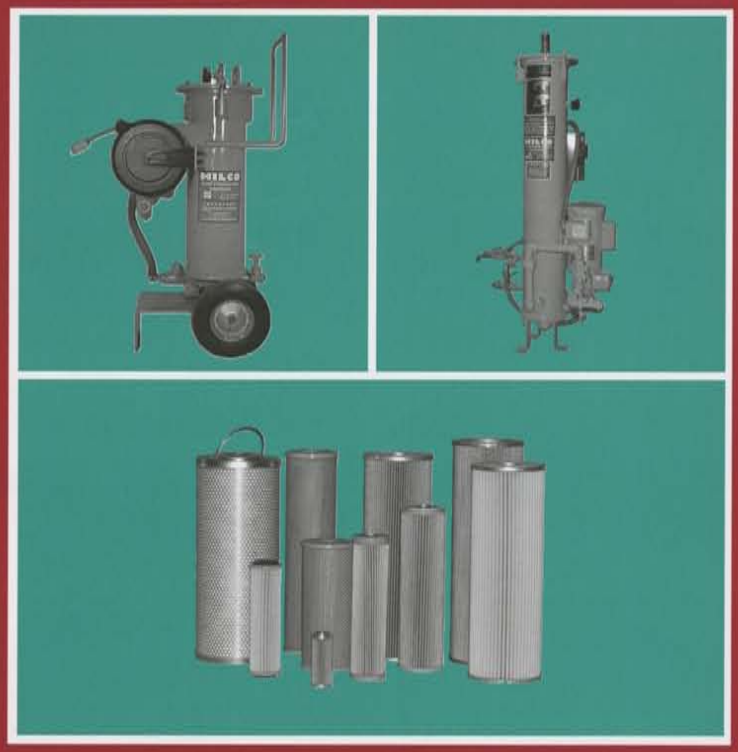
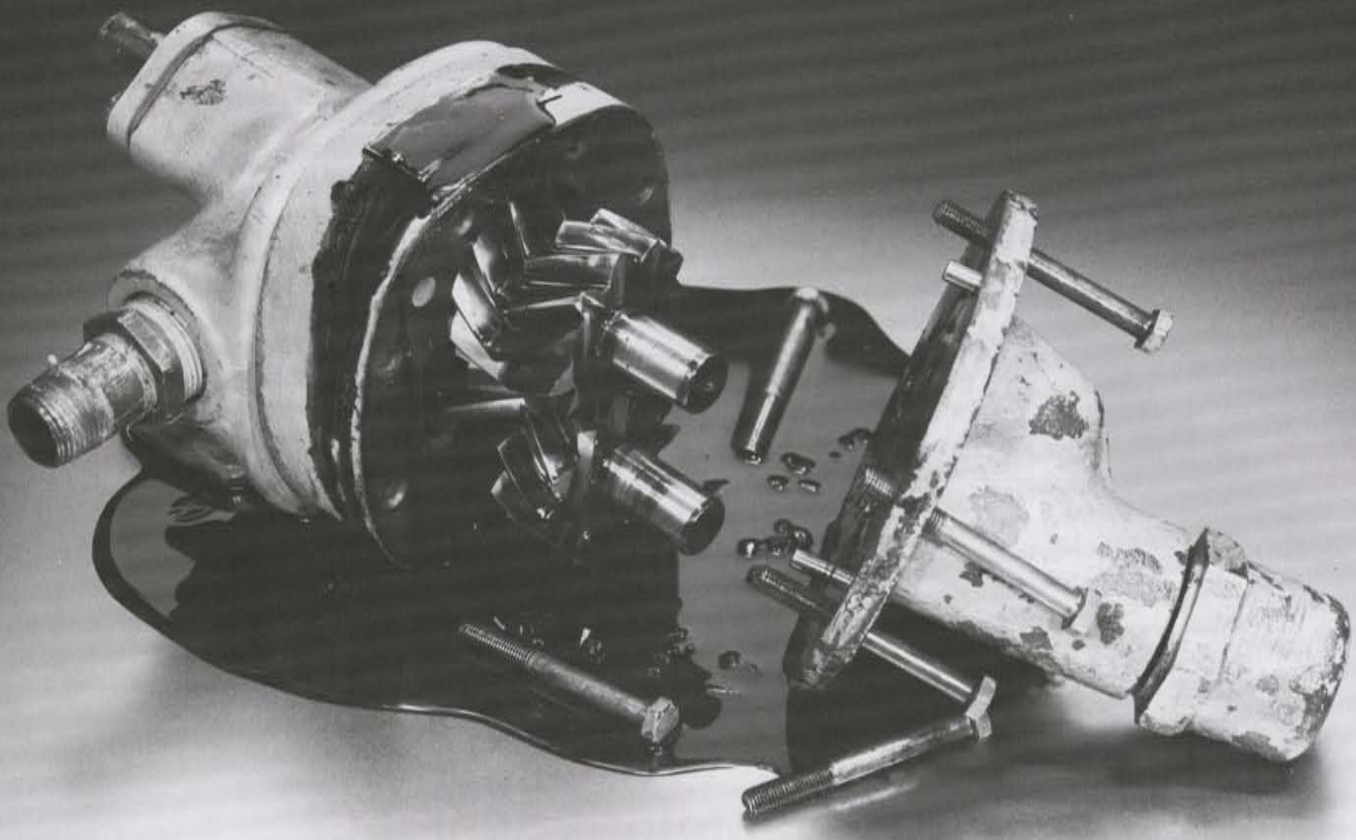
HYDRAULIC SYSTEMS PROTECTED. LONGER LIFE. LESS DOWN TIME.



