TODD TECHNOLOGIES INC

How to Fight Contamination with Better Filtration Choices

By Todd Technology Inc.

How to Fight Contamination with Better Filtration Choices

Most of the wear that a machine endures during its lifespan comes by way of particle contamination. Through a machine's life, particles are ingested, generated, or built-in. But no matter how they get there, particles cause a variety of problems for lubricants and machines alike. Fortunately, by combining high-quality filtration with contamination exclusion tools such as desiccant breathers, it is possible to mitigate or avoid many problems that stem from particle contamination and reduce the total cost of machine ownership.

THE GROWING PROBLEM OF PARTICLE CONTAMINATION

A typical particle population growth lifecycle may look something like this: new oil arrives onsite and is stored unsealed; later, the oil is pumped with a dirty drum pump, then the oil, without being filtered, is transferred to a dirty top-up container; the oil is then poured through a dirty funnel into a machine that does not have a proper breather.

These are just a few of the ways that particles contaminate lubricants before they are even introduced to the machine system. But the good news is that if this story sounds familiar to you, you have a major opportunity to improve contamination control and decrease maintenance costs at your facility.

Contaminant Origins

There are three source categories when discussing solid particle contamination: built-in, ingested, and generated.

Built-in contaminants are contaminants created during the manufacture of servicing of a machine — this category also includes contaminants from new machine parts.

Manufacturing debris includes burrs, drill turnings, filings, machine swarf, and other such abrasives. Debris commonly enters a machine system during service and repairs through dirty hoses and fittings, unfiltered new oil, and contaminated top-up containers.

The solution to built-in contaminants is cleanliness. For example, new machines and parts should be flushed or cleaned thoroughly before use, and new oil should be filtered before it is applied to the machine system.

PowerGuard™ Element Performance

TTI's PowerGuard Element line brings together Dual Phase microglass media along with other key performance characteristics:

- 150 PSID collapse pressure
- 50 PSID change out recommended
- 250°F (121°C) maximum operating temperature
- Buna-N seals standard – replace B with V at end of part number for Viton/FKM seals
- Dual Phase, dual laminated microglass media reinforced with epoxy coated mesh

Machines that are not kept clean or that operate in dirty environments can ingest a significant amount of contaminants.

> "We were most amazed by the low particle counts produced after completion of our filtering process. We will definitely be utilizing TTI going forward for our filter needs."
>
> ***— Lubrication Specialist from Pilot Thomas Logistics***

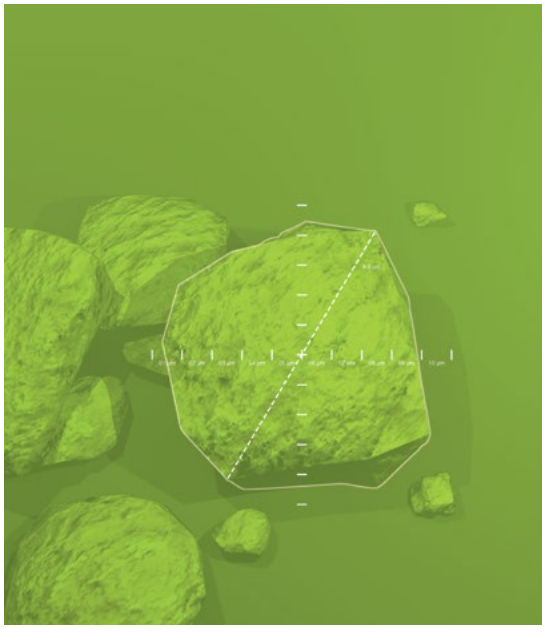
Ingested contaminants are contaminants that enter a machine during use or are ingested because of improper storage techniques. There are three categories of ingested contaminants:

- Process — These particles, typically byproducts of a machine's environment, include compressed air, ore dust, cement, and process chemicals.
- Atmosphere — Particles that enter the machine through a tank opening, seals, a breather, or other areas where outside air can enter the system. These particles can include quarry or foundry dust, slag, and mill scale.
- Combustion — These contaminants are created by the machine's functions and include soot, fly ash, and blow-by.

The solution to ingested contaminants is to configure machines for exclusion — this can be done using tools like desiccant breathers.

Generated contaminants are produced within a machine system during use — either from surface wear or oil degradation. Surface particles, such as hose fibers, filter fibers, paint chips, and break-in debris can be generated from mechanical and corrosive wear, cavitation, and exfoliation. The particles generated from the oil degradation process, such as oxidation, include sludge, varnish, coke, and oxide insolubles.

These contaminants are unavoidable but can be controlled through proper lubrication and filtration techniques.



