NEW PROCESS APPLICATIONS OF FIBER MIST ELIMINATORS

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For many years extensive research has been carried on at Monsanto in the area of air pollution control. This has included experimental work on different types of dust and mist collection equipment and on analytical methods for evaluating plant equipment (1, 2, 3, 4, 5). These research studies led to the development of fiber mist eliminators, which are highly efficient on sub-micron particles. Efficiencies as high as 99.98% have been demonstrated in large-scale acid plants (4). Prior to this development electrostatic precipitators for difficult mist collection problems had been used. Since this development precipitators have been replaced with fiber units. Fiber mist eliminators are quite simple in construction (Figure 1), since they are only a packed bed of fibers retained between concentric screens.

Continuous steady-state operation is essential from an economic standpoint. That is, we could not afford to throw away our fiber packing at frequent intervals after they became plugged and the gas flow restricted. Therefore, we directed our effort toward the development of equipment which could be operated continuously under steady-state operating conditions. We have spent years studying the chemical and mechanical stability of fiber beds and developing stable beds. Chemically, we have had to solve the problems of holding corrosion rates to the order of a micron per year. Mechanically, we have had to learn how to design dimensional stability into fiber beds where our structural members (fibers) have diameters measured in microns.

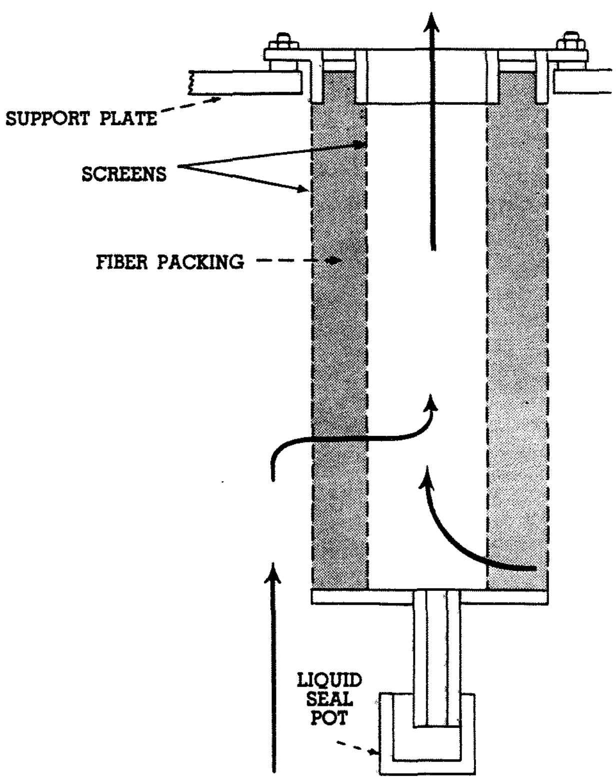


Figure 1. Cross-sectional view of fiber mist eliminator element.

Drain rate

In fiber mist eliminators (Figure 1), the fine mist particles which are collected on the surface of the fibers drain from the fiber bed at the same rate at which they are collected. The liquid on the surface of the fibers is moved through the fiber bed by the forces of gravity and the drag of the gases on the liquid film. This drainage, therefore, is at an angle inward and downward rather than straight down or horizontally across the fiber bed. Liquid from the bed drains to the liquid seal pot on the bottom of the element and then overflows back into the process vessel.

Gas cleaning

After we had solved several difficult air pollution problems with fiber mist eliminators, operating people in our plants brought several other types of problems to our attention. They asked the question, "Why can't we clean up our gases within our processes as well as our air pollution problems?" We answered this question by further research and development work on the purification of process gases within various processes.

Catalytic processes

Many applications for fiber mist eliminators may be found in catalytic processes, since catalyst poisoning is quite common. We have applied fiber mist eliminators to a process where we clean up both reacting gases and also recover catalyst lost from the reactor.

In the nitric acid processes, we have successfully purified both the ammonia and the air separately prior to a platinum catalyst. In addition, we have applied fiber mist eliminators to the recovery of platinum in an experimental platinum filter. In this type of application the platinum filter does not operate as a mist eliminator, but eventually plugs up with solids. Its operation on a throw-away basis is justified because of the high platinum value. Our work on platinum filters is quite recent, and we have just obtained our first experimental results. These results were extremely good in that we operated the experimental filter for a period of four months at 800°F without any degradation whatsoever of the fiber bed. The results indicate that we can operate this type of unit for even longer periods of time without changing the fiber packing. Our yields of platinum were considerably higher than those obtained previously.

High pressure application

Another new application of fiber mist eliminators (Figure 2) has been the use of this equipment at high pressures. There are two units now running at high pressures in an ammonia synthesis loop. One unit has operated successfully for several months at 3000 psi. A newer installation has been made at 5500 psi, and further operating time will be required before conclusive results are obtained. These installations have been made in a Monsanto customer's plant.

