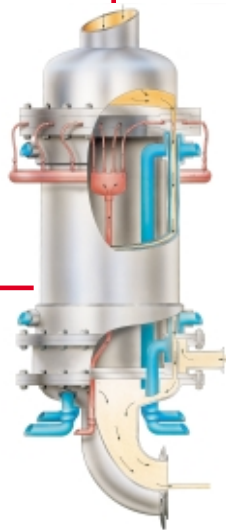
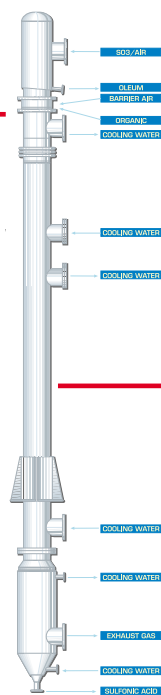




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ABSTRACT:

Sulfonation reactor technology has improved to minimize downtime with permanently calibrated feed distribution systems. Since these feed distribution systems are designed with superior "micro mole ratio control" for exact distribution of the feedstock and the SO₃-in-air, it is possible to produce the highest quality surfactants. Two of the five current Chemithon/IIT Chemithon reactor designs that are used widely in the detergent and specialty chemical markets are profiled to demonstrate the distribution mechanisms and relative application strengths. The reactors are "NCR" designs, i.e., "no calibration required" at site.



Micro vs. Macro Mole Ratio Control

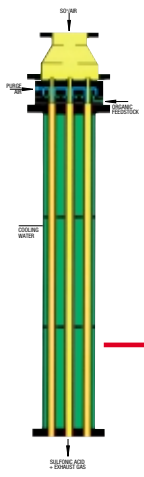
- Mole Ratio Control at any production rate is the MOST Important Criteria
- Effective Mole Ratio Control Has Two Requirements:
 - Macro Control: Constant sulfur trioxide and feedstock flow rates at desired ratio
 - Micro Control: Exact distribution of the feedstock and air / SO₃ within the reactor

Controlling Mole Ratio

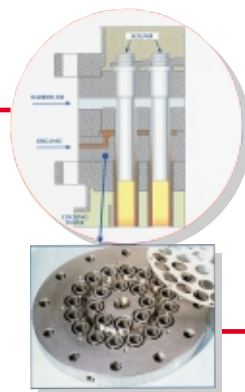
- Reactor Design Provides Micro Mole Ratio Control
 - Metering flanges provide superb distribution
 - Carefully bench calibrated to $\pm 0.5\%$ variation
 - Corrosion resistant alloy eliminates change with time
 - Gas distribution is inherently better than other designs
 - Smooth transition surfaces and fully developed flow
 - Symmetrical flow path to reaction zone

Sulfonation System Features

- Reactors designed to meet the process requirements
- Micro Mole Ratio Control
 - Removable calibrated distribution flanges to form uniform falling film
 - Gas flow path designed for uniform flow



The organic distribution cartridge is removable for cleaning. The organic distribution slots have uniform clearance and high tolerances to ensure that distribution to the tube walls is always accurate and consistent. Distribution flow among the tubes does not vary by more than 1%.



Reagents Feeding Cartridge

The factory calibrated cartridge system is fitted to the top of the reactor body, between the cyclone and the reactor. It is comprised of a set of plates, a spacer and nozzles that distribute the reagents (organic, barrier air and SO₃/air gas) evenly to all the reaction tubes. Material of construction is AISI 316 SS.

The uniform ratio between reagents is ensured by uniform distribution of the liquid and a homogeneous configuration of the reaction chamber.

A calibrated slot is created around the upper ends of all reaction tubes by means of a precision machined set of plates and spacer piece. This arrangement distributes a uniform thin film to all reaction tubes and on the perimeter of each tube.

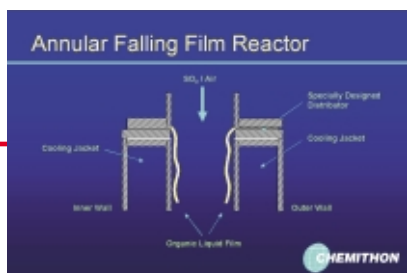
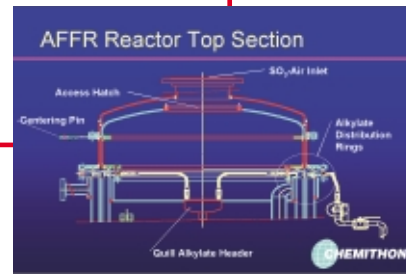
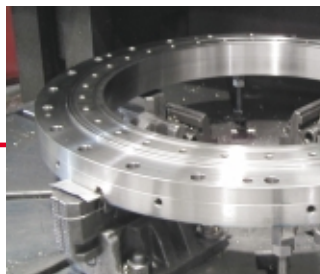
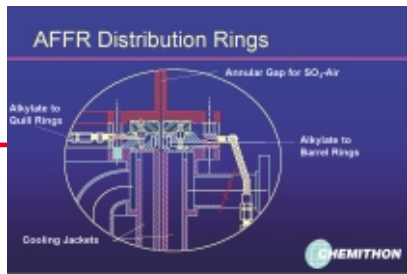
The distribution cartridge

- is very simple, static and removable
- can be easily and rapidly removed, cleaned and installed
- does not require calibration
- can be bench tested
- can be easily reconditioned
- allows drainage of oleum condensates
- allows design of compact reactors
- allows simple modification of slot thickness (for special feed materials)

The feed material is distributed onto all of the reaction tube walls through the reagent feed cartridge which also distributes the SO₃-in-air and barrier air. This reactor design has more volume per tube than other MTR types and better control of the organic film. Sulfonic acid exits the reaction tubes and flows into the gas/liquid centrifugal separator at the bottom of the reactor.

The IIT Chemithon MTR uses a "pneumatic barrier" system to protect the organic distribution system from progressive charring, a condition that reduces product quality in conventional MTR systems and causes frequent washouts. Dry air is injected through the distribution cartridge which prevents SO₃ and oleum from contacting the organic in the distribution slots. The system results in longer runs at high product quality levels that reduce production losses and maintenance costs by minimizing washout frequency and eliminating corrosion at the distributor. This also lowers the risk of equipment corrosion and minimizes acid waste water. The barrier system also serves to protect the reactor distribution system in the event of a power cut-off or failure of the organic feed system. It does not produce off-spec material as do systems which depend on feeding organic through the reactor.

- Liquid flow rate is controlled at less than $\pm 0.5\%$ variance between any two points
- Liquid/gas contact is mechanically controlled and does not rely on fluctuations in product completeness
- Washouts are a short, simple process



The following conclusions apply to BOTH the IIT Chemithon MTR and the Chemithon AFFR reactors:

- 1) The removable organic distribution cartridge (MTR) and flanges (AFFR) are factory calibrated prior to installation in the reactors and, due to the unique designs and materials of construction (316 stainless steel and high nickel alloys), do not require periodic recalibration.
- 2) Both designs significantly minimize shutdowns for reactor maintenance. "Streaming factors" exceed 95%. Large, 20,000 MT/hour plants such as Procter & Gamble Mariscala and ITC base their figures on an 8,400 hour/year operation. Zschimmer & Schwarz Koblenz has similar figures.
- 3) Both designs ensure consistent reaction conditions and product quality.

In today's economic climate, it is necessary to maximize the utilization of capital equipment. Permanently calibrated sulfonation reactor distribution systems constitute a significant step toward more efficient plant operation.