

Porous metal solids separation filtration systems
for recovery of precious catalyst or product,
environmental and system component protection, and
enhanced product quality.

**PALL POROUS METAL FILTERS FOR
SOLIDS SEPARATION IN LIQUID AND GAS SERVICE**



Pall Porous Metal Filters For Solids Separation in Liquid and Gas Service

Pall—World Leader in Filtration Technology

Pall has established itself beyond question as the world's leading company in fluid clarification technology, hardware, and technical service for the most demanding applications. Since 1946, Pall products have answered critical filtration/separation and dehydration needs in the chemical process, hydraulic fluid power, oil production, aerospace and biomedical industries. Producing a full standard range of highly advanced filters, housings, air/gas drying equipment and other fluid clarification products, Pall offers more experience, expertise and worldwide support in this technology than any other company. Pall has a tradition of innovation that includes the introduction of many significant firsts in the field.

Pall Porous Metal Filter Media—Field Proven Since 1946

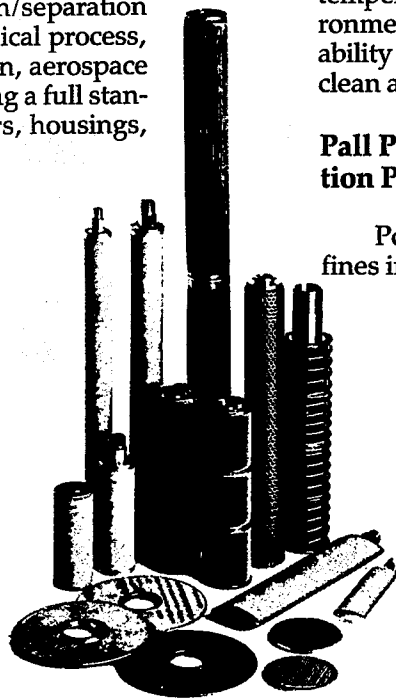
Pall PSS® sintered powder metal medium or Rigi-mesh® sintered woven wire

mesh medium, and combinations thereof, are the heart of our solids separation metal filter systems. They were developed and patented by Pall Corporation as our original products. Filters made of these media have been in service for the clarification of fluids at high temperatures, high pressures, in corrosive environments, as well as for processes in which the ability to chemically, thermally or mechanically clean and reuse filters offers an advantage.

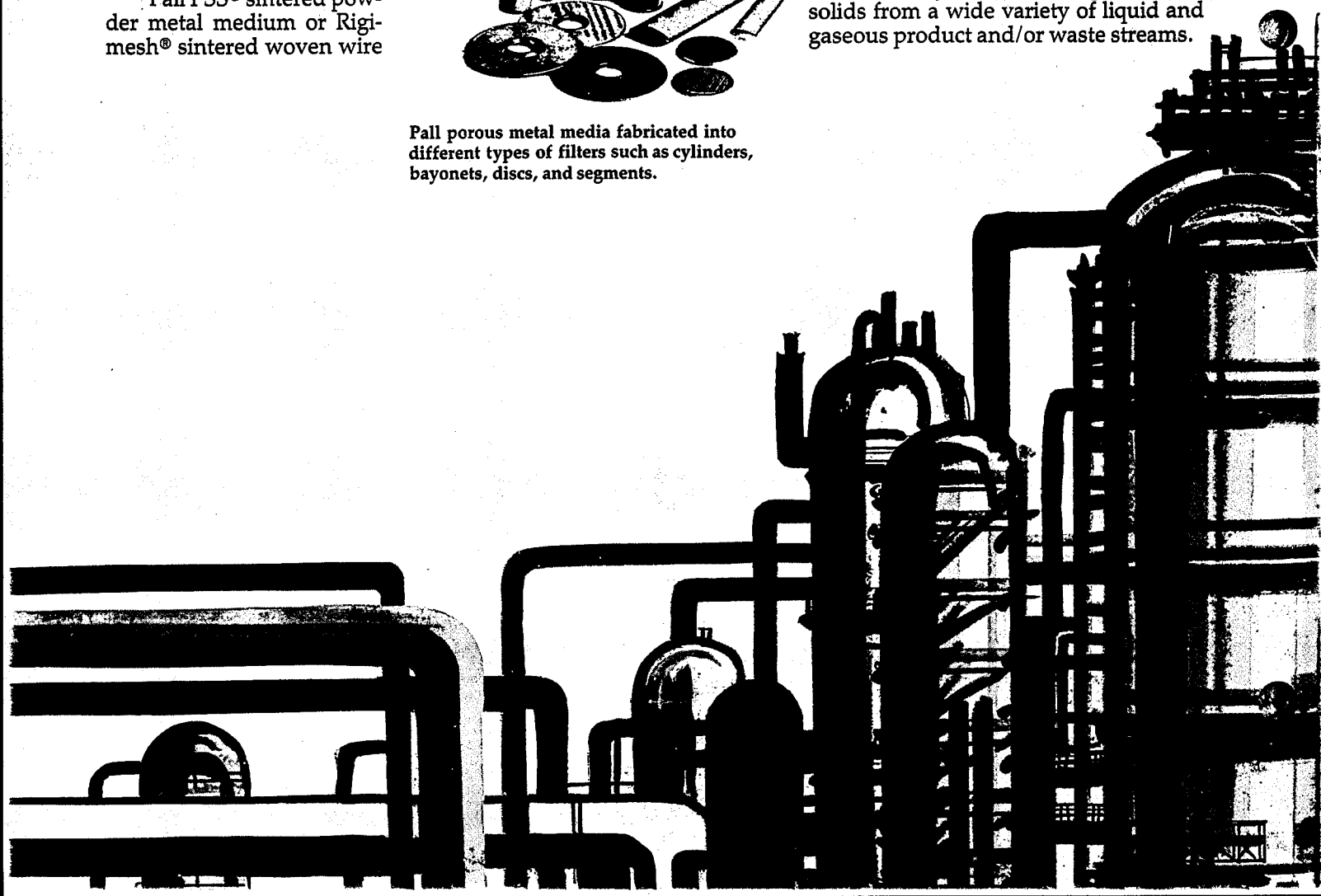
Pall Porous Metal Filters for Solids Separation Proven Successful for Over 30 Years

Porous metal filters for recovery of catalyst fines in such applications as Phthalic Anhydride, Hydrogen Peroxide, and coal indirect liquefaction, were first introduced in the early 50's. Since then Pall filters have been used in hundreds of applications with many of the early installations still onstream after 30 years of service.