The design of the fiber element in high pressure units is usually somewhat different than for low pressure units. We have eliminated the liquid seal pot in many of these installations. The liquid which is collected on the fibers accumulates inside of the element until its static pressure is sufficient to overcome the pressure drop across the fiber bed. When the level reaches this point, the liquid will drain back through the element back into the process as shown in Figure 2.

The determination of mist collection efficiency in systems under pressure is difficult and expensive, and is therefore not usually warranted. Test equipment must be designed to compensate for volatilization upon pressure release when samples are to be weighed or analyzed. We know from experience, however, that the problems these mists caused before removal are solved by installation of fiber eliminators.

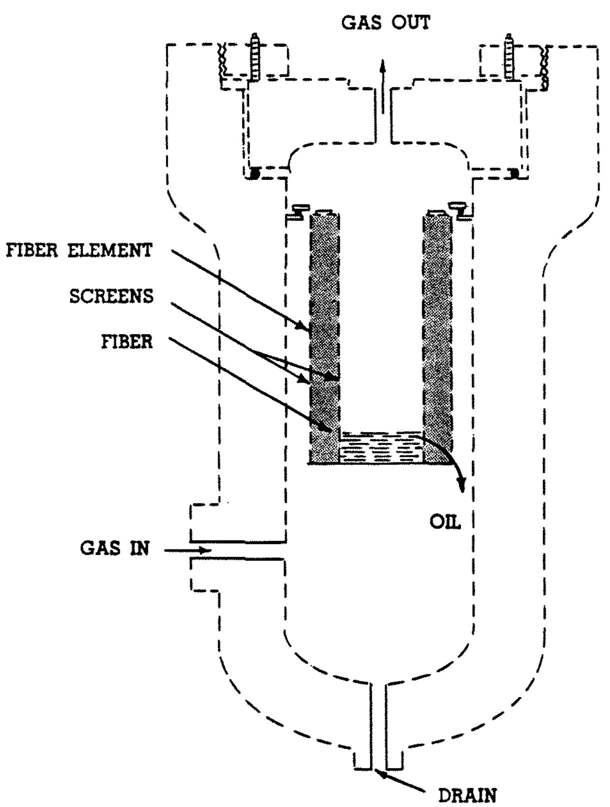


Figure 2. Fiber mist eliminator design for high pressure service.

Oil mist removal

Many applications have been found for the removal of oil mist from compressed air within Monsanto plants. Our experience has shown that lubricated compressors produce air containing extremely fine oil mist. Oil mist can contaminate products which are air-conveyed, dried or otherwise handled, and can cause extremely high maintenance costs in instrument systems. It is much more practical to remove oil from the air than to remove it from chemicals or instruments. We have been able to produce extremely clean compressed air from oil-lubricated compressors. Lubricating oils with low vapor pressures should be used in the compressor since fiber mist eliminators will not collect oil vapor. Our experiences on compressed air would indicate that there will be applications in air plants.

Purification of natural gas

The purification of natural gas is an important new application of fiber mist eliminators. Solvents used in the scrubbing of natural gas and also other hydrocarbons may be present. Extremely fine mist particles may be removed economically from natural gas prior to transmission by the gas producer or prior to use in petro-chemical operations.

Bacteria-free processes

We have literally "de-bugged" chemical processes with fiber mist eliminators (Figure 3). There are many processes in which bacteria-free operation is required. Fiber mist eliminators can be installed on process vessels or storage tanks to prevent bacteria contamination from atmospheric air. The bacteria col-

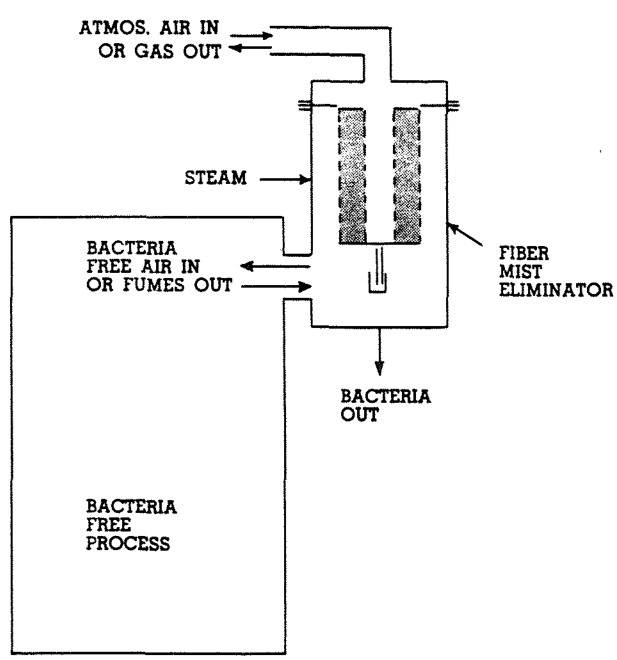


Figure 3. Fiber mist eliminators can protect processes from bacteria.

