

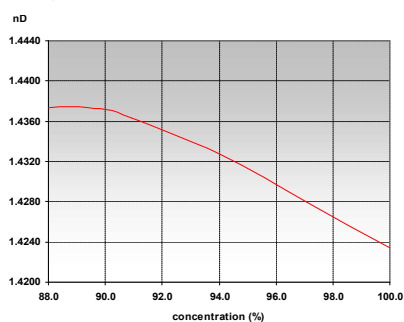
## SULFURIC ACID, H<sub>2</sub>SO<sub>4</sub> AND OLEUM

### Typical end products

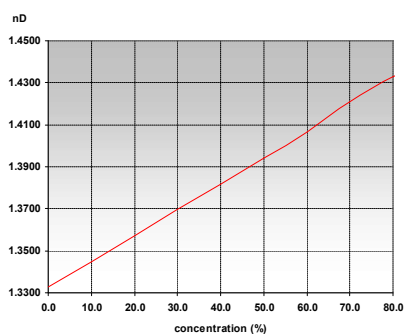
Sulfuric acid and oleum for different uses, e.g. for the production of fertilizers, explosives, dyes, and petroleum products.

Chemical curve: Sulfuric acid R.I. per wt-% at T<sub>REF</sub> of 20 °C

### Range 0-80%



### Range 85-100%



## Introduction

Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) is the most produced chemical in the world. It is widely used in all industries for the manufacture of different substances.

Sulfuric acid is sold in the form of various solutions of H<sub>2</sub>SO<sub>4</sub> in water or of sulfur trioxide (SO<sub>3</sub>) in H<sub>2</sub>SO<sub>4</sub>. The latter mixture is called fuming sulfuric acid or oleum and its marketing is based on the percentage of dissolved free SO<sub>3</sub>.

Sulfuric acid and oleum are produced industrially in Contact Plants from sulfur-containing gases resulting from e.g. sulfur burning, acid regeneration, or metallurgical operations. The process consists in the catalytic oxidation of sulfur dioxide (SO<sub>2</sub>) to SO<sub>3</sub>, and the hydration of SO<sub>3</sub> to H<sub>2</sub>SO<sub>4</sub> by absorption in concentrated acid. Depending of the number of absorption steps, the Contact Plants are classified as Single or Double Contact Process. The Double Contact process is the most used technology.

## Application

In the Double Contact Process, dry SO<sub>2</sub>-containing gas is fed into a large fixed bed reactor consisting usually of 4 catalytic beds known as the converter. The gases are removed from the third catalytic bed,

cooled, and passed through a primary absorber where SO<sub>3</sub> is absorbed in concentrated sulfuric acid (~98 %). The remaining gases (mostly SO<sub>2</sub>) return to the fourth bed of the converter.

After the converter, the gases flow into a final absorber where once again SO<sub>3</sub> is absorbed in concentrated acid. The result is oleum, and is stored in an oleum dilution tank where by addition of water the desired acid concentration is achieved. The concentration of the liquid is usually kept at 98 % to avoid the acid to escape from the liquid.

The operation of the absorbers is different depending on the desired product. For a sulfuric acid product, 93-98 % acid is used for the absorption, and for oleum or liquid SO<sub>3</sub> the tower is irrigated with 22% or 35% oleum.

### Instrumentation and installation



The K-Patents Process Refractometer PR-43-G is used in various stages of the Contact Process. The refractometer monitors and controls the concentration of acid during drying, absorption and dilution steps to keep the concentration of H<sub>2</sub>SO<sub>4</sub> constant at 93, 98 or 104% by weight.

K-Patents refractometers provide 4-20 mA and Ethernet output signals for real-time process control.

The refractometers can be installed in a control loop measuring the concentration of acid as it gets blended or concentrated. The PR-43-G also controls the acid circulation to the towers to ensure operation within the optimal concentration range and to maximize the absorption.

In the production of oleum, the final product is viscous with a temperature of 80°C (176°F), and containing small air bubbles. This is a source of errors in density and ultrasonic meters. K-Patents refractometers measurements are not affected by bubbles, color or changes in flow thus providing continuous reliable information. Typical concentrations in oleum applications are 22-35% at a temperature of 60-80°C (140-176°F).

K-Patents PR-43-G refractometers are designed to withstand harsh, corrosive environments and are available with special wetted parts materials and intrinsically safe and hazardous area certification. Both storage tanks and process piping in a sulfuric acid plant can be stainless steel, providing that the sulfuric acid concentration never drops below 95%. For less concentrated acid, which is very aggressive, K-Patents offers a chemically resistant Teflon material option (PR-23-M or PR-23-W) to ensure a viable service life.

Instrumentation	Description
	K-Patents Process Refractometer PR-43-GP is a general industrial refractometer for pipes and vessel installations. The PR-43-GP can be installed with 2, 3 and 4 inch flange and 3 inch Sandvik L coupling process connections and a variety of flow cells for pipe sizes of 1 inch and larger. 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.
	K-Patents Process Refractometer PR-43-GC is a compact refractometer for smaller pipe sizes in general industrial applications. Available in 2 inch and 2.5 inch process connections and via reducing ferrule in 1.5 inch process connection. The refractometer is installed in the process directly in a pipe elbow by an L coupling connection or in a straight pipe via a Wafer flow cell or a Pipe flow cell. 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.
Measurement range:	Low: 0-80% H <sub>2</sub> SO <sub>4</sub> High: 85-100% H <sub>2</sub> SO <sub>4</sub> 0-30% Oleum