DAMAGE CAUSED BY PARTICLE CONTAMINANTS

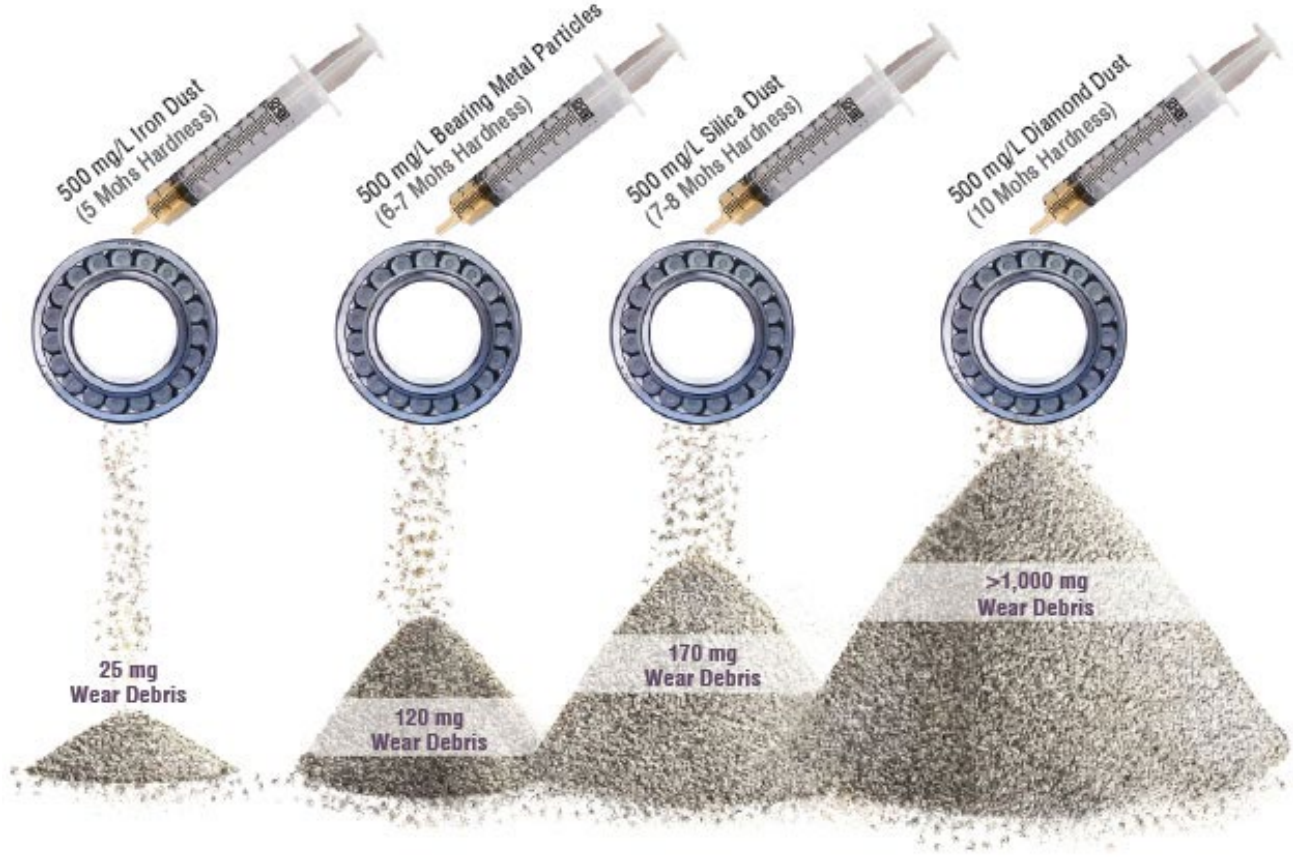
The primary cause of machine failure is the degradation of component surfaces — and the primary cause of surface degradation is particle contamination. The damage that a particle is capable of inflicting depends on two factors: the particle's size and the particle's hardness.

Size

A particle's size determines how much damage it can cause. Particle size is typically measured in microns (µ). The majority of machine damage is caused by particles between 3 and 10 microns in size, roughly the same size as the lubricating film. As a reference of scale, human hair has a thickness of about 80 µ, fine floor dust a size of 40 µ, and red blood cells typically measure in at 5 µ. When in-service lubricants are submitted to a particle count, smaller particles are generally present in greater numbers than larger particles.

Hardness

Some solid particles have higher compressive strengths than others; this strength, or hardness, influences the amount of damage a particle will cause. Particles with a high compressive strength cause more significant damage than softer particles. This damage is also influenced by the angularity of a particle, which refers to a particle's sharp edges. Dirt particles are particularly hard relative to machine surfaces and can be very crystalline in nature, thus having sharp edges.



Measuring the hardness of particles is generally achieved using one of three methods, all of which measure a material's strength through indentation or scratching: Mohs hardness, Rockwell hardness, and Vickers hardness.