Hilco® Filters, Reclaimers and Reclamation Systems for Oil Contaminating Control.

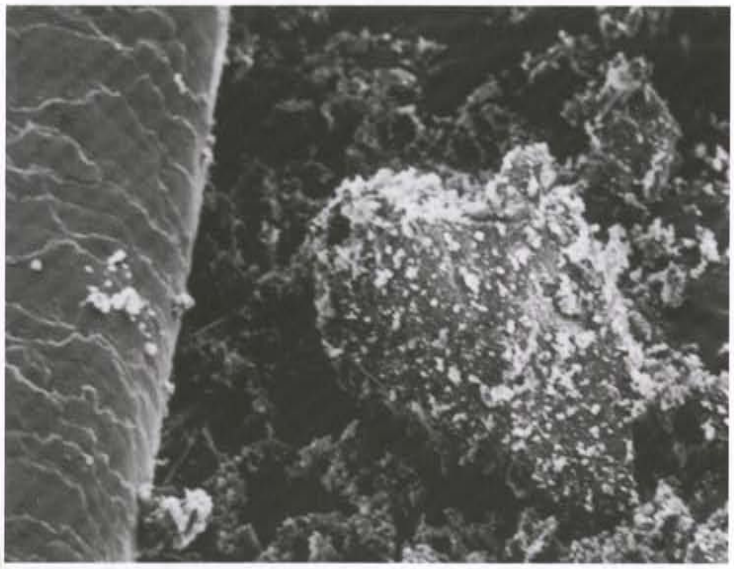
Hilliard

Murder Most Foul!



Today's high-performance hydraulic components are very expensive, and the price of the skilled labor required to replace them continues to escalate. But the biggest cost to the user in the event of system shutdown is **the downtime itself**—precious hours, days or weeks which cannot be replaced at **any** price.

This pump was killed by invisible contamination



These particles, photographed under 850X magnification, are only 0.5 to 70 micrometres in diameter, but can disable a hydraulic pump or control valve. The object that resembles a tree trunk at the left of the photograph is a human hair; the object adhering to it near the bottom is about 10 micrometres in diameter.

High-performance hydraulic equipment can easily be damaged or disabled by microscopic particles of contamination, some of them a **hundred times finer** than a human hair.

To meet demands for higher performance, higher working pressures and more precise action, tolerances and clearances in hydraulic-system components have become tighter and tighter. Today's pumps, valves and cylinders may have clearances as small as 0.5 micrometres—clearances so small that most **bacteria** can't pass through them!

These tightened clearances require finer finishes on component surfaces—surfaces that can be scored and eroded by contaminant particles, until degraded performance or even seizure shuts the system down.