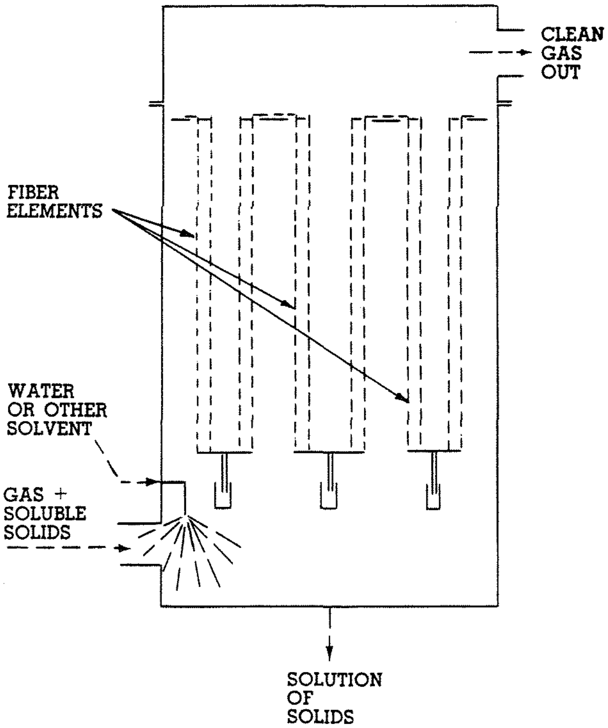
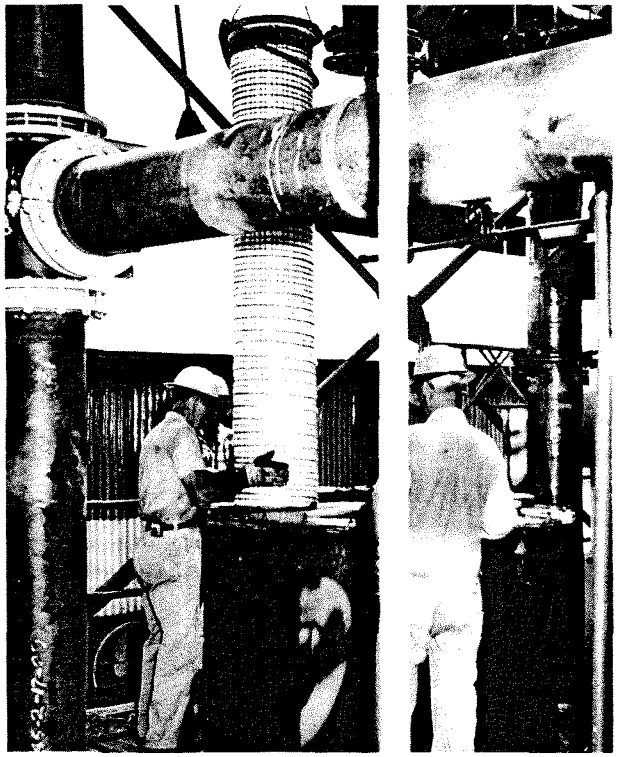


Figure 4. Removal of soluble solid fumes from process gases.


Installing mist eliminator.

lected on the fibers can be killed by sterilization with steam. The fiber elements are chemically and mechanically stable and can be steamed many times and also can be operated with the gas flow running at times into the unit and at times out of the unit, as depicted in Figure 3. Any fumes which come out of the process vessel are also collected and any air pollution caused by particulate matter can be eliminated at the same time as the bacteria.

Solid fume removal

We have applied fiber mist eliminators to the removal of soluble solid fumes from process gases (Figure 4). In this type of application we introduce water or some other solvent into the process gas stream. The water or solvent is collected on the fiber bed and dissolves the soluble solid particles as they are collected. The solution drains from the fiber element in the same manner as in liquid mist eliminators.

Fiber mist eliminators will not operate continuously on insoluble solid fume particles. If an appreciable quantity of insoluble solids is present in the gas stream, they will eventually plug the fiber bed; however, we have not had pluggage difficulties with traces of insoluble solids, since some self-cleaning takes place. For example, in contact sulfuric acid plants sulfate pluggage has not occurred in our fiber elements.

Chlorine purification

Our experience with the use of fiber mist eliminators in the DeNora Electrolytic cell process for Cl_2 has been excellent. It is much more practical to remove contaminants from chlorine cell gases with a fiber mist eliminator than it is to shut down subsequent equipment and clean the accumulation of contaminants from it. Our results in this area have been so good that Monsanto now recommends fiber mist eliminators for every new DeNora process plant.

