mott corporation

84 Spring Lane, Farmington, CT 06032-3159
860-747-6333 Fax 860-747-6739
www.mottcorp.com

SINTERED METAL FILTRATION TECHNOLOGY FOR INDUSTRIAL WASTEWATER MANAGEMENT

Dr. Kenneth L. Rubow
Louise L. Stange
Mott Corporation

Paper presented at the
American Filtration and Separation Society
Summer Conference and Expo
Water and Wastewater Filtration

Anaheim, CA

July 25-26, 2000

Abstract

This paper will discuss Sintered Metal Filtration Technology and its diverse suitability in the field of industrial wastewater management. Applications vary from straightforward gas/liquid contacting, or sparging, to advanced separations using sintered porous metal backwashable media for both barrier and cross-flow filtration systems. Today, both environmental and materials cost concerns have encouraged industry to evaluate waste recycling and water reuse programs. Manufacturers in the U.S. use about nine trillion gallons of fresh water every year. Interest in wastewater filtration is growing due to shrinking water supply, rising water costs and stricter regulations.

Introduction

Sintered porous metal media is capable of a long filter life through years of continuous use. The solids state diffusion bonding of the sintered porous metal media eliminates tear, fatigue, and breakthrough problems typical of other media. A typical surface cross-section of sintered porous metal is shown in Figure 1. It's tensile strength makes it well suited for high differential pressures. All metal construction, with welded joints and seams can withstand high temperatures.

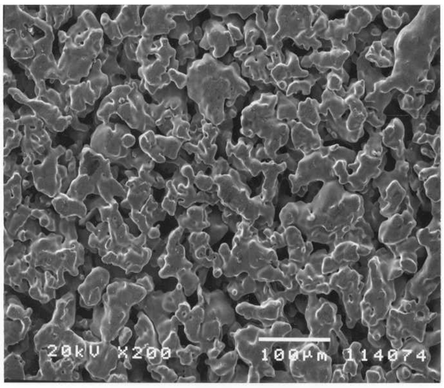


Figure 1. SEM photomicrograph of sintered porous metal media.

Figure 2. Mott sintered metal cartridges.

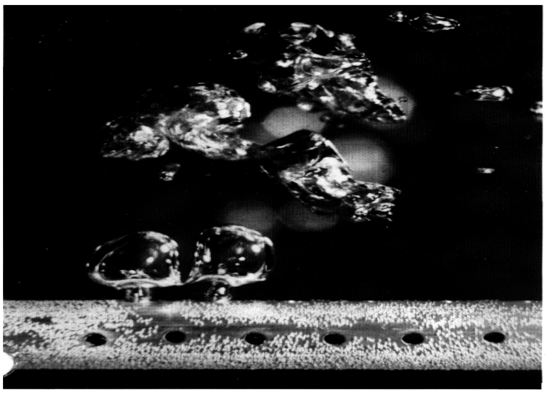
Sintered metal media can be fabricated into a wide variety of cartridge configurations for retrofit, as shown in Figure 2. In addition to 316L stainless steel, other alloys are available to meet special requirements, such as, high temperature, or chemical resistance. It's uniform porosity results in high retention efficiency. In the cases presented, sintered porous metal media has performed a major role from the pretreatment of waste streams, to a finishing stage filter for final solids removal.

Sparging Applications

Gas/liquid contacting is an important process operation in wastewater treatment. Sintered metal spargers provide a new dimension in efficient, cost-effective performance. In addition to rugged construction and corrosion resistant properties, the porosity significantly improves mass transfer. Sintered metal spargers have had proven success in applications including stripping, adsorption and direct steam injection which are found in a broad array of industries.

Sintered metal media is available as either static or dynamic spargers. Static sparging relies of the gas pressure to form the bubble and self release into the liquid. In dynamic cases, the bubble is formed at the surface and is sheared off by high fluid velocity. There are two types of dynamic spargers, intrusive and non-intrusive. Intrusive spargers are inserted into a pipeline, while non-intrusive spargers are a shell-and-tube design fitted into the pipeline. Non-intrusive sintered metal spargers were compared with traditional tank sparging under both agitated and non-agitated conditions. Absorption using sintered metal media more than doubles, increasing gas savings by 65 – 74%, as indicated in Figure 2.

