-43-GP is a heavy-duty instrument with non-weld body construction for diverse oil and gas industry applications. The refractometer is installed in the main processing line, bypass line or vessel either directly with Flange process connection, or via a large variety of cost-effective and easy to mount flow cell options. The refractometer can operate as a stand-alone device or with different user interface options. The user interface of the refractometer can be installed locally in the field, remotely in the control room or in both locations by connecting several user interfaces in a network.

Area classification	Intrinsic safety and hazardous area approvals available.
Measurement range	Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 % by weight.