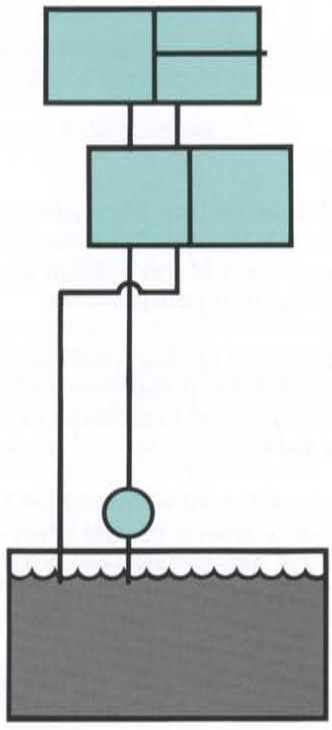
Contamination circulates in **every** hydraulic system, grinding away at components with every piston stroke and every pump revolution:

- Some is built into the system during manufacture: metal particles from machining, sand from casting cores or airborne dust and fibers.
- Some is introduced by new fluids when they are added to the system.
- Some is drawn in from the air, as cylinders reciprocate and reservoirs breathe.
- Some is ground out by the system itself.

No matter what the source, contamination circulating freely in your system leads to component wear, performance losses, even component failure. The inevitable result—time and money lost through downtime.

While the introduction of contamination into your system can't be avoided, it can be **controlled**.

Vital hydraulic-system components such as pumps, valves and cylinders must be protected from destructive contaminants if they are to perform to design capacity.



With modern contamination-control techniques, you can remove contaminants from your system **before** they have a chance to clog, grind and jam expensive components—for a good deal less than the cost of a new pump, or a contract lost because of equipment-failure delays.

By controlling **contamination** you also control **costs**: by eliminating unnecessary repairs, downtime, or the added expense of replacing components.

The next few pages will tell you how you can protect your hydraulic system by controlling contamination.

Filter locations determine filtration effectiveness

The interaction between a hydraulic system and its filter should be limited to the removal of contaminants from the fluid. The filter exists solely for the protection of the system, and should not interfere with normal system operation. Yet

1

Usually called a pump intake suction "filter," this is actually a fine, wire-mesh strainer placed downstream of the fluid reservoir and upstream of the system pump, on the intake (or suction) side of the system.

Contamination control in this location is difficult because the flow through the strainer must equal the full flow through the pump. Since any flow restriction may cause pump cavitation, a screen rated at 75 to 100 micrometres is used, through which the much finer particles that cause pump wear and valve jamming can easily pass.

Thus a strainer's protection consists solely of keeping large particles and chips from causing catastrophic pump-failure.

2

A full-flow, in-line, high-pressure filter, typically equipped with a 0.5 to 5.0 micrometre cartridge and placed downstream of the system pump and upstream of all other system components.

A filter in this location protects the system from the result of catastrophic pump failure and provides the fine filtration needed to protect valves and cylinders from pump wear particles.

But since it must withstand the full system flow and pressure, the filter vessel is usually small and expensive, and its cartridge has a limited dirt-holding capacity. The filter must be monitored closely and the cartridge changed frequently to avoid restriction of system flow, and possible collapse of the cartridge element. Filtration can take place only during system operation, and changing cartridges requires shutting the system down or bypassing the filter.

In addition, system pressure surges can release contaminants already captured by the cartridge, allowing these particles one more opportunity to pass through the system once again. A filter in this location can also allow air to be drawn into the system, which can cause spongy, imprecise action.

3

A low-pressure return-line filter, typically equipped with a 0.5 to 5.0 micrometre cartridge and placed in the return line between the last system component and the reservoir.

The contamination control provided here would be quite good, except for one serious drawback. This location is subject to the extreme flow surges generated by the cylinder and the valve which can release contaminant already trapped by the cartridge. Furthermore, a filter in this location provides filtration only during system operation.

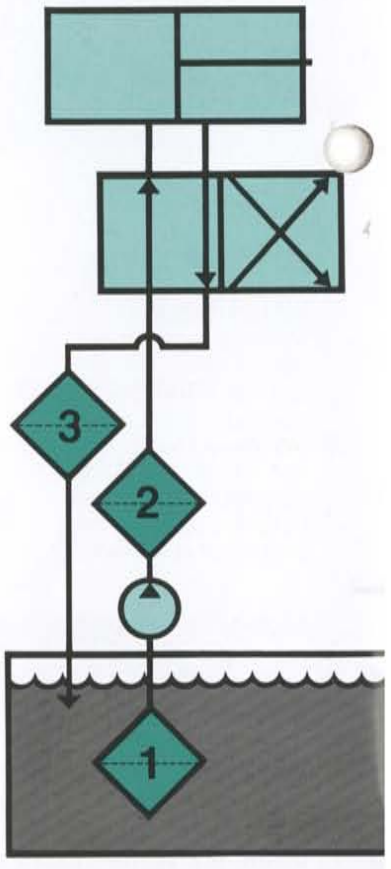


Figure 1. Hydraulic-system filters can be installed in any of these locations—but the effectiveness of filtration and its effect on system operation varies with the location.

normal operation includes surges, spikes and variations in flow and pressure. Filters cannot simply be mounted in any location that offers a convenient take-off point for the fluid—a proper balance must be struck.