Standard or conventional tank sparging methods of introducing gas include: Bubble caps with large bubble propagation and low oxygen uptake; spraying and surface agitation which are energy intensive and inefficient, and drilled pipe spargers which produce large, rapidly rising bubbles with low contact area and poor mass transfer.



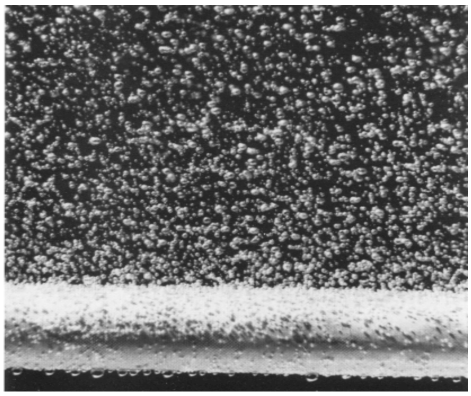


Figure 3. Photo on left shows sparging through a drilled pipe, as compared to sintered metal media on right.

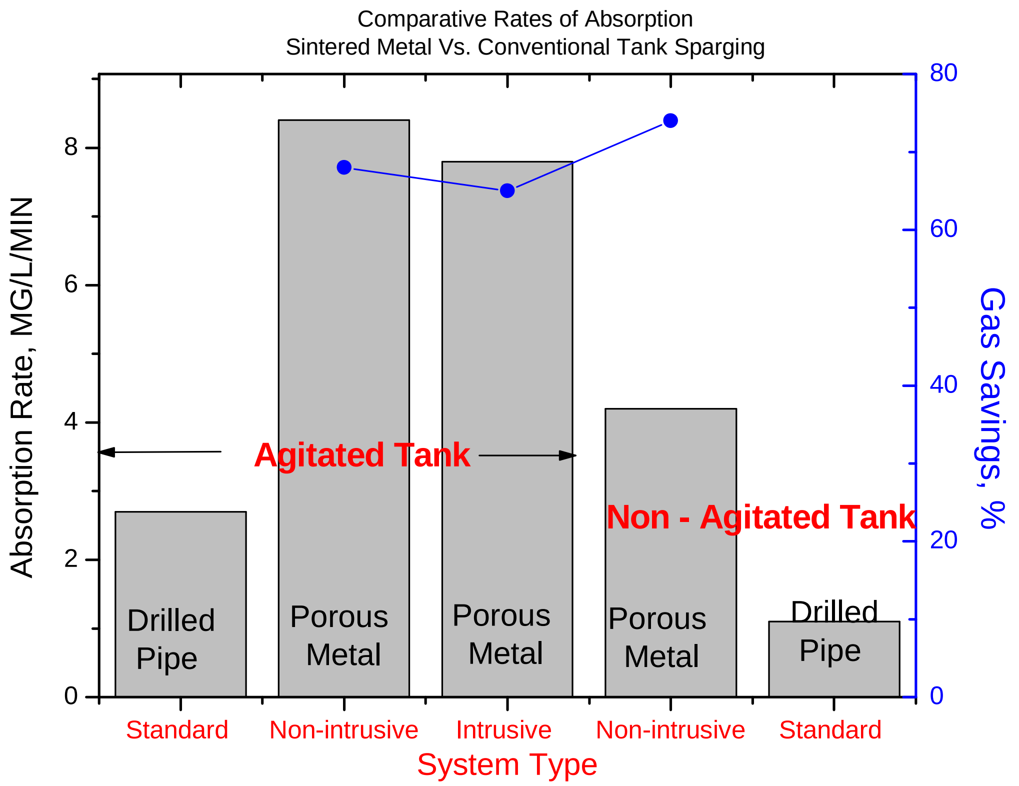


Figure 4. Benefits of using porous metal spargers versus conventional tank sparging.