The physical properties of Pall's porous metals coupled with our design and fabrication capabilities have made it economically feasible to separate fine solids from a wide variety of liquid and gaseous product and/or waste streams.



Pall porous metal media fabricated into different types of filters such as cylinders, bayonets, discs, and segments.



Characteristics of Pall Porous Metal Media

The following properties make Pall porous metal filters ideal for solids separation filtration service:

High Particulate Removal Efficiency: Porous metal filters will, consistent with their ratings, retain a high percentage of particulate matter in both gaseous and liquid service. Pore dimensions are carefully controlled and cannot change in service due to compression. The result is quantitative filtration, free of medium migration or unloading of particulate matter, and consistently superior effluent cleanliness.

High Permeability: A uniform distribution of interconnected pores represents up to 50% of the filter media's volume providing low resistance to flow even at high velocities through the filter.

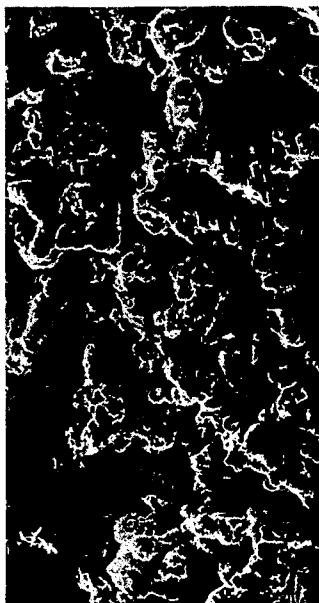
Temperature Resistance: Porous metal filter materials are available for extreme temperatures ranging from -450°F to $+1650^{\circ}\text{F}$ depending on

the selection of appropriate alloys.

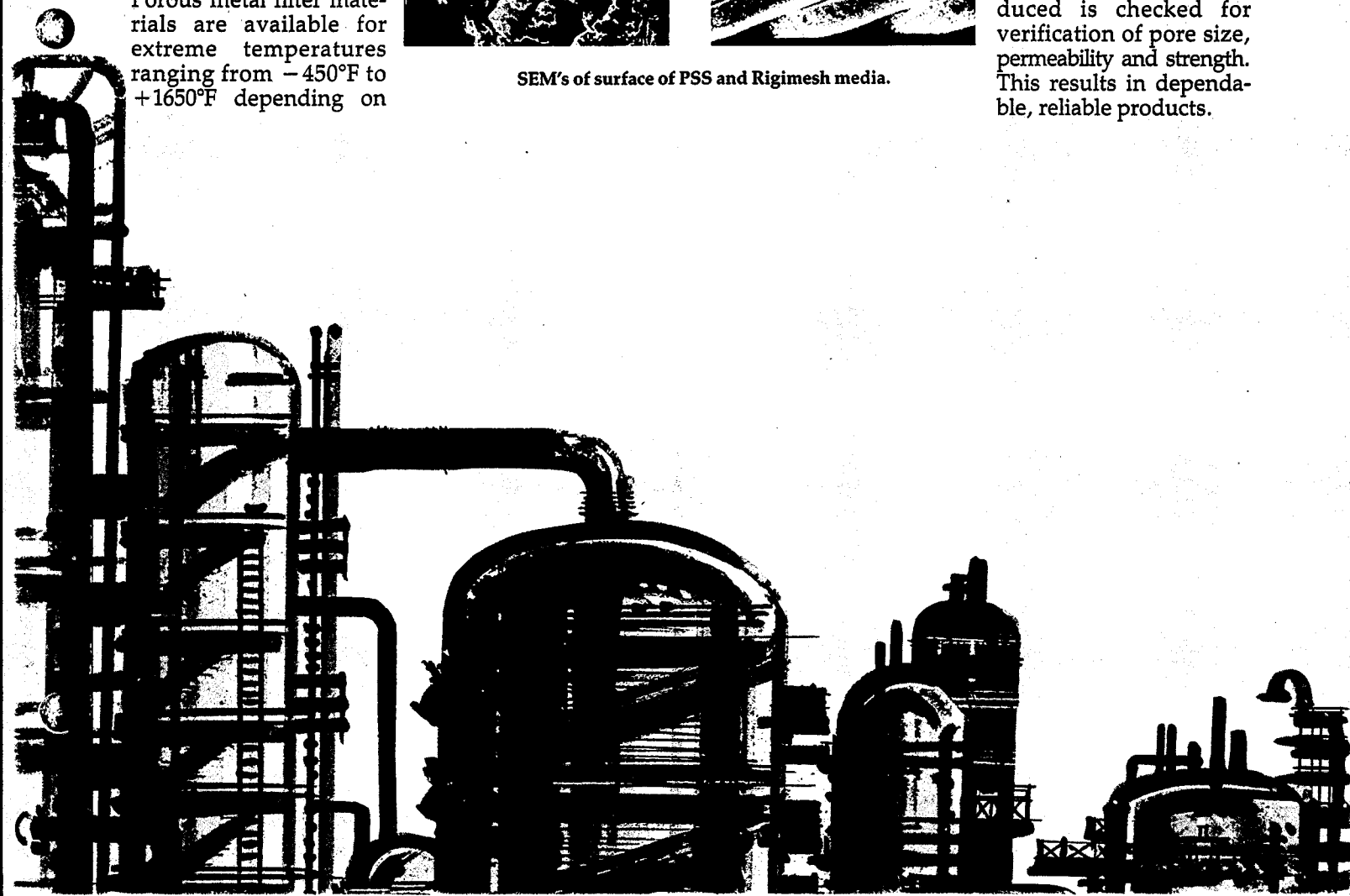
Physical Strength: Porous metal filters are inherently strong and durable for long-term service. Filter element designs are available to 10,000 psid and are capable of withstanding repeated cycling in the reverse flow direction.

