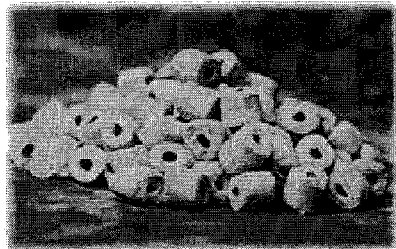


## SULFURIC ACID CATALYSTS

### PRODUCTS

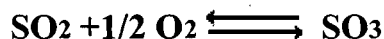
Monsanto has been manufacturing and marketing sulfuric acid catalyst since 1925.



The catalyst is sold worldwide and Enviro-Chem provides high quality technical and commercial support before and after the sale.

The vanadium-based catalyst is an extremely important "cog" in the many sulfuric acid technologies provided by Monsanto Enviro-Chem.

The sulfuric acid catalyst is used to catalyze the oxidation of sulfur dioxide (SO<sub>2</sub>):



The sulfur trioxide (SO<sub>3</sub>) is then reacted with water to form sulfuric acid (H<sub>2</sub>SO<sub>4</sub>). The main components of the Enviro-Chem catalyst include: SiO<sub>2</sub> (silica; as a support), vanadium (V), potassium (K) and/or cesium (Cs), and various other additives. The reaction shown above actually occurs within a molten salt consisting of potassium/cesium sulfates and vanadium sulfates, coated on the solid silica support. This unique catalyst has proven to be very stable and long-lived in the sulfuric acid production industry.

Because of the unique chemistry of this molten salt system, the vanadium is present as a complex sulfated salt mixture and NOT as vanadium pentoxide (V<sub>2</sub>O<sub>5</sub>). Therefore, the catalyst is more correctly called a "vanadium-containing" catalyst rather than the commonly-used "vanadium pentoxide" catalyst.

Monsanto Enviro-Chem provides a wide variety of sulfuric acid catalyst products:

### Conventional Catalyst:

Enviro-Chem's conventional "potassium-promoted" sulfuric acid catalysts have been specifically designed for high activity and long life. The LP-120/T-210 properties are formulated to handle the most harsh converter environments (high SO<sub>2</sub>, high temperatures, high dust loadings, etc.) while maintaining excellent conversion

### BENEFITS

- Long life; low pressure drop
- Low screening losses
- Worldwide warehousing
- Variety of packaging
- Technical support

### FEATURES

- High temperature tolerance (LP-120)
- Designed for low SO<sub>2</sub>, low O<sub>2</sub> (LP-110)
- High activity at low temperatures (Cs-110)
- Complete technical service
- Sulfuric acid technology

performance and ring/pellet strength. The LP-110/T-11 catalysts were designed for the lower bed environment (low SO<sub>2</sub>, low O<sub>2</sub>, possibly high SO<sub>3</sub>, slow reaction rates) to provide the highest catalytic activity level while maintaining ring/pellet integrity. Several beds of these high activity catalyst are still in service after 25 years. Vacuum screening losses for these catalysts generally range from 10-12%; manual screening losses are usually 5% or less.

<b>Rings</b>	<b>LP-120</b>	<b>LP-110</b>	<b>LP-220</b>
<b>Application</b>	<b>First/Second Beds</b>	<b>Third/Fourth Beds</b>	<b>First/Second Beds</b>
Outside Diameter (mm)	12.5	9.5	9.5
Inside Diameter (mm)	5.0	4.0	4.0
Average Ring Length (mm)	14.0	13.0	13.0
<b>Pellets</b>	<b>T-210</b>	<b>T-516</b>	<b>T-11</b>
<b>Application</b>	<b>First/Second Beds</b>	<b>First/Second Beds</b>	<b>Third/Fourth Beds</b>
Diameter (mm)	5.5	8.0	5.5
Crush Strength (kg)	12.0	16.0	12.0