Proper filter location can make a big difference in the effectiveness of contamination control and its effect on system operation. Figure 1. shows four possible locations for filters on a typical hydraulic circuit. Each location has its use, but some of them have serious operational drawbacks.

4

An off-line low-pressure filter, equipped with a 0.5 micrometre cartridge, mounted in a recirculating loop on the reservoir. Figure 2. shows this arrangement in detail.

A filter in this location avoids the problems caused by system flow and pressure surges by placing the filter on a separate loop, with its own constant-flow, low-pressure pump to recirculate fluid from the reservoir. This arrangement provides an ideal, steady-state environment for the filter by isolating it from system flow-and-pressure variations.

In addition, filtration in this location **cannot** impede system flow under **any** circumstances, because flow through the filter is provided by a separate pump, and is **totally independent** of system flow. Consequently, continuous filtration can be provided by recirculation on the reservoir **even when the hydraulic system is not in operation**.

More efficient contamination control can also be provided in this location, since very fine filtration can be achieved without any restriction on system flow. Since the system fluid ultimately passes through the filter many times, 0.5 micrometre cartridges in this location provide the highest possible level of fluid cleanliness.

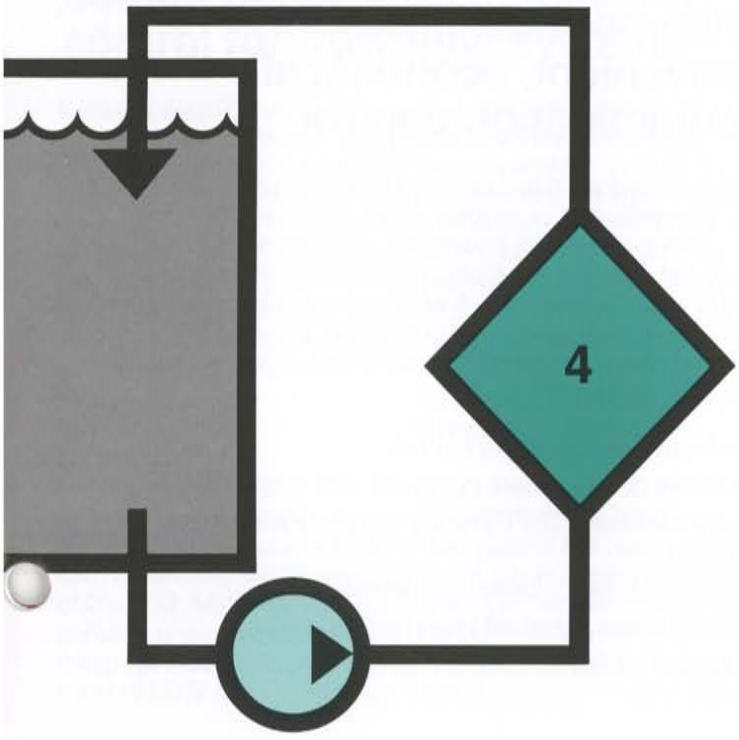


Figure 2. A filter installed on a low-pressure recirculation loop connected to the reservoir combines efficient contamination control independent of system operation with convenience of operation and service.

Besides providing the most efficient filtration, a recirculation loop allows other contamination-control and fluid-conditioning equipment, such as oil reclaimers or coolers, to be applied to the system. Any equipment installed on such a loop can readily be serviced without shutting down the hydraulic system.

A special case of the off-line loop is the use of self-contained portable filters and reclaimers. These portable units are equipped with pump sets and flexible inlet and outlet hoses which allow them to recirculate reservoir oil **without** a plumbing connection. Such an arrangement allows one piece of purification equipment to serve several hydraulic systems, minimizing the cost of contamination control while maximizing its effectiveness per dollar invested.