Corrosion Resistance: Pall's patented sintering process retains the corrosion-resistant properties of the various porous metal alloys of which the media are made. These materials are compatible with a wide variety of liquids and gases, providing long economic service life.

Reproducible Quality: Quality control throughout the manufacturing process produces the most reliable filter media that the state of the art permits. Each sheet of filter medium that is produced is checked for verification of pore size, permeability and strength. This results in dependable, reliable products.



SEM's of surface of PSS and Rigimesh media.



Pall Blowback/Backwash Filter Systems for Economical, Efficient Solids Separation

In today's economy, it's more important than ever to maintain high process yields and top quality products; keep system components operating, and conform to EPA requirements, particularly as they relate to particle emissions into the atmosphere and disposal of liquid wastes. And, it's important to achieve these objectives as efficiently and economically as possible.

How Pall Blowback and Backwash Filter Systems Work

Pall Solids Separation Filter Systems are designed to remove particulate matter from liquid or gas streams. To accomplish this, a porous metal filter medium with

sufficiently small pores and sized at an appropriate flow rate per unit of filter area effectively retains solids at or near the filter surface. This results in the formation of a permeable cake of solids which is dislodged at a pre-determined pressure drop (a function of cake thickness and compressibility) by initiating a reverse flow. The dislodged solids are purged from the filter system where they may be returned directly to the process stream or removed from the process stream and sent to a storage or collection unit. The filter is then returned to full forward flow and to a pressure drop which remains essentially constant through repeated blowback or backwash cycles. (Figures 1-3).

Cake Formation and Release

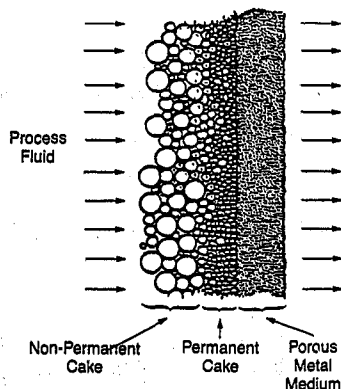


Figure 1. Hypothetical cake structure.

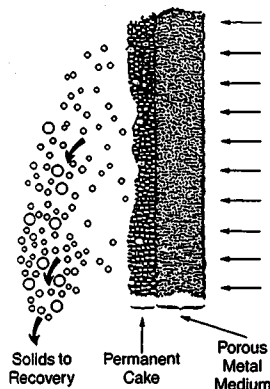


Figure 2. Hypothetical Cake Release.

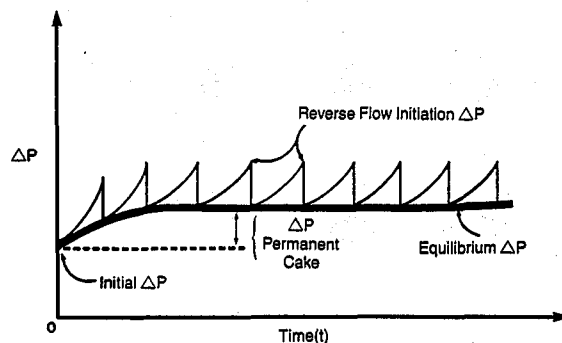


Figure 3. Differential Pressure vs. Time.

Sequence of Actual Cake Formation and Release



Pall porous metal filter element before use.



Element caked with fine solids prior to blowback.



Reverse flow effectively dislodges non-permanent cake.



Element with permanent cake ready for resumption of forward flow.

Engineered Systems for Continuous Service Applications

Pall Porous Metal Filter Systems are quality engineered and built for continuous automated service in small or large flow applications.

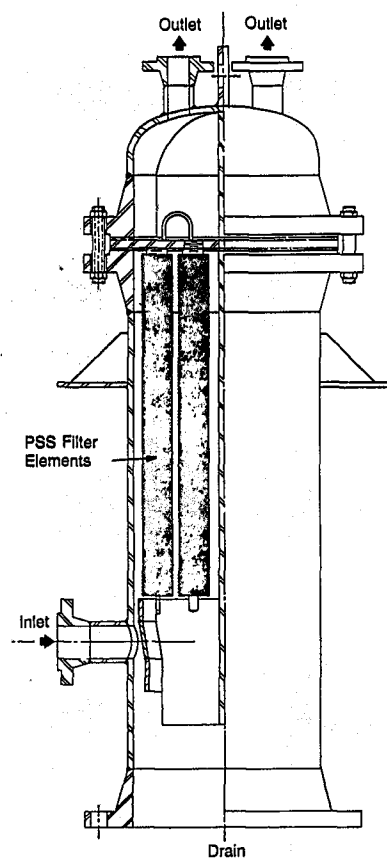
In blowback operations where uninterrupted flow is desired, chambered single vessel and multiple vessel modular designs are available. The chambered single vessel is designed for small flow continuous service applications. Two to four chambers permit 100% forward flow at all times with one of the chambers at a time in the reverse flow cleaning mode.

For large flow continuous gaseous service, modular designs may be used with either the Reverse Flow

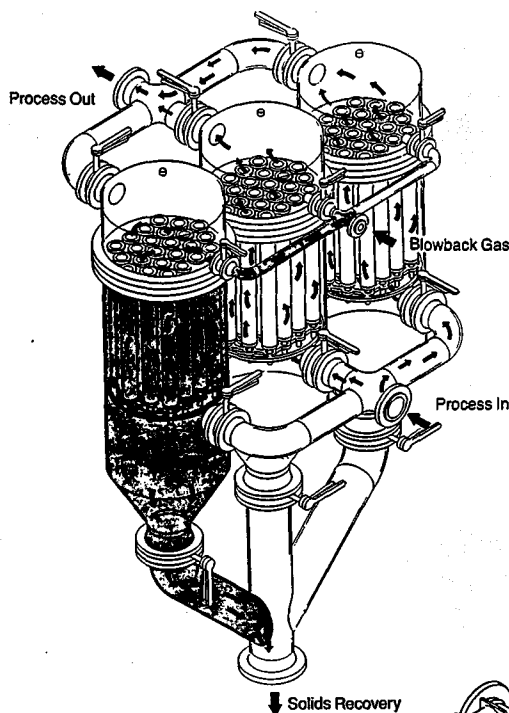
or Jet-Pulse method of blowback, as detailed on page 6. In the case of Reverse Flow, multiple vessels are required with individual vessels being blown back sequentially. The Jet-Pulse method utilizes one or more vessels. 100% forward flow can be maintained at all times while individual groups of filter elements or individual vessels are blown back sequentially.