Applications vary using sintered porous metal spargers as mixers in wastewater settling tanks, or for steam injection to heat water. The energy savings benefit of using sintered metal spargers for steam injection when compared with a drilled pipe distributor is shown in Figure 5. Other sparging applications that would benefit using sintered metal media are:

- Oxygen Injection for BOD and COD
- Oxygen Stripping
- pH Adjustment and Control – Neutralizing Alkaline Solutions
- Elimination of Steam Hammer
- Volatile stripping – removal of VOC (Volatile Organic Compounds) from waste streams
- Adding O_2 to O_2 depleted water prior to discharge from a plant site, sparging directly into basins to maintain aerobic bacteria activity
- Adding O_2 and O_3 to purify and supply oxygen to municipal water supplies
- Ozone Treatment

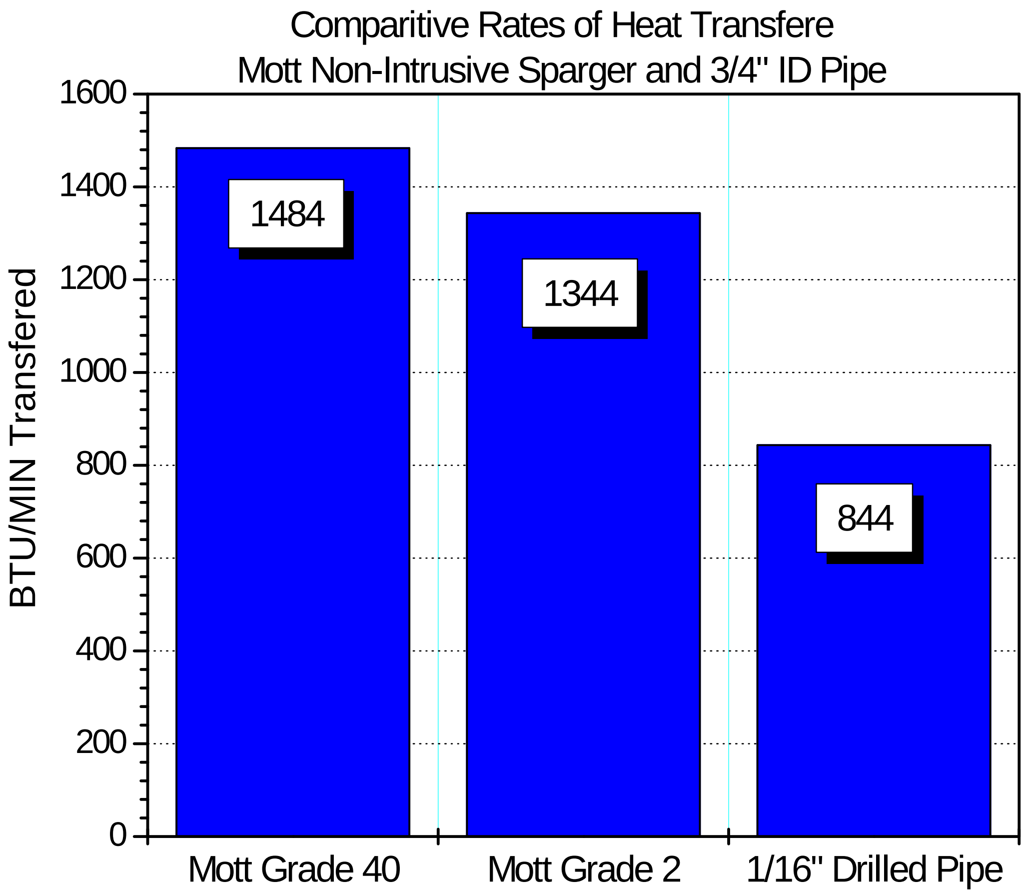


Figure 5. Benefits of using metal sparger for steam applications.