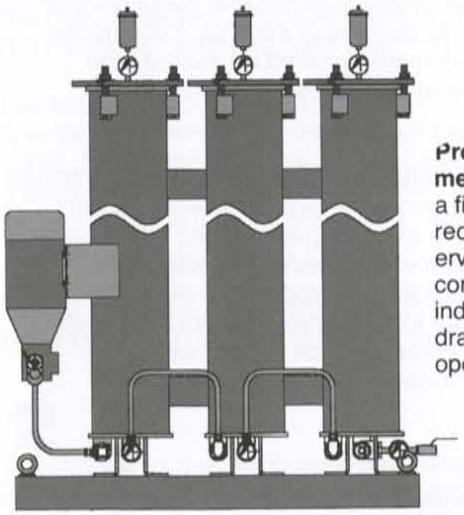
OPERATIONAL CHARACTERISTIC:	LOCATION: 1.	2.	3.	4.
Fine Filtration without Pump Cavitation		✓	✓	✓
Captures Particles before Exposure to Pump	✓		✓	✓
Low-Pressure Operation	✓		✓	✓
Cannot Introduce Air into System	✓		✓	✓
Cannot Impede System Pressure/Flow			✓	✓
Unaffected by System Flow Surges and Peaks				✓
Continuous Filtration, Independent of Hydraulic System Operation				✓
Can Be Serviced without Hydraulic System Shutdown			✓	✓
Suitable for Portable Filtration/Reclamation				✓

Table 1. compares the operational characteristics of devices in each of the four locations shown in Figures 1. and 2.

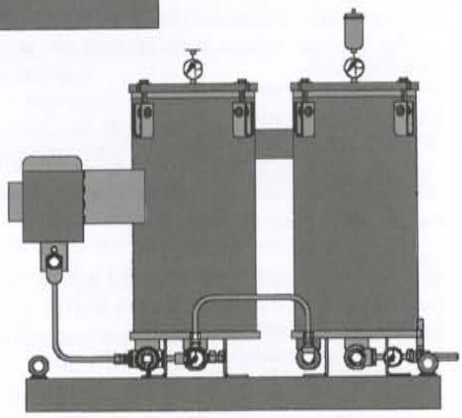
High-quality, reliable Hilco® contamination-control products

The efficient, convenient, system-independent contamination control made possible by the off-line loop also allows maximum flexibility in the choice of Hilco equipment for specific operational requirements.

Among the factors which must be considered in choosing contamination-control equipment are:



Protect your equipment investment with a filter mounted directly on the fluid reservoir, for continuous contamination control independent of hydraulic system operation.



Standard Hilco filters can solve your hydraulic filtration problem

Hilco offers 8 standard families of filters, and dozens of standard filter-cartridge combinations, for flow rates to 400 gallons per minute. One of these combinations can handle virtually **any** hydraulic filtration application.

Standard filter vessels can be chosen with:

- a variety of cartridge types, sizes and dirt-holding capacities, for application versatility
- duplex construction, for uninterrupted filtration during cartridge changeout
- stainless steel construction, for applications where rust or corrosion may cause problems
- ASME code construction, including "UM" and "U" stamps, for applications requiring certification
- screwed or flanged in/out connections in several sizes and configurations, for installation flexibility
- a variety of options and accessories, including special paint and gasket materials for fluid compatibility, special mounting styles, integral relief valves, and cover lifters

Off-line recirculation allows a Hilco filtration system, complete with pumpset, to be mounted directly on the reservoir of hydraulic equipment such as presses and machine tools. A range of filtration equipment capacities and configurations is available to suit virtually any size reservoir.

This arrangement is ideal when a common reservoir is used for several machines. Centralized contamination control offers reduced service and maintenance costs in addition to a high level of equipment protection.

Hilco portable filters for convenient, economical contamination control

If several hydraulic systems are widely separated, operate only intermittently, or employ small reservoirs, portable contamination-control equipment, equipped with hoses and pump set, may be the most cost-effective answer to contamination problems. A wide variety of Hilco equipment is available in completely self-contained, portable form, allowing one contamination-control unit to serve several pieces of equipment.

Standard portable filters feature:

- positive displacement pump set with relief valve
- fully-enclosed (TEFC) motor complete with starter and 15′ line cord
- steel base with rubber-tired wheels
- ability to use standard Hilco cartridges

In addition, many Hilco filters can be made portable on special order.

- **Cost,** including initial investment, operating costs and recovery of costs through payback.
- **Contaminant** type, size, ingression rate and system tolerance.
- **Duty cycle** of the system.
- **Space** availability and equipment access.