For continuous automated operation in liquid applications, Pall offers manifolded Backwash Filter Assemblies. Multiple units permit 100% forward flow at all times and allow sequential backwashing of each vessel as required.

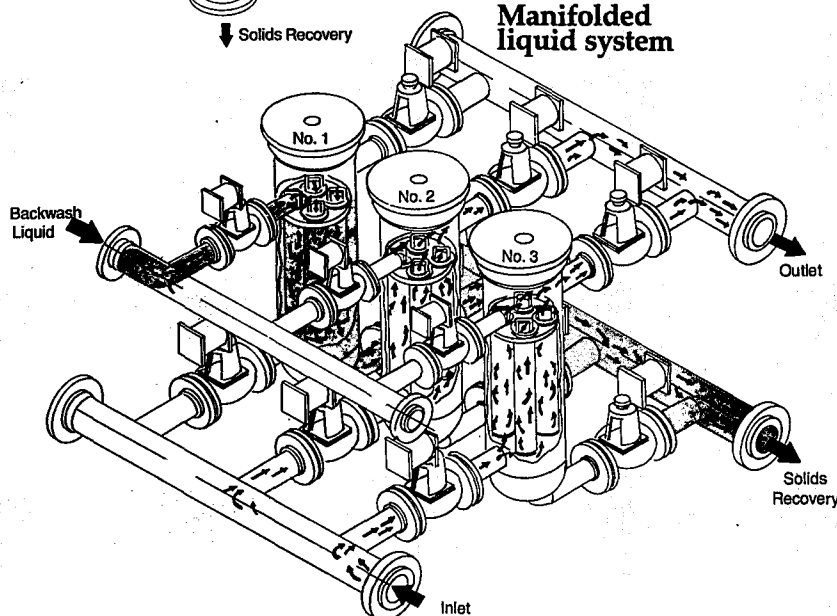
Quadrant design single vessel blowback unit



Multi-vessel blowback arrangement



Manifolded liquid system



Pall Porous Metal Blowback Filter Systems for Gaseous Service

The physical properties of Pall's porous metals, coupled with our design and fabricating capabilities, make it possible to offer industry economic, as well as technically feasible solutions to difficult off-gas particle control problems. Significant operating benefits are derived from a system which:

- Recovers Precious Catalysts
- Recovers Product
- Protects System Components
- Protects Environment

System design and operation are important factors in the successful application of Pall Blowback Filter Systems to ensure continuous, long-term and trouble-free operation. There are two ways in which solids are discharged from the filter system.

Reverse Flow Method: This filtration system employs one or more vessels. For the smaller continuous flow applications, a single vessel with internal compartments is typical. One vessel or compartment within a vessel is isolated, thereby diverting its share of the flow to the other compartment(s) or vessel(s). A reverse flow of low pressure gas is initiated at 50-70% of the normal forward flow rate for 2-3 seconds to sweep the collected solids clear of the vessel or compartment (Figure 4). Process flow is then allowed to resume. When multiple vessels are used, the remaining vessels are sequenced in the same manner.

Jet Pulse Method: The filtration system in this case employs one or more vessels, however compartmentalizing is not required here. Blowback is accomplished by sequentially applying a reverse high pressure pulse to groups of filter elements within a vessel. This short

duration (0.25-1.0 second) pulse affects only those elements in the group being blown back. The pulse overcomes normal flow and allows the collected solids to lift away from the elements and fall, by their combined mass, clear of the vessel. (See Figure 5).

Unique Features of Pall Blowback Filter Systems

• High Efficiency of Solids Separation

Suitably selected pore grade of filter medium can quantitatively separate particles $> 0.05\mu\text{m}$ in size from a gas stream with 99.999% efficiency.

• High Flow Rate per Unit of Filter Area

Due to the fixed fine pore structure and high voids volume of the filter medium design rates of 20 ACFM/ft.² are possible, which reduces total surface area required.

• High Filter Area per Unit Vessel Volume

Element designs using a high length to diameter ratio and efficient element spacing arrangements, minimize vessel size and subsequent vessel cost.

• High Solids Loading Rate

The ability to effectively handle up to 0.1 lbs of solids/ft.³ of gas often reduces or eliminates the need for pre-treatment equipment, such as cyclones.

• Automated Operation

Completely automated control and monitoring of system operation is also available.

• Durability

Material strength and system design can provide years of trouble free service.

• Custom Designs

Availability of custom designs provides flexibility to meet most specific user requirements.

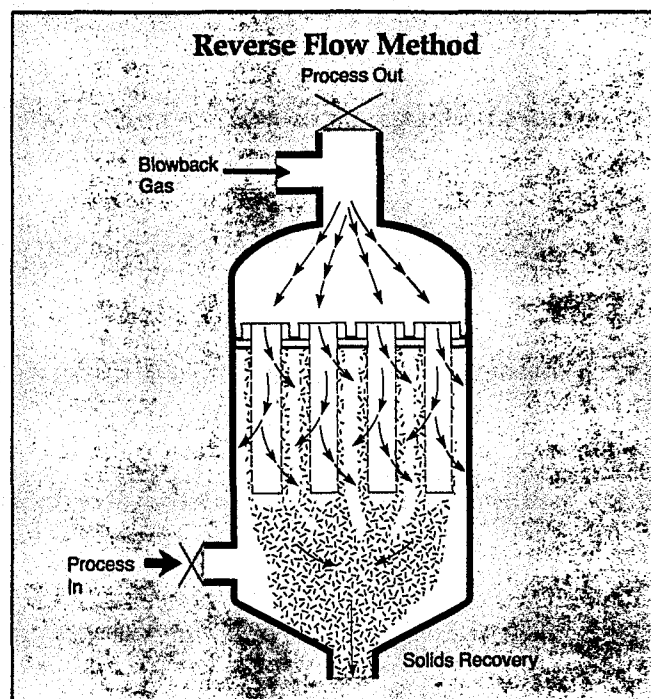


Figure 4.

