

**IMPROVED FIBER BED MIST ELIMINATORS  
FOR SULFURIC ACID PRODUCTION**

**BY  
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## **ABSTRACT**

Novel technologies and product improvements present an opportunity for Sulfuric Acid plant designers and operators to improve the performance of mist eliminator systems. Extended life, reduced carryover, reduced pressure drop can be achieved with one or more of these technologies. Heat treating of fiberglass media has been proven to extend the life of this media in corrosive environments. Extensive experience with synthetic fibers allows these to be used where fiberglass may be chemically attacked, such as downstream of ammonia scrubbers used for SO<sub>2</sub> control. Where plugging with insoluble solids may occur, patented prefilters have proven to reduce the cost of maintaining the mist eliminator system. Newly patented "TWIN-PAK" filters feature a nested design of different diameter cylindrical elements. The gas flow splits up among the elements to present a much higher surface area in the same physical space. Reduced pressure drop, increased thruput, increased efficiency or some combination of all three can be achieved. Impaction type mist elimination systems can often be upgraded to brownian diffusion systems with no changes in vessel size.

## **PREFACE**

Mist eliminators have been an integral part of sulfuric acid production almost from the inception of the contact process. These devices serve the purpose of protecting process equipment from corrosion, preventing emissions of acid particulate and recovering product. Today's manufacturing environment demands that plant operators find ways to reduce the cost and improve the quality of production. Environmental pressures continue to increase, adding to the challenges faced by plant operators. In the competitive marketplace of the 1990's, the companies that make continual improvements are those that will survive and prosper into the next century.

CECO Filters, Inc. specializes in the field of fiber bed mist eliminators. This mist elimination technology is the most efficient available when droplets <3 microns need to be captured. The technology consists of deep beds (1 to 3 inches) of fine fibers (<50 microns). Collection of the fine particles is achieved through high efficiency impaction and brownian diffusion mechanisms. CECO utilizes technology that extends the life of glass fibers in corrosive environments and has developed one product line that prevents insoluble solid plugging of the main bed and one product line that allows improved performance of existing mist elimination systems without requiring extensive vessel work.

## FIBER CORROSION

### Sulfuric acid:

Sulfuric acid is a corrosive material. Although special chemical resistant formulations of glass fibers withstand corrosive effects well, they still break down over time. Currently available fiberglass material, although improved in the past several years, may exhibit inferior corrosion resistance to that supplied prior to 1984.

CECO's SITE-PAK® manufacturing process includes heat treating of the filter media. This processing step effects a surface chemistry change to the glass fibers. The surface chemistry change has been proven to increase the fiber's resistance to chemical corrosion. Laboratory tests have yielded the following results:

#### WEIGHT LOSS OF FIBERS

| <u>PH</u> | <u>ANNEALED</u> | <u>UNANNEALED</u> |
|-----------|-----------------|-------------------|
| 1.0       | 2.5%            | 6.13%             |
| 1.6       | 2.38%           | 3.32%             |
| 3.0       | 0.68%           | 1.08%             |
| 5.0       | 0.18%           | 0.44%             |
| 9.0       | 1.34%           | 3.33%             |
| 11.0      | 6.35%           | 15.91%            |

This represents a 50% average increase in corrosion resistance across the pH range tested.

The end result is a longer filter life in a corrosive environment.

### Ammonia:

For plants utilizing single absorption and ammonia scrubbing to control SO<sub>2</sub> emissions, filter systems are used to control ammonium sulfite particulate. These systems present a more severe corrosion problem because free ammonia attacks fiberglass. The simplest solution to this problem is to utilize synthetic filter media such as polyester or polypropylene. These medias stand up well to free ammonia. Polyester is preferred because of its higher temperature limits.

The SITE-PAK® manufacturing process is beneficial here because the filter fibers are subjected to compressive (as opposed to tensile) stresses. The compressed nature of this media form prevents the filters from suffering cold creep stress relaxation which would result in sagging and bypassing of filter media. CECO has nearly 15 years of successful synthetic filter media experience in a variety of applications.