The interaction of these factors and their influence on system operation make each application's requirements unique, so Hilliard offers a wide variety of products for hydraulic-system use. Here are some off-line contamination-control approaches which have been successfully applied:

Water, acids and volatile contaminants can be removed from hydraulic fluid by Hilco reclaimers, portable reclaimers or reclaimer systems.

Hilco Oil Reclaimers... comprehensive contamination control for hydraulic systems

If your application involves oil with substantial amounts of water or volatile contaminants, an oil reclaimer may be the most cost-effective solution to your contamination problem. The addition of settling and clean-oil holding tanks, filters and controls converts the basic Hilco Oil Reclaimer into an extremely efficient reclamation system. The reclamation process uses a combination of filtration and vacuum distillation to purify the oil and return it to a like-new condition. Other contaminants best removed by this process include acids, solvents, dissolved gases – almost any volatile contaminant. Although most reclaimers are part of a permanently installed system, they can be made portable for the greatest flexibility in dealing with your application.

Hilliard offers 2 standard series of reclaimers and reclaimer systems, with capacities of 50 to 100 gallons per hour, which can reclaim in a "single pass" hydraulic oil containing a maximum of 2% H_2O. Many models are available as fully self-contained, portable units. In addition, Hilco Hyflow™ reclaimers, custom-designed and individually built to customer specifications, can meet virtually any set of design criteria.

Off-line loop on wheels: A single, cost-effective portable filtration system can provide contamination control for a number of hydraulic system locations.

Supplemental protection for other locations

A particular set of operating conditions may require contamination control in addition to that provided by the off-line loop. Examples include pressure-line filters for in-line protection of remotely mounted critical components, and reservoir air-breather filters to protect against ingestion of airborne contaminants in hostile atmospheres. Hilco products are available for these special applications, and Hilliard's applications specialists can advise and assist you in the selection of such equipment for supplementary locations.

An effective filter medium for your contamination problem

The preceding pages have detailed how the location of contamination-control equipment affects its performance. You've seen how the off-line loop allows maximum versatility in controlling hydraulic-system contamination problems, and how various types of equipment can be employed in this location regardless of the system's operational characteristics.

The key component in any contamination control system is the one that actually removes the contaminant from the fluid. In applications requiring a reclaimer, that key component is the vacuum vaporizer. But in the vast majority of applications contaminants are removed by filtration, and the key to filter performance is the filter medium. No matter how or where you use a filter in your hydraulic system, its performance hinges on the ability of the medium to deal with a specific contamination problem.

Media must not only do the contamination-removal job for which they are chosen, but must be compatible with the demanding operating conditions and costly specialized fluids commonly encountered in hydraulic applications. For example, our Hilite A cartridges were expressly formulated to meet compatibility demands of phosphate-ester fluids.

In addition, many types of contaminants besides solid particles can cause problems in hydraulic systems, and specialized media or methods may be necessary for controlling them. These non-particulate contaminants include:

- **Water,** which enters the system as vapor, causing rust and hydrolytic fluid breakdown and forming emulsions with system fluids
- **Acids,** which are formed from fluid breakdown and oxidation products, and can disable system components through corrosion
- **Air** and other gases, which enter the system through tiny leaks, and can degrade system performance and hasten fluid-breakdown

Because these contaminants often occur in combination with particulate contamination and with each other, in various proportions and concentrations, the choice of a contamination control system requires careful consideration of interactions between method, medium, contaminants, fluids and operational factors.

In addition to filters, Hilco offers one of the widest ranges of contamination-control products available anywhere, including special cartridge designs and paper formulations, **ab**sorbent and **ad**sorbent media, and a complete line of reclamation equipment with a choice of three different built-in filtration methods and media.

That's why we call the Hilco Division the "oil purification division" of The Hilliard Corporation—we deal in **total contamination control,** not just filtration.

Standard Hilco cartridges incorporate specialized filter media in a wide variety of sizes. One of them can solve your hydraulic-system contamination problem.

Efficient Hilco filter cartridges, for reliable, long-life contamination control

Hilliard offers 7 standard cartridge types for hydraulic applications, incorporating specialized media in each type, in a variety of sizes, filtration efficiencies and dirt-holding capacities. One of them is ideally suited to your hydraulic system contamination control needs.