Applications for Porous Metal Media in Barrier Filters

Plastics and Synthetics Materials Industry: Crystallizer Tails Polishing for Waste Water COD Reduction

The objective of this filtration was to capture tails from the crystallizer $\geq$ 2 µm and return them back to the crystal separator for zero waste operation and minimal waste water contamination. Process conditions required all 316L SS materials of construction. Sintered metal tubular backwash filter met process requirements regarding flux, delivered acceptable filtrate quality, and operates with automatic backwash cycling. The continuous flow of the crystallizer was handled with an automatic triple filter system, with two filters on line simultaneously and one on stand-by. The original elements have been working for over 6 years of use with multiple daily backwashing This proved to be an economical solution to reduce chemical oxygen demand (COD) problems in a wastewater treatment plant.

Figure 6. Mott HyPulse® Filter System.

Food and Beverages Industry – Extraction Products
The manufacture of juice and flavor extracts generates both liquid and solids wastes. Wastewater is generated during fruit expressions, evaporation and steam distillation. Wastewater is typically drained into municipal sewerage systems.

The use of sintered metal tubular backwash filters has been validated under plant conditions for juice processing. The LSI filter configuration is described in Figure 7. Tests were conducted on a variety of juices. Filtration was compared to plant filtration using precoated leaf filters and polishing filter presses. The process requirement of filtration is to reduce juice turbidity.

The plant filters start with a load of precoating juice with high concentrations of filter aid to precoat the filter screens with filter aid. Juice is circulated, building up filter aid, until the turbidity is in spec. After that, a reduced concentration of filter aid body feed is used until the filters reach high-pressure drop, typically 60 PSI. The filters are then drained and the filter cake removed manually from the filters. The cleaning can take up to an hour. The sintered metal filter was operated similarly with a heavy load of filter aid to build precoat. After a minute the juice was in spec and passed forward to product tanks.

Improvements include:

- The quick achievement of in spec juice at lower pressure drop almost doubled the throughput per batch.
- The use of sintered metal also lowered the bodyfeed concentration, while still meeting turbidity specification.
- The sintered metal filter turnaround was much faster than the leaf filters. Total off line time was less than 10 minutes with juice drain, cake drying and discharge, and water washing. This short turnaround is a critical feature of the sintered metal filter as it makes more filtration time available.
- The system was completely automated, eliminating the need for an operator to handle the leaf filters.

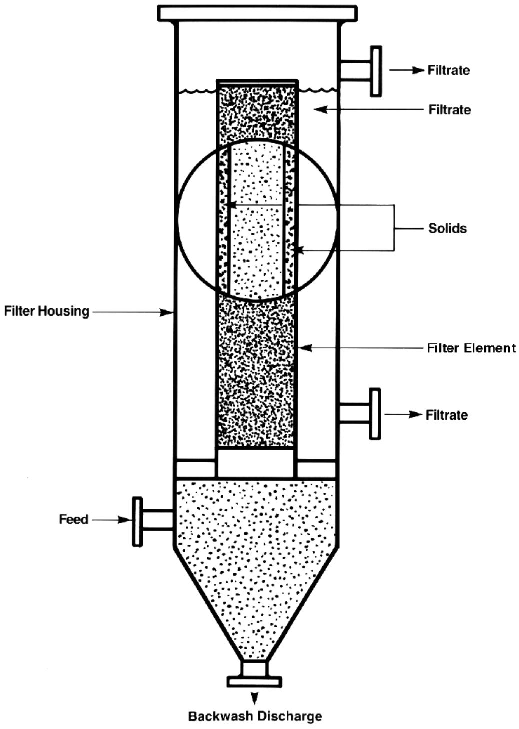


Figure 7. Mott HyPulse® LSI Filter.

Cake properties from the sintered metal were similar to the leaf filters, with moisture contents estimated at 50%.

Another improvement over the leaf filters was achieved by using a finer grade of filter aid not available to the leaf filters. The leaf filters are limited in filter aid selection because of the screen media. The filter operation was successful on all counts, meeting juice specifications, reducing filter aid usage, and producing effective wet cake discharge.