### **INSOLUBLE SOLID PLUGGING**

In observing plugging patterns of deep bed filters over the years, CECO engineers noticed that the plugging usually occurred in the first 1/4 to 1/2 inch of filter depth. The socks that had been tried in the past failed to significantly decrease the plugging of the main filter. The reason for the socks failure appeared to be in the fact that it was made of a larger, less dense media than the main filter. It was reasoned that if a 1/2 inch thick filter could be manufactured with a similar density and fiber size to the main filter, then a successful prefilter would be in hand.

This research yielded the patented N-SERT® and X-SERT® prefilter. These prefilters are made with their own internal and external cages to create the structure. The N-SERT® goes on the inside of the main filter cage for filters with inside-out flow. The X-SERT® goes on the outside of the main filter cage for filters with outside-in flow. N-SERT® prefilters have been used on drying tower filters in sludge burning acid plants.

The filter media is the same as that used in the main filter. The cages can be made of carbon steel, stainless steel, high grade alloys, and plastics. The prefilters are attached to the cage of the main filter by wire clips compatible with the service. They can be made in sections so that installation in tight spaces is possible. The N-SERT and X-SERT prefilters are in operation at many installations and have been saving customers significant amounts on maintenance cost.

### **MULTIPLE BED FILTERS**

On August 14, 1990 CECO Filters, Inc. was awarded U.S. Patent No. 4,948,398 for its MULTI-CANDLE FIBER MIST ELIMINATOR. This revolutionary design features an arrangement of filters where one or more smaller filters are nested into a larger filter. The incoming gas is then split to pass through the filters simultaneously. This arrangement utilizes the vacant space on the interior of a cylindrical element to effectively increase the available surface area by 60% or more.

On new installations, the multiple bed filters allow smaller vessels to be used. This effectively reduces the capital cost and real estate requirements.

On existing installations, the following can be achieved with little or no modifications to the containing vessel:

- A. Increase system volume flow capacity without increasing pressure drop,
- B. Decrease system pressure drop requirements at the same system volume flow,
- C. Increase filtration efficiency without increasing pressure drop, or
- D. Some combination of the above items.

The first acid plant to install the 2 filter arrangement of the multiple bed design was the Kidd Creek Div. of Falconbridge Ltd. in Timmins, Ontario. The 2 filter arrangement is known as the TWIN-PAK filter. Kidd Creek was able to decrease pressure drop by 47%, increase gas volume flow by 5%, and increase acid production by 7%. The investment paid for itself in less than 6 months.

A large western fertilizer plant has recently taken delivery of 44 TWIN-PAK filters for their final absorbing tower. They chose this option in order to achieve a 33% reduction in pressure drop. The holes in the tubesheet needed to be enlarged from 18" to 21" and new bolt holes were required.

All of CECO's GATOR model systems that are used for removal of oil mist from the bearing and reservoir vents of gas turbines utilize some version of the multiple bed filters. Several new systems on other acid and oil applications utilize the technology. All of these installations benefitted with the multiple bed filters by being able to use smaller vessels, resulting in a lower capital cost and less physical space required.

CECO has investigated several other tower upgrades utilizing TWIN-PAK filters. In one instance, a company is currently utilizing impaction candles on an absorbing tower. This tower had been upgraded from an impaction pad design in the past. The design is a severe compromise for the candle's performance. By using a TWIN-PAK design, the company will be able to go to a diffusion design candle, operating well within the accepted performance range for this type of filter. The change will require increasing the diameter of the top of the tower to match the diameter of the lower part of the tower and installing a new tubesheet. With standard single wall design filters, this customer would need to increase both the diameter and height of the vessel, thus affecting the ducting as-well-as the vessel.

At another plant location, the customer operates a dual impaction pad set-up in a separate vessel after the absorbing tower. The pad is not performing well and the company has asked CECO for diffusion candle retrofit recommendations. By utilizing the TWIN-PAK design, the company will be able to install diffusion candles with only the addition of a new tubesheet.