Microgard™ cartridge: A three-layer pleated cartridge, with an outer, cellulose-paper element for coarse filtration, an intermediate, glass-paper layer for microfine filtration, and an inner cellulose-paper element for added support. Nominal 0.5 micrometre rating with Beta 10 of 1000 offers excellent protection for sensitive hydraulic components, especially when used in an off-line loop.

Safegard™ 3, 5 and 10 cartridges: Single-layer, pleated-cellulose-paper cartridges, offered in three filtration ratings. For economical use in less critical applications.

Efficiency ratings:

Safegard 3	$Beta_{30} = 75$
Safegard 5	$Beta_{40} = 75$
Safegard 10	$Beta_{60} = 75$

Hilsorb™ dryer cartridge: A specialized, absorbent cartridge for use where small amounts of water must be removed along with particulate contamination. Offers high efficiency with low pressure-drop. Hilsorb has an efficiency rating of up to a $Beta_5 = 75$ ($Beta_{10} = 1000$) depending upon the medium used.

Hilite™ cartridge: Hilite consists of low volatile grade, calcined fuller's earth, superior to ordinary earths because of its water resistance. Hilite cartridges effectively remove colloids, surfactants, dissolved paints and varnishes, metallic soap acids and other oxidation products from industrial oils. Hilite cartridges are economical and excellent for filtering inexpensive hydrocarbon base oils used in transformers and hydraulic systems.

Hilite A™ cartridge: A water-resistant adsorbent cartridge employing activated alumina as the medium, for super-adsorption of acids, other decomposition products and water from costly synthetic fluids. When used with phosphate-ester fluids, activated alumina will not form precipitates or gels which can interfere with equipment performance.

Since Hilite-A has two times the volmetric density of fuller's earth – and two to three times the acid neutralizing power by volume – it can be used in smaller quantities and still provide longer life. The result is less downtime for cartridge removal, less make-up fluid and less-frequent changeout.

Hilco performance is based on Hilco quality

The Hilliard Corporation has been a leading innovator in the field of oil purification and contamination control since 1925, when we built the first commercially-successful oil reclaimer.

Then as now, our policy has been to combine the highest quality with the most effective contamination control in the design and manufacture of every product.

Our standards are so rigid that we test **every** filter vessel at 150% of its maximum working pressure—whether or not it is subject to ASME Code approval—to ensure that all welds, joints and gaskets will perform properly under field conditions.

But **cartridge** design is the real key to filter performance. The same careful attention is paid to every facet of cartridge design, from the formulation of filtration media to the selection of adhesives and gasket materials.

Specially-formulated papers are individually developed to suit the application, in cooperation with specialized paper manufacturers, not chosen from standard filter-paper offerings. Formulations are constantly refined to incorporate the most effective combination of particle-separation efficiency, fluid compatibility and structural properties.

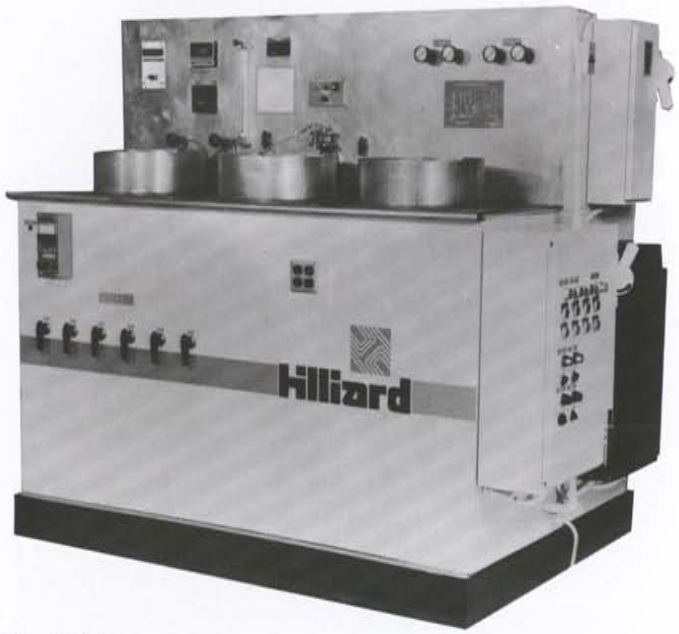
Controlled-radius pleats maximize filtration area and dirt-holding capacity, resist bunching, distortion and rupture. Sharp creases overstress fibers, causing cracks and bypassing. Our manufacturing process forms a larger radius outside, a smaller one inside for strong, uniformly nested pleats that won't pinch off under normal operating pressure drop.