Reactor Water Cleanup Unit -Condensate Polishing Precoat Filter

The purpose of the Reactor Water Cleanup System (RWCU) is to maintain a high reactor water quality by removing contaminants, corrosion products, and other soluble and insoluble impurities. The filtered water is returned to the reactor vessel. Water reuse via condensate polishing sintered metal tubular backwash filters has proven successful at electric power generating stations. When a major utility retrofitted a (RWCU) with sintered metal elements, effluent had a lower conductivity than conventional units, as shown in Figure 8. Sintered metal filters are made of inert material that have uniform permeability, integrity and strength, and all welded construction. Uniform resin distribution is attributed to the success of the filter for water reuse. Testing of over 50 cycles at 4 gpm/ft^2 flow resulted in a recovery pressure drop of less than 0.5 PSI, as shown in Figure 9. This represented 2 ½ years of operation. Ion-exchange precoat is removed periodically, based on water chemistry or differential pressure, by a gas assist backwash method.

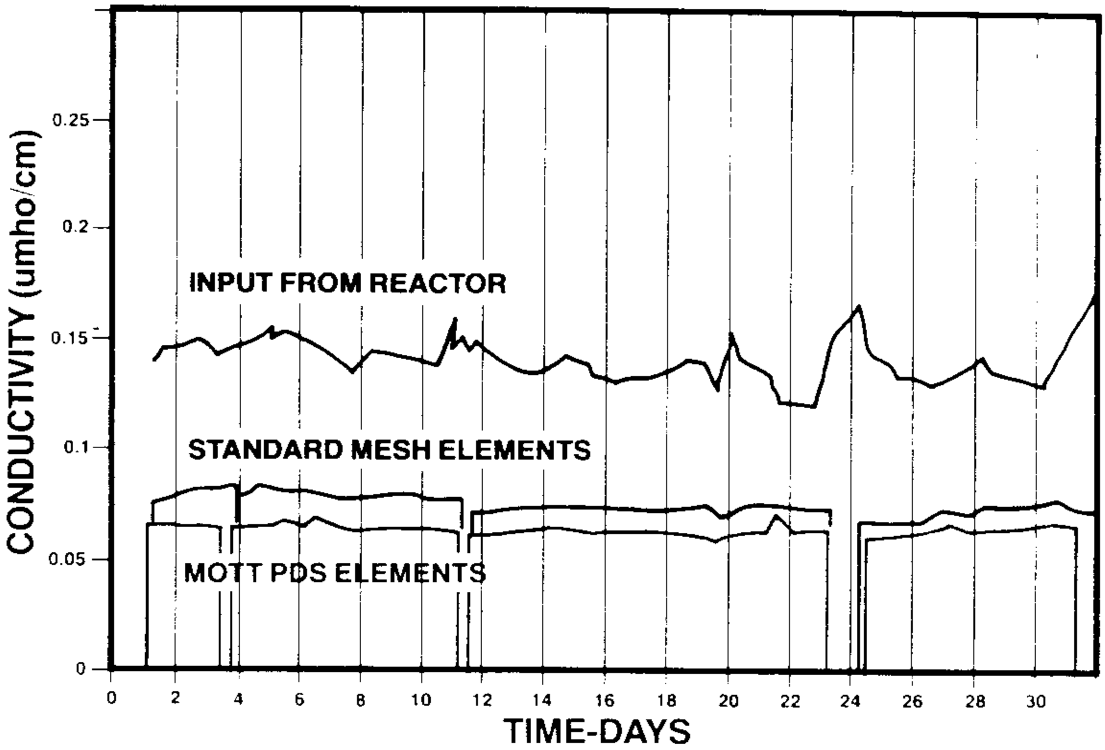


Figure 8. Effluent conductivity for standard mesh and Mott elements.