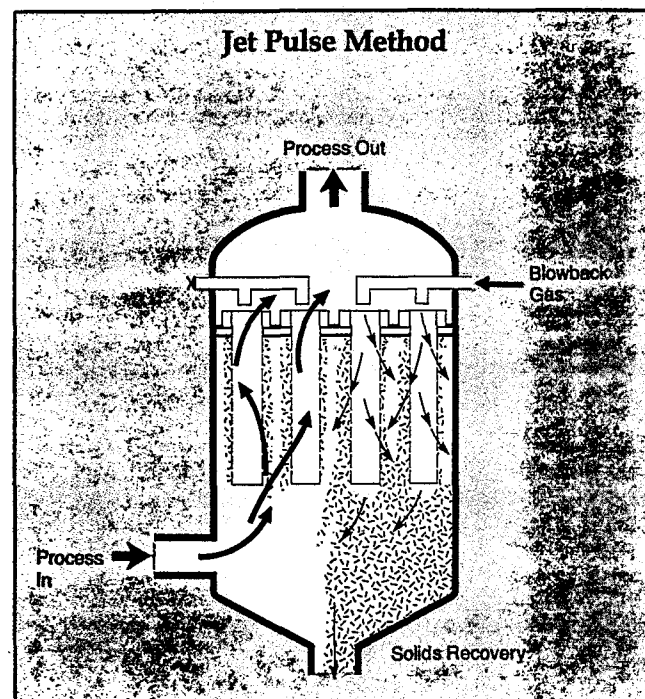


Figure 5.

Pall Porous Metal Blowback Systems Have Wide Application

Pall Porous Metal Blowback Filter Systems offer high removal efficiencies that meet specific application requirements in a wide range of applications, including:

Recovery of Precious Catalysts

Phthalic Anhydride	Fischer-Tropsch Reactions
Maleic Anhydride	Methanation

Product Recovery

Polyethylene	Dry Foods and Powders
Pharmaceuticals	Silicon Products

Environmental Protection

Calciners	Fluid Bed Dryers
Incinerators	Nuclear Fuel Preparation
Reduction of Radioactive Waste	Catalyst Preparation and Regeneration

System Component Protection

Turbine Blades & Seals	Vacuum Filling Systems
	Fluid Bed Dryers

Pall Porous Metal Blowback Filter Systems are Effective Alternatives to other Separation Equipment

Pall Porous Metal Blowback Systems are generally more efficient and economical than other separation equipment under similar operating conditions of pressure, temperature and environment.

Cyclones

Porous Metal Systems offer higher efficiency, independent of flow rate, under similar operating conditions of pressure, temperature, and environment.

Bag Houses

Porous Metal Systems offer higher efficiency, reliability, and safety, particularly at temperatures above 550°F.

Electrostatic Precipitators

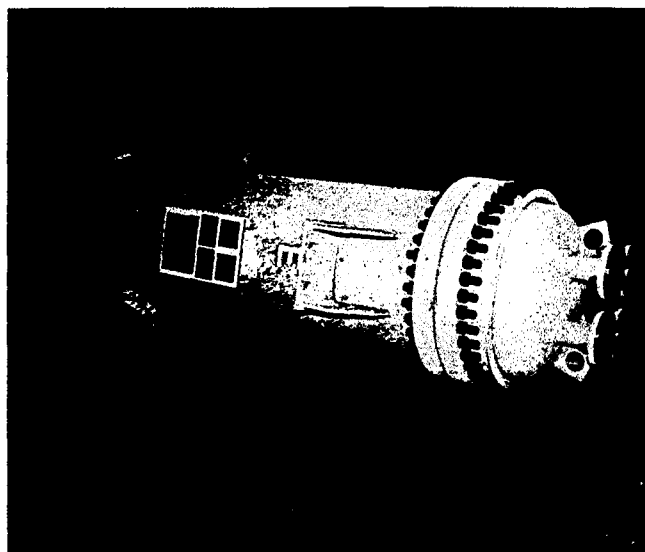
Porous Metal Systems offer higher efficiency, independent of flow rate, and they are safer, particularly at temperatures above 900°F.

Scrubbers

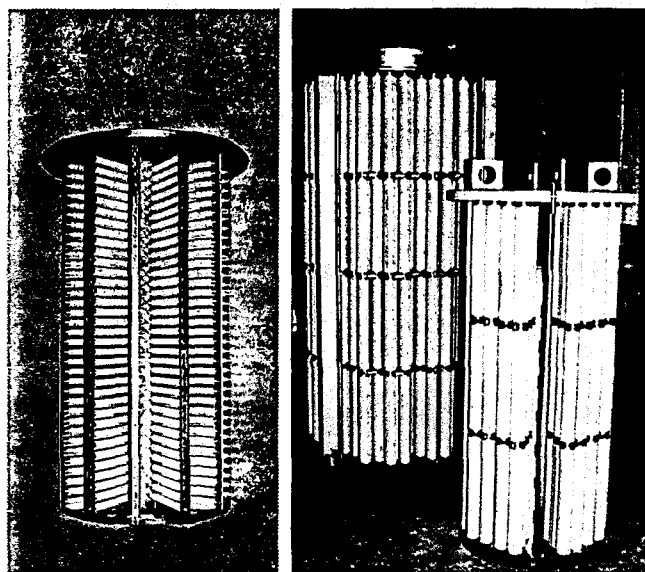
Porous Metal Systems offer higher efficiency without high energy costs and without need for secondary waste treatment.



Catalyst activator in Polyethylene plant uses Pall porous metal filters.



Typical Pall blowback vessel design.



Tube sheet and element arrangements for blowback applications.