#### **CONCLUSION**

By making careful observation and listening to the needs of users of high efficiency mist eliminators, CECO is advancing the technology of fiber bed mist filters. The technology provided today by CECO makes use of more economical, maintenance friendly, and space efficient devices. SITE-PAK segments improve corrosion resistance and widen the range of usable filter media; N-SERT and X-SERT prefilters prevent plugging of main filter beds; and TWIN-PAK or other multiple bed filters reduce the size and cost of fiber bed filter systems while allowing economical upgrading of existing systems.

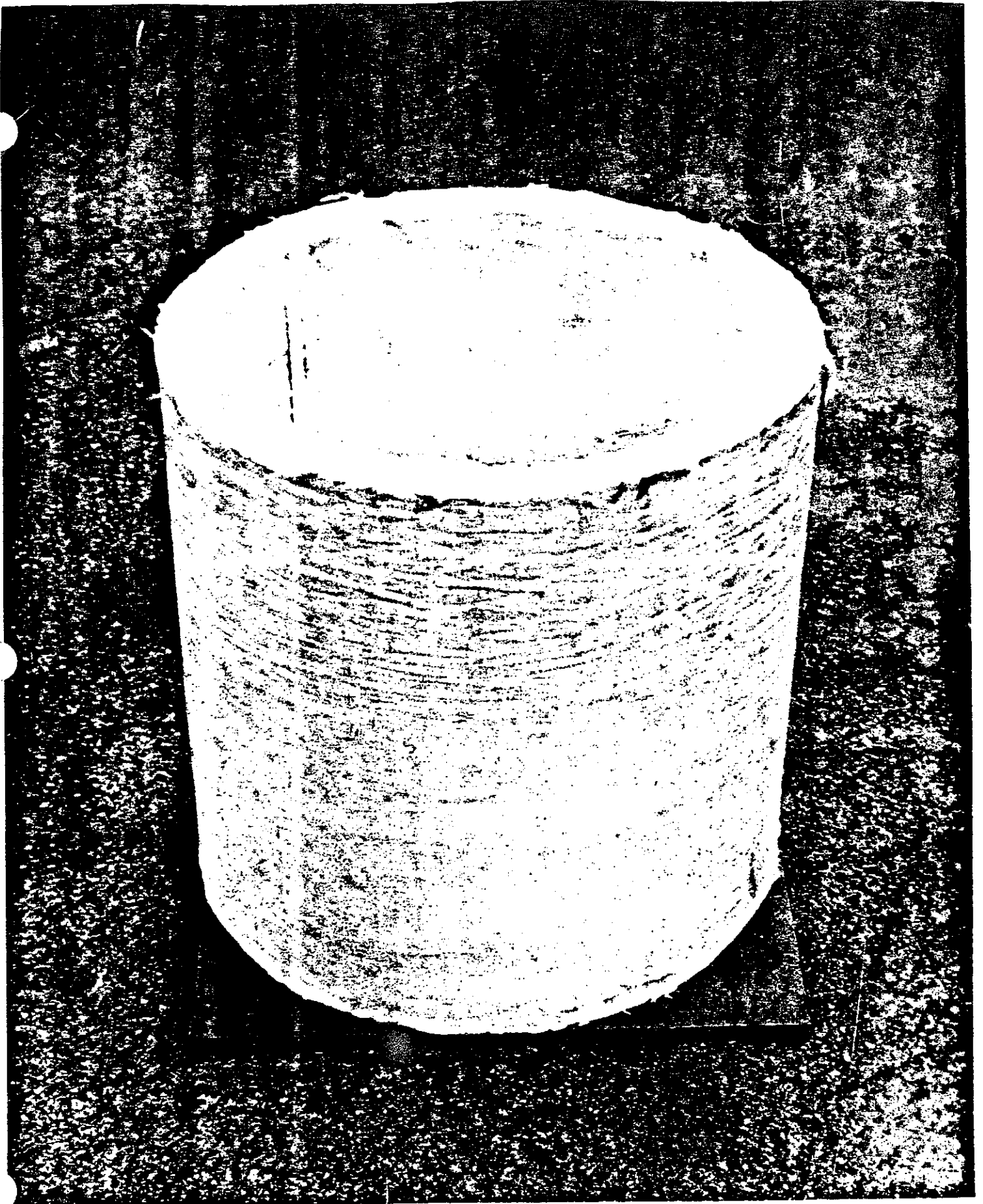


FIGURE 1  
SITE-PAK® SEGMENT