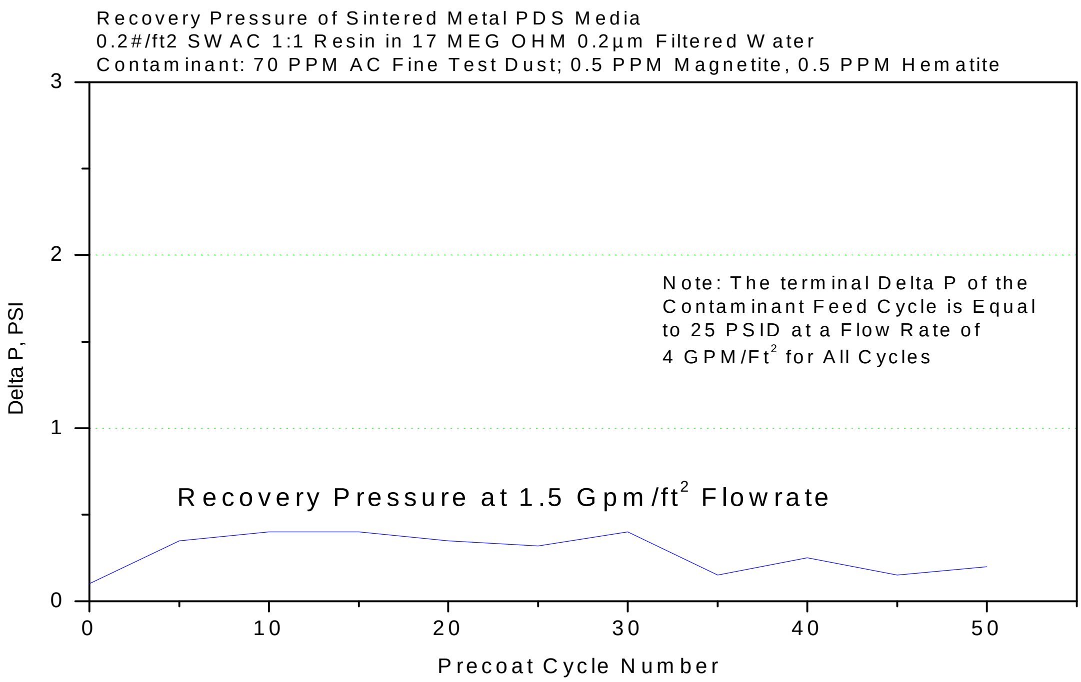


Figure 9. Testing of over 50 cycles shows a recovery pressure drop of less than 0.5 PSI.

Extensive testing showed 0.04 parts per billion resin leakage over a 24-hr period. The feature that allows for retention is its excellent resin coating and dirt holding capacity. Sintered metal tubular backwash filters have survived severe upset conditions, including resin attrition. New resin was measured to be in the 5 – 60 μm range, with mean of 30 μm based on volume. Spent resin 2.5 – 64 μm range, with mean of 14.7 μm based on volume.

Sintered metal elements have been designed to replace conventional elements in:

- Condensate Polisher /Demineralizers
- Make-up Water Demineralizers
- Spent Fuel Pool Filters
- Equipment/Floor-drain Filters
- Spent Resin Filters
- Reactor Water Clean-up Units
- Suppression Pool Filters
- Laundry Filters

Inertial Cross-flow Filtration

Inertial cross-flow filtration continues to provide an alternative in the treatment of industrial liquid wastes. Sintered metal media used in the HyPulse® LSX crossflow configuration provides a backwashable, self-cleaning, continuous flow filter designed for particulate or sludge concentration and liquid recovery. Filtration via crossflow flows the fluid is directed tangentially over the surface of sintered metal media, so that particulate rejected at the filter surface are kept in suspension rather than plugging the media. Sintered metal filters can be cleaned in place via a reverse pulse of liquid or filtrate. Backpulsing at a regular interval can ensure long filter life. Sintered metal is the preferred media for nuclear applications because of its absolute reliability. The all-metal welded construction eliminates the worry of seal failures. Sintered metal media offers a variety of media grades. Media grades 0.1, 0.2, and 0.5 are most typically used.