Pall Porous Metal Backwash Filter Systems for Liquid Streams

Pall Backwash Filters, for the efficient separation of finely divided particles from liquid streams, have a service history comparable to that of Pall Blowback Filters. Recovery of the collected solids from the surface of the porous metal filter medium is accomplished in a similar fashion by periodic reversals of flow (liquid backwash) through the filter elements. The physical properties of Pall's porous metals coupled with our design and fabrication capabilities have made it economically feasible to recover the fine solids from a wide variety of liquid products and/or waste streams.

Significant operating benefits are derived from a system which:

- Recovers Precious Catalysts/Reactants
- Recovers Solid Products from Process Liquids
- Clarifies Liquid Streams for:
 - Environmental Protection
 - System Component Protection
 - Product Quality

System design and operation are important factors in the successful application of Pall Backwash Filter Systems for continuous, long-term and trouble-free operation. There are two ways in which solids will be discharged from the filter system.

Pressurized Liquid Method: This filtration system employs one or more vessels. Multiple vessel systems are used when process flow rates are high, or continuous uninterrupted flow is required. When a backwash cycle is required, one vessel is isolated and a reverse flow of low pressure liquid is initiated at a rate equal to or greater than the forward flow rate (Figure 6). The volume of liquid consumed is at least equal to one vessel volume. The backwash liquid may be the filtrate or a secondary external liquid. Use of the latter is preferred where the loss of process liquid is either costly or damaging to the environment. The pressure

required for the backwash liquid will be in a range approximately equal to that of the process stream. Forward flow is restored to the vessel allowing the balance of the filter vessels to be sequentially backwashed.

Gas Assist Method: The filtration system, in this case, employs one or more vessels, again contingent upon process flow rate and the need for continuous uninterrupted filter operation. When a backwash cycle is required, one vessel is isolated and the downstream side of the vessel is pressurized with a controlled quantity of air or other suitable gas. The vessel drain port is rapidly opened resulting in a hydraulic pulse which bursts the collected solids from the filter surface. As the gas head expands, the solids and remaining liquid in the vessel are forced into a receiver or returned to a reaction vessel (Figure 7). Forward flow is restored to this vessel allowing the balance of the filter vessels to be backwashed sequentially.

Unique Features of Pall Backwash Filter Systems

• High Efficiency of Solids Separation

Suitably selected pore grade of filter medium can quantitatively separate particles typically $> 0.5\mu\text{m}$ in size from a liquid stream with 99.9% efficiency. This is accomplished without the use of filter aids in most cases.

• **No Medium Migration or Particle Unloading**
Effluent quality is assured due to strong sintered (fixed) pore structure of Pall porous metal media.

• **High Flow Rate per Unit of Filter Area**
Due to the fixed fine pore structure and high voids volume of the filter medium, design rates up to 2 gpm/ft.^2 are possible with relatively clean low viscosity liquids. For liquids which are heavily loaded with very fine particles, the flow rate per unit area is reduced.

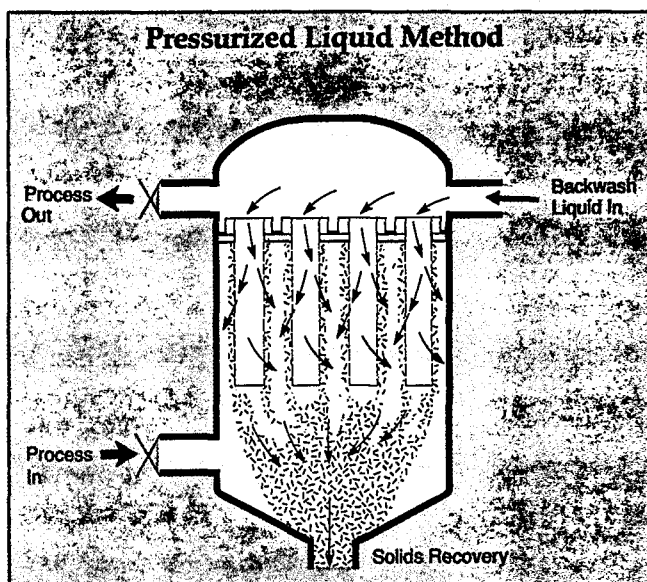


Figure 6.

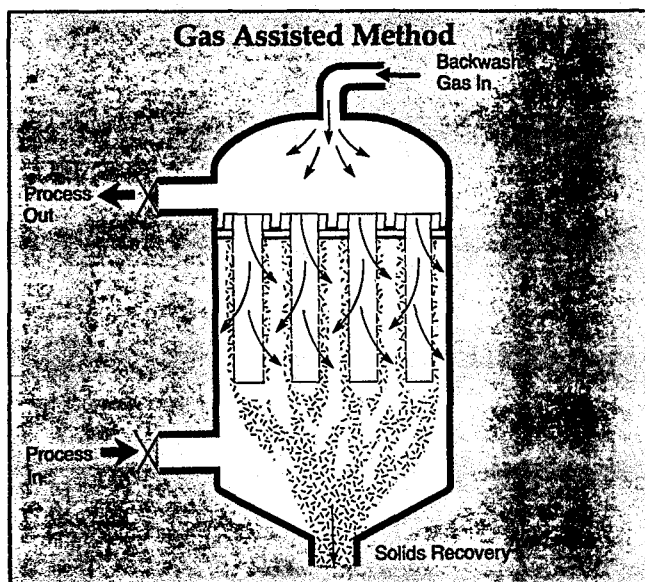


Figure 7.

- **Automated System Operation**

Provides continuous system operation with only minimal use of operating personnel.

- **High Solids Loading**

Can handle solids concentration up to 2500 ppm, reducing the need for upstream pre-treatment systems.

- **Minimum Loss of Process Liquid**

Selection of an appropriate backwashing method and vessel design can greatly reduce loss of process liquid.

- **Durability**

Physical strength of the filter elements and system design can provide years of long economic life.

- **Custom Designs**

Availability of custom designs provides flexibility to meet many specific user requirements.

Pall Porous Metal Backwash Systems Have Wide Application in Petrochemical, Food and Beverage, Health and Beauty Industries

Pall Porous Metal Solids Separation Systems find wide application in the Process Industries.