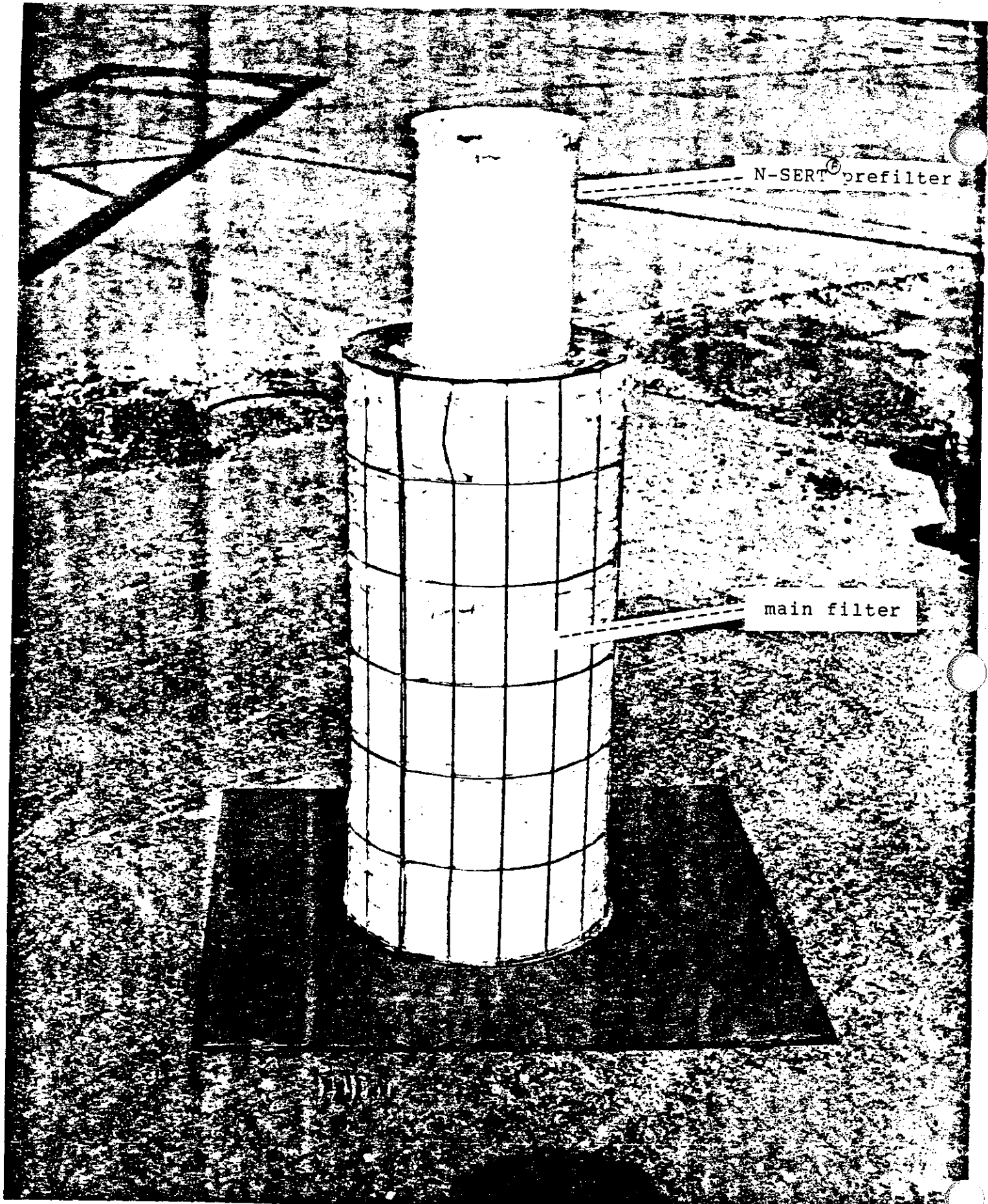


FIGURE 2  
N-SERT® PREFILTER



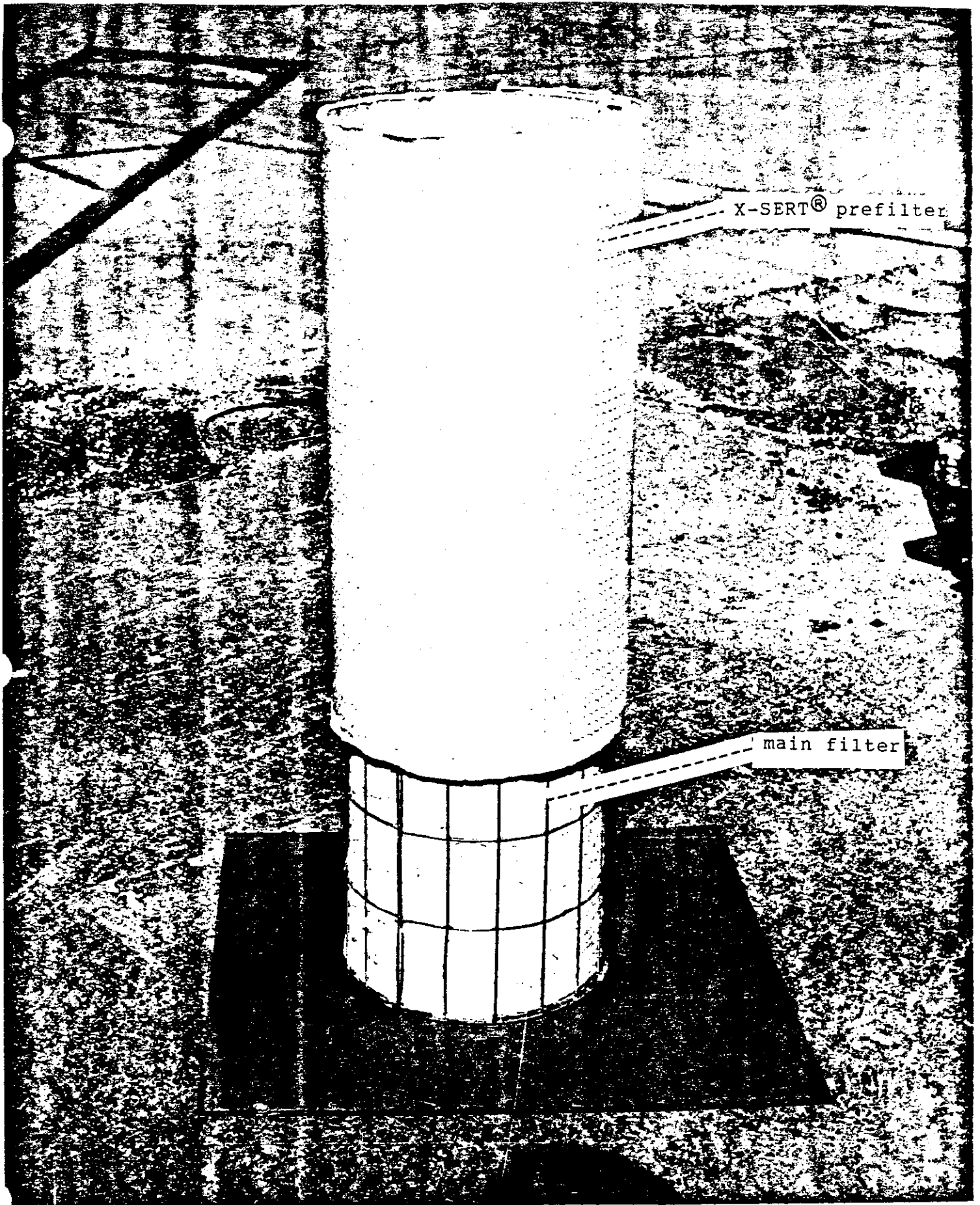


FIGURE 3  
X-SERT® PREFILTER

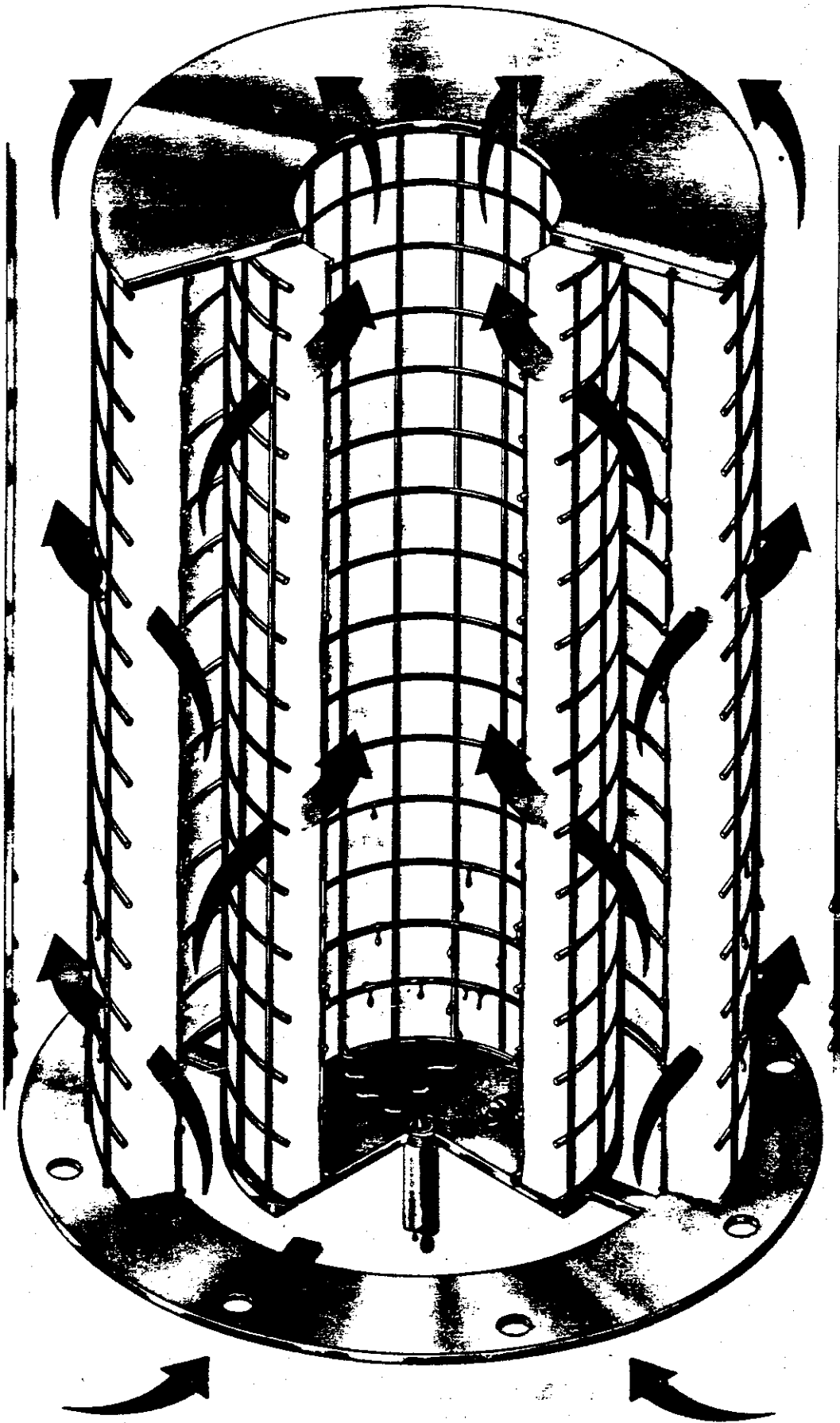


FIGURE 4  
TWIN-PAK FILTER