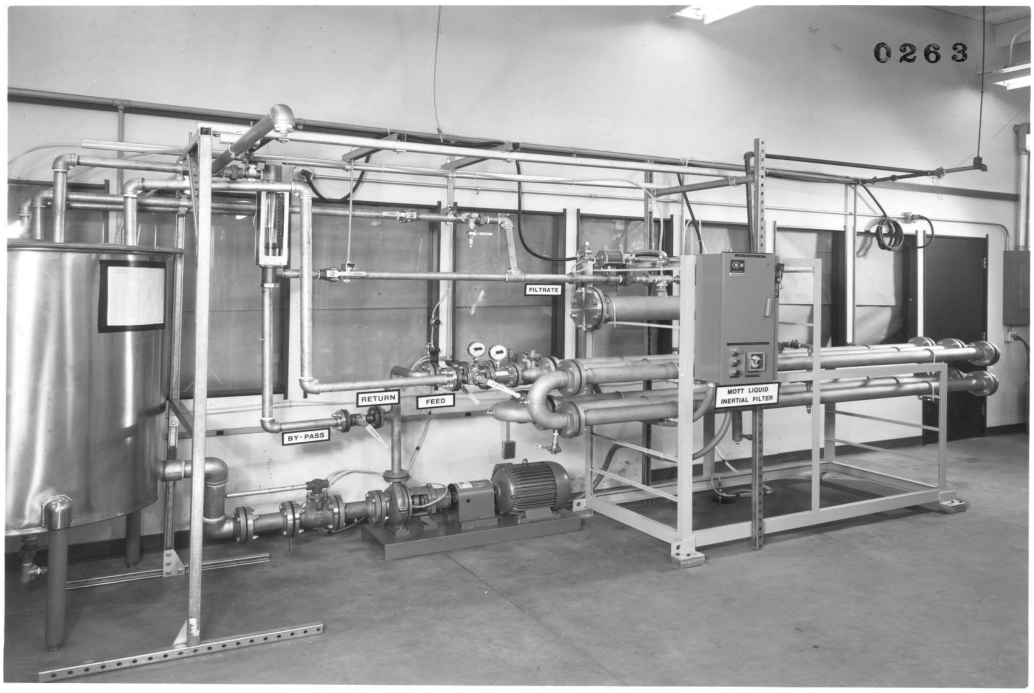


Figure 10. Mott HyPulse® LSX Laboratory Inertial Cross-flow Filter.

Nuclear Applications: Pretreatment Filter

A sintered metal inertial filter has operated successfully as a pretreatment filter used to guard ion exchange columns. Inertial filtration allowed for the concentration of low level radwaste radioactive slurry by a factor of 150 to 200 times (up to 20% solids), producing a slurry which is suitable for encapsulation. The filter has performed successfully over the last 10 years with no chemical cleaning and infrequent backpulsing. The site has been successful in safely turning radioactive liquid into manageable solids glass.

Other Industrial Wastewater Applications

Inertial cross-flow filtration is a proven technology in the pharmaceutical and chemical processing industry. Some applications include:

- Separation of Iron Oxide (Fe_2O_3, 95% < 1µm). This application permits cycle of water, resulting in savings of 13,000,000 gallons per year in a critical drought area.
- Separate and concentrate titanium dioxide (TiO_2, 0.1 – 0.3 µm particles) from water.
- Supply polished, particulate-free liquid samples to process stream analyzers.

References

Liquid Assets 2000: America's Water Resources at a Turning Point, Water Online News.

Mott Corp. Steam Sparging and Filtration Engineering Guide.

Mayer, E. and Julkowski, K.J., and Rubow, K. Waste Minimization with Sintered Metal Tubular Backwash Filters, Fluid /Particle Separation Journal Vol.11. No.3, Dec 1998.

Cheremisinoff, N. P., Liquid Filtration, Second Edition , Butterworth-Heinemann, 1998.

U.S. Patent No. 4,552,669, R. Sekellick, assigned to Mott Metallurgical Corporation, (November 1985).