### **Cesium-promoted Catalyst:**

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The cesium-promoted catalyst was developed specifically for lower temperature operations which can lead to greater SO<sub>2</sub> conversion and hence lower SO<sub>2</sub> emissions to the atmosphere. The cesium salt promoter reduces the required operating temperature for the sulfuric acid catalyst by as much as 40°C (70°F). Higher SO<sub>2</sub> conversion is possible at lower temperatures as long as the catalyst is "active"; the cesium-promoted catalysts are sufficiently active at these lower temperatures (390-410°C/735-770°F) to take

advantage of this conversion "opportunity." The cesium/vanadium catalyst can be used in the first bed to reduce the bed inlet temperature (saving energy and start-up time). The Cs-110 or Cs-210 catalyst can be used in the final catalyst bed (at a low inlet temperature) to maximize the SO<sub>2</sub> conversion and reduce emissions. This unique catalyst was introduced in the late 1980's and has been applied in a variety of situations with significant SO<sub>2</sub> emissions reductions. Although the cesium catalyst is more costly than the standard potassium/vanadium catalysts, many customers have justified the added expense (with short pay-back times) by increased production, higher steam production, and reduced emissions.

Cesium-Promoted	Cs-120	Cs-110	Cs-210
Shape	Ring	Ring	Pellet
Application	First/Second Beds	Lower Beds	All Beds
Outside Diameter (mm)	12.5	9.5	5.5
Inside Diameter (mm)	5.0	4.0	-

### **Manufacturing Facility:**

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The Enviro-Chem sulfuric acid catalysts are produced at a single location (The Avon Plant) in Martinez, California. This production facility is solely dedicated to sulfuric acid catalyst production; it has been in operation for over 25 years. The plant has sufficient capacity and productivity to supply all client product needs. The Avon Plant has received numerous acknowledgments for fugitive emissions reductions and waste minimization during a time period when production was steadily increasing.

Technical service is also a major part of the overall sulfuric acid catalyst story. Enviro-Chem provides catalyst engineering studies to assist the customer in determining the catalyst needs in a specific plant. A Customer Sample Analysis (activity analysis and hardness determinations for used catalyst samples), and on-site converter-heat exchanger testing (called *PeGASyS*) are available to fully

characterize the sulfuric acid plant operations that assist the customer in maintenance planning.

Enviro-Chem has a variety of commercial and inventory locations throughout the world (California, Florida, Missouri, Louisiana, Antwerp, Sao Paulo, Johannesburg, Mumbai, and Hong Kong). Technical service functions are centered in St. Louis, MO (U.S.A.) and in Brussels, Belgium.

#### **E-MAIL AN ENGINEER**

If you have specific technical questions or would like to request a pricing proposal for your application, send an email to one of our engineers at [planttechnology@na1.monsanto.com](mailto:planttechnology@na1.monsanto.com)

#### **ADDITIONAL TECHNOLOGIES    ▪    SULFURIC ACID CATALYST PRODUCTS & SERVICES**

***PeGASyS*** HOW TO SEND CATALYST SAMPLES MATERIAL SAFETY DATA SHEETS

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This is based on the fact that they estimate ~~only 2000~~ if they can only achieve 4.5 lb/ton at a production ~~loss from~~ <sup>requested</sup>.

1. The letter from Enviro-Chem providing guarantees estimates of emissions for different production rates does not provide reasonable assurance that ~~these~~ Plants C and D will meet 3.5 lb/ton at 2,750 TPD rate proposed in the application. The

2. ~~It would~~

One would expect that the complete replacement of all catalyst in the 4<sup>th</sup> converter with high vanadium cerium-promoted catalyst will result in very significant reductions in SO<sub>2</sub> emissions given the relatively modest production increase that is planned.

3.5

~~5.0 - 7.0  
or 4.5 - 5.0~~ requirement

3.5

### Control Equipment

With high activity, cerium promoted high vanadium catalyst in the 4<sup>th</sup> converter.