Catalyst Recovery

Caprolactam	Toluenediamine
Hydrogen Peroxide	Phthalate Esters

Environmental Protection

Clean-up liquid waste streams for disposal or well injection

System Component Protection

Pump Seal Fluids	Cooling Water
Heat Transfer Fluids	Scrubber Liquids

Improved Product Quality

Corn Syrup	Fruit Juices
Food Products	Cosmetics
Citric Acid	

Porous Metal Separation Systems Are More Efficient and Economical Than Alternative Methods

Pall Porous Metal Backwash Systems are generally more efficient and economical than other separation equipment under similar operating conditions of pressure, temperature and environment.

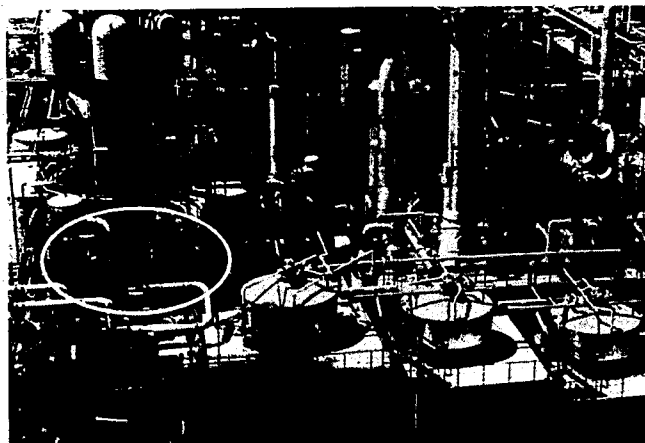
Pall Porous Metal Backwash Systems are effective alternatives to:

Pressure Leaf and Plate & Frame Filters

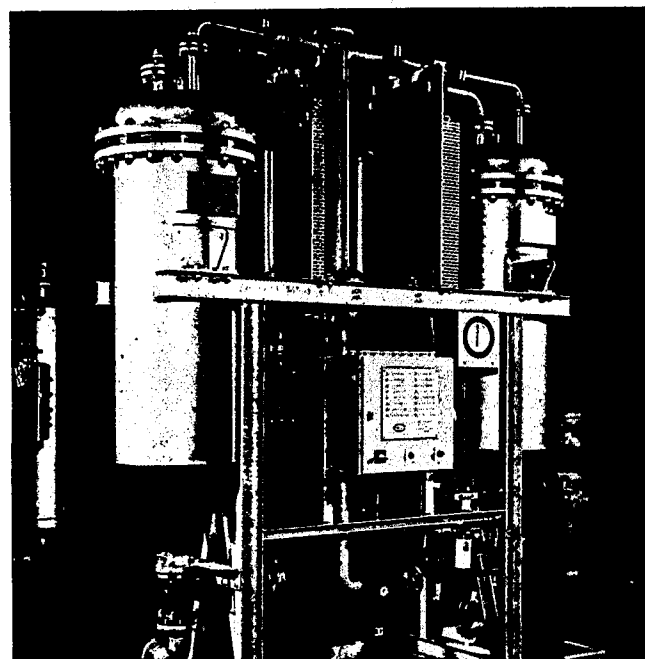
Porous Metal filters offer higher efficiency, often without the need for filter aids; require less maintenance, are smaller in size, and can minimize liquid losses.

Tubular or Sock Filters

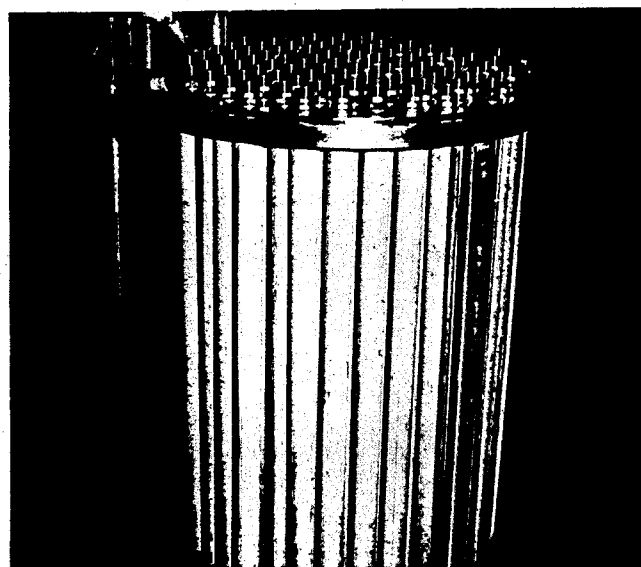
Porous Metal filters offer higher efficiency and reliability under similar operating conditions of pressure, temperature and environment.



PSS catalyst recovery system in Caprolactam plant.



Typical Pall multi-vessel porous metal backwash system.



Typical element configuration and tube sheet arrangement for backwash applications.

How Pall Serves You Better



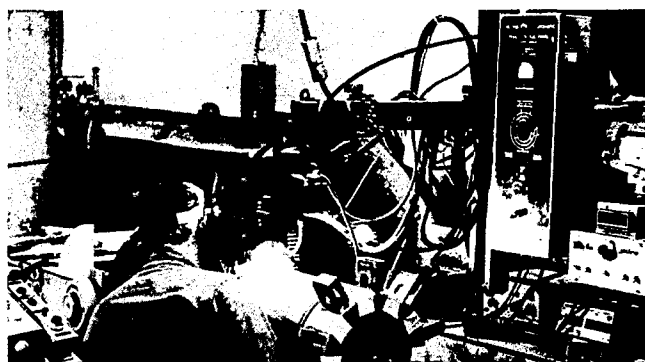
Pall manufacturing facility in Cortland, N.Y. See back page for other plant locations.



Part of modern welding area in Cortland, N.Y. plant.



Inhouse element and tubesheet fabrication.



Certified welding for specialized nuclear applications.

There are definite distinctions that set Pall apart from other manufacturers of filtration equipment. These differences make a strong case for selecting Pall products and taking advantage of our expertise and services for your applications.

Pall Products Are Currently Used In Plants and Processes the World Over

Unlike other manufacturers, Pall develops, designs, manufactures and markets its filtration/separation systems with the philosophy that every Pall product should be correct in concept for the application, and superior in function and safety.