In one such installation, sodium chloride and sulfuric acid mists were causing daily shutdown for cleaning the equipment immediately following the chlorine coolers. After installation of a fiber mist eliminator, these shutdowns were reduced to once per year with essentially no attention required for the mist eliminators. No fiber pluggage has occurred to date, and over a year of operation has taken place.

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DISCUSSION

JONES—The range of environment that you can accept is quite broad. What materials of construction are used?

BRINK—Monsanto: For a platinum filter we operated at 800°F. for a period of four months without any degradation of our fiber or fiber bed. Now this does not mean that under all environments we can operate at 800°F. because we also have to consider the chemical attack that can occur on fibers. If you use a fiber of one mil in diameter, a corrosion rate of five mils a year would be a disaster to say the least. Now we do handle sulfuric acid (98%), oleum and all ranges of phosphoric acid up to 85% acid. Of course, oils are a real easy problem corrosion-wise compared to these severe acid conditions.

JONES—Have these acids been filtered at moderately elevated temperatures?

BRINK—Yes. We don't change the temperature of the process in a contact sulfuric of phosphoric acid plant, which may be 150—180°F.—somewhere in that range.

JONES—It sounds as though you are using something like platinum fiber to me.

BRINK—No. We are not using platinum fibers by any means. We have worked primarily with glass, ceramic and synthetic fibers.

JONES—Do you vary your fibers?

BRINK—We vary them as far as diameter, chemical composition, packing density of the fiber bed, thickness of the fiber bed, gas velocity through the fiber bed, etc. There are about twenty or thirty variables that go into the design of one of these units.

FUNK—I am just wondering whether this is available on the market?

BRINK—Yes. This is available on the market. Sales have been made throughout the country and also some in Europe. About sixty-five plant installations have been made to date.

BOLLEN—Can you tell me if there is any decrease in efficiency with increased temperature when used as an oil eliminator?

BRINK—We have not found any decrease, except that you have to consider the vapor. At higher temperature more oil vapor may be present and the mist eliminator will not collect oil vapor in any continuous operation.

WELLS—On the slide you showed of the nitric acid plant, in addition to the platinum filter, you showed a filter in each of the ammonia and air lines. Were these also Brink's filters?

BRINK—Yes. All three of these were. On the air, we were concerned about any particles that might be present and, on the ammonia, we were concerned primarily with oil. Of course, the one following the platinum gauze was a platinum recovery filter.

JENKINS—U. S. I. is the company who has the 3,000 pound filter. It is on nitrogen going to the cold box. In the past we have plugged our cold box nitrogen circuit with oil several times per year. We are trying to eliminate this and, so far, are very satisfied with the Brink Eliminator in this service. We have gone as long as two months without showing any oil on a downstream desiccant bed.

SOMMERS—Over the years, most everybody in the synthetic ammonia business has tried out filters of every conceivable description which the human mind can think of. Filters, such as superficially resemble the Brink have been tried out by TVA and by Mathieson which were essentially a series of fine, cylindrical, concentric screens and these were quite successful from the standpoint of stopping the oil for a short time. Unfortunately in most plants, in this particular location, you have a small amount of CO_2 which forms ammonium carbamate and it accumulates on the filter, and before very many days elapse, the screens collapse. Now my question is, how do you take care of a situation with a Brink eliminator where you have solid particulate matter forming on the fibers, blocking them and causing a high pressure drop?

BRINK—This has been very much of a concern to us in contact sulphuric acid plants. Those of you familiar with these know that after you open equipment that has been in service any time at all, you find thick films of sulfate all over the equipment. We looked into this quite a bit. We found that we were getting flushing action of the mist on the fibers and any solid that would tend to emulsify or tend to flush at all could be handled. Now, if you have a solid which is insoluble and will not tend to flush or wash through a fiber bed, you can get yourself into a bad situation. This can be a very serious problem. However, we have found that we can tolerate reasonable levels of solids. We have not had, to my knowledge, a pluggage of an oil mist eliminator to date. We have had one on as long as two years in compressor service without pluggage. The other point is that this collapsing of filter media is very common if you do not build mechanical stability into a fiber bed. You have to design it into the unit.

SIMMS—Phillips Chemical: You indicated that you use this filter successfully on the air supplied to the nitric acid unit. I assume that is one of the new modern nitric acid units. Just go back twenty-five years and put it on an old so-called Du Pont plant where you are oxidizing your air preheater rather rapidly and you get a considerable quantity of iron oxide which presently will find its way onto your gauze. That is a problem I had. Can you cope with that problem with the Brink filters?

BRINK—We can collect the iron oxide. There is no question about that, and it is a question of where is best to collect it—in a unit where you have your hands on it or in the gauze where it affects your activity of your catalyst and your yield? We have the mist eliminator and filters I described installed on an old nitric acid plant.