Rugged plated steel center tube which can resist corrosion can withstand a pressure differential of up to 100 PSI—more than **three times** the working pressure which cartridges should ordinarily encounter—so it can't collapse and cut off oil flow to a critical component. Hole diameter and spacing are optimized for minimum flow restriction with maximum support to resist media extrusion and rupture.

Adhesives and gasket materials are selected and formulated for fluid and temperature compatibility under real-world operating conditions. A cartridge that can remove the tiniest particles is worse than useless if it disintegrates and floods your system with debris.

Safegard Pleated Paper Cartridge illustrates Hilco design features and quality construction

Innovation and improvement through research and testing



Hilliard's laboratory facilities for analysis and testing of fluids, contaminants and filtration materials includes the Multi-Pass test stand shown above, used for Beta ratio determinations (see explanation at right).

Hilliard also supports others engaged in research in the field of contamination control with membership and participation in such industry and professional groups as the National Fluid Power Association, the Fluid Power Society, the Worldwide Filtration Society, the American Society of Mechanical Engineers, and the American Society of Lubrication Engineers. Hilliard personnel hold and have held various offices and committee chairmanships in these organizations, and have presented many technical papers before their memberships.

Equally important is Hilliard's support of academic research, through unconditional grants-in-aid to such bodies as the Fluid Power Research Center at Oklahoma State University. The Center's director, Dr. E. C. Fitch, widely recognized as the foremost authority in the field of hydraulic-system contamination control, has been instrumental in the development and promulgation of test methods and standards for hydraulic filters. One of the most important of these is the "Beta Ratio" (sometimes called simply "filtration ratio"), which describes the efficiency of a cartridge in the removal of particles larger than a specified size (commonly 10 micrometres). Because the method measures actual particle counts upstream and downstream of the filter, the Beta ratio describes cartridge efficiency in terms of performance:

$$\text{Beta (x)} = \frac{\text{no. of particles} > \text{x micrometres upstream}}{\text{no. of particles} > \text{x micrometres downstream}}$$

Hilliard's leadership in the field of contamination control is built on a half-century of innovation which includes introduction of many original products and processes, some of which form the basis for today's standard and accepted practice. We've made an ongoing commitment to maintaining that position—a commitment reflected in our testing and research and development facilities, which are among the industry's finest.

Today, these facilities serve two functions. Their principal purpose is still the original one: the development of new products for better contamination control. But over the years, they have taken on a second role: testing of competitors' products against our own to ensure that Hilco contamination-control products continue to offer the best quality and performance available **anywhere.**

Information on levels of filtration protection required for specific hydraulic equipment should be obtainable from hydraulic system and component manufacturers. As the use of Beta ratios becomes more widespread, these levels are more and more commonly expressed as Beta requirements.

A filtration-ratio standard now used by some manufacturers for very sensitive hydraulic components is a $Beta_{10}$ of 1000, indicating a particle count downstream of the filter which is only 1/1000 of the count upstream (for particles 10 micrometres and larger). The Hilco Microgard cartridge meets this standard (see Beta graph), and in conjunction with the off-line bypass loop described on page 5 provides excellent protection for virtually any hydraulic system.

More than 50 years of applications-engineering expertise can solve your contamination problem

In the half-century that we've been in the business of solving fluid-contamination problems, we've seen just about every possible combination of fluids, contaminants and operating conditions. We've been making oil-purification equipment since the state-of-the-art used materials like shredded bark and cotton linters as filter media. We're constantly improving and refining our product line, and we're confident that our standard products can handle most of the applications we will encounter.

But if **your** application is special, **you** can feel confident that the Applications Engineers at Hilliard can solve your contamination problem. Often, a minor change to an existing Hilco product will enable it to fit the application. Sometimes a major change, or even a custom-designed system, is the only way to cope with an unusual problem. Whatever the circumstance, Hilliard Engineers can find the most efficient, economical solution to your problem.

Contact your Hilco representative or the Hilliard Corporation with your special needs, and receive the kind of expert consultation that has made Hilco products leaders in the field of oil purification since 1925.

The Hilco Division is a leader in the design and manufacture of high-quality oil filters, reclaimers and filtration and reclamation systems, with more than 50 years of experience in the field of oil purification.

Hilliard
HILCO DIVISION

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