Pall Exercises Total Control Over Manufacturing

Where other filter companies simply assemble components, Pall develops and produces its own filter media, all its filter cartridges and vessels. In fact we are certified to meet the most stringent pressure vessel code requirements. Where applicable, vessels are stamped with the "U", "UM", or "N" stamps. Pall Solids Separation Systems are designed and manufactured in the company's extensive world-wide facilities. Because Pall controls all aspects of design and production, you are assured of the strictest quality control and consistent performance.

Pall Offers Unique Scientific and Laboratory Services

Technical help with difficult problems is provided by Pall's Scientific and Laboratory Services Department (SLS). The Department's main headquarters are in the U.S. and Great Britain, with support laboratories located in Canada, Germany, France, Italy and Japan. These laboratories are staffed with skilled engineers and scientists trained in disciplines associated with fluid clarification and are equipped with the most sophisticated analytical instruments available. They are prepared to conduct performance feasibility and design optimization studies in support of solids separation

applications using Pall's specially designed laboratory blowback and backwash test apparatus. Field test equipment for in-process side stream evaluations can be arranged by contacting Pall. Pall's scientists and engineers help analyze requirements, help determine fluid compatibilities and solve complex solids separation problems. Their efforts help Pall customers find practical, prompt, reliable and cost-effective solutions.

Pall Offers Start-Up Services

To further ensure long-term satisfaction with Pall backwash and blowback systems we provide complete start-up service. After your system is delivered, a qualified Pall representative will visit your plant on a scheduled date. At that time, all components will be thoroughly checked. The installation will be examined to make sure it conforms to the specifications; and adjustments, resulting from process changes, will be made. This service is your assurance that your Pall system will perform as specified as soon as you start using it.

Pall Offers Cleaning Service Consultation To Ensure Long-Term Optimum Performance

As the manufacturer, we understand both filter and system integrity, and know how our filters can be expected to perform under many operating conditions. Based on this knowledge, our long experience, and backed by sophisticated testing equipment, Pall scientists and engineers can develop effective cleaning procedures specific to the application. Customers may use these techniques in their own plants.

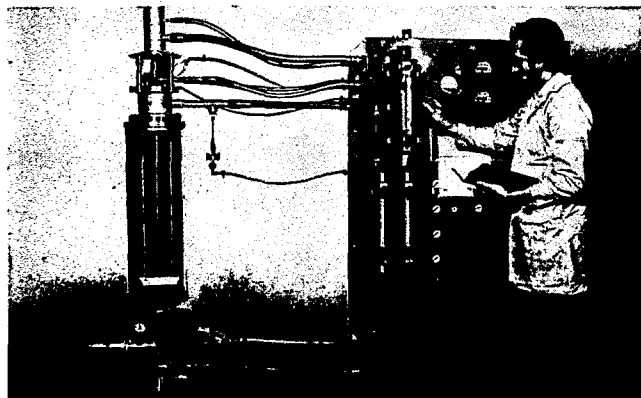
Pall Offers Technical Seminars

As an additional service, Pall provides a series of scientific and technical seminars encompassing the subjects of fluid clarification and solids separation. These programs are presented by senior application engineers and scientists and are available at no cost. We welcome your inquiries.

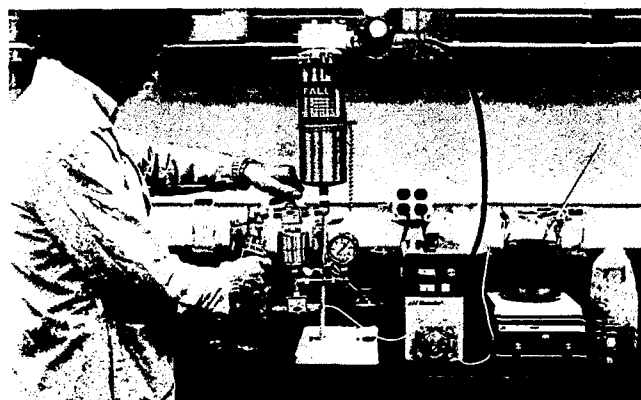
Sound Reasons for Selecting Pall

Because your selection of the proper filtration and solids separation equipment can be critical to ultimate success and economy of use, it makes sense to choose the most reliable, most experienced and the most proven source — Pall Corporation. Pall scientists and engineers are ready to help you with any problem; ready to assist you in finding the most effective, economical solution for your solids separation requirements, and ready to work with you on the specification and design of the filtration equipment for your particular application. Our start-up service and proper maintenance, helps to ensure Pall products will perform to their specifications for many trouble-free years.

Pall has proven itself and its products completely. Put that dependability and reputation to work in your process.



Pall custom built blowback filter test stand demonstrates performance of porous metal filters.



Technical help with fluid clarification problems is provided by Pall's Scientific and Laboratory Services Department (SLS).



Pall SLS laboratories are equipped with the most sophisticated analytical instruments. Shown is Scanning Electron Microscope.



Pall provides a series of scientific and technical seminars on fluid clarification.

For Additional Product Information, Technical Seminars, Scientific or Engineering Assistance, or for Application Recommendations, Contact:



Pall Process Filtration Company
A Division of Pall Trinity Micro Corporation
East Hills, New York 11548-1289
(516) 484-5400 • 1-(800)-645-6532
Telex: 968855 TWX: 510-223-0606
FAX: 516-484-5228

International offices and plants: Pall Corporation, East Hills, New York, USA; Pall Europe, Ltd., Portsmouth, England; Pall Filtrationstechnik GmbH, Frankfurt, Germany and Warsaw, Poland; Pall Industrie s.a., Paris, France; Pall Italia, s.r.l., Milan, Italy; Pall (Canada), Ltd., Toronto, Ontario; Nihon Pall, Ltd., Tokyo, Japan; Pall Industrial do Brasil, Ltda., São Paulo, Brazil; Pall Fluid Clarification Pte. Ltd., Singapore; Pall Filter Ges.m.b.H., Vienna, Austria; Pall (Schweiz) AG, Basel, Switzerland; Pall España S.A., Madrid, Spain. Distributors in most major industrial areas of the world.

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