- **Mohs hardness —** This scale, older than the other methods discussed, is primarily used by jewelers and those dealing with minerals. Mohs uses a scale of 1-10. Materials are tested against each other — materials that cause scratches receive a higher numeral value than the materials they scratch. Diamonds, because of their ability to scratch almost any material, are given the highest value (10). The Mohs scale is easy to interpret but lacks specificity, leading many tested materials to have a range of hardness (ex. The Mohs hardness of cast iron is 3-5).
- **Rockwell hardness —** This method has several scales. The test is performed on metals using a, typically diamond, indenting tip. A load is applied to the indenting tip, which transfers the load to the tested material. The depth of the indention formed is measured, and a number is determined for the tested material. The higher the number, the harder the material.
- **Vickers hardness —** This method, like the Rockwell scale, employs a diamond indenting tip. Instead of measuring the depth of the indention, the Vickers scale measures the force required to make the indention.

FILTERS

The goal of filtration is to achieve equilibrium — a state where the particle removal rate is equal to or exceeds the particle ingression rate. For filtration efforts to be effective, high-performance filters should be used. Additionally, timely filter servicing should be prioritized. Filters should be seen as an asset in your reliability or maintenance efforts, and choosing the right filter comes down to several key factors.

Factors for Proper Oil Filter Selection

Structural Integrity

Structural Integrity refers to a filter's ability to prevent oil from passing through an unfiltered flow path. The International Organization for Standardization (ISO) has created methods for testing fabrication integrity, flow fatigue, material compatibility, and other structural factors.

Contamination (Dirt-Holding) Capacity

A filter's contamination capacity is the amount of contamination that a filter can hold. Exceeding this limit hinders a filter's efficiency.

Pressure Loss

A filter's placement within a system can affect overall differential pressure. The filter's surface area and media porosity influence the degree of pressure loss.

Particle Capture Efficiency

The particle capture efficiency of a filter refers to its effectiveness in extracting and retaining oil contaminants.

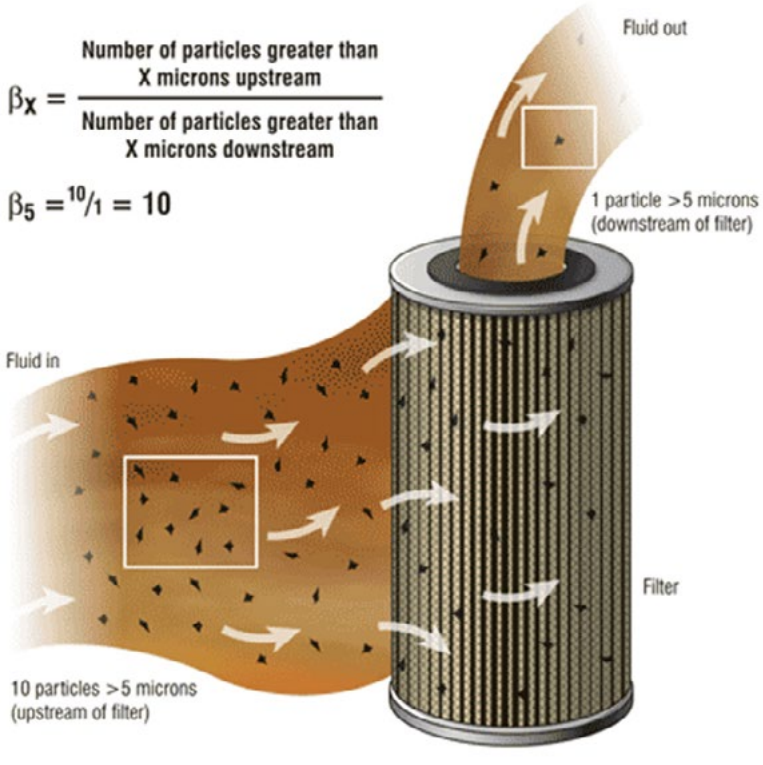
System/Environment

Flow rates, location, vibration, contamination expectations: these are all factors that influence performance and are produced by a filter's machine and environment; these factors should be considered when selecting a filter.

Best Practices for Oil Filter Usage

Storage — Proper filter storage and handling are essential. Improper storage can lead to filters failing before they are even introduced to a machine. Ensure that filters are kept clean, cool, and dry, and always follow the first-in/first-out rule.

Installation — Although filter installation may seem routine and straightforward, refer to the manufacturer's recommendations for proper procedures. Over-tightening is a common mistake. Confirm that connections, seals, and pathways are fitted appropriately and are free of contaminants.



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FINDING THE RIGHT FIT

Filters and filter housings are often designed to be interchangeable, but just because a filter fits does not mean it's the right filter for the job. The OEM's specifications should be referred to when choosing a filter, along with concerns related to the specific operating environment of your machine. One of the most important factors to consider is the filter's beta rating.

Beta Rating

Beta rating is the most prevalent filter rating in the industry. The Multipass Method for Evaluating Filtration Performance of a Fine Filter Element (ISO 16889:1999) is used to derive a filter's beta rating.

Beta Ratio (x = particle size in microns)	Efficiency
$\beta x = 2$	50.0%
$\beta x = 10$	90.0%
$\beta x = 20$	95.0%
$\beta x = 75$	98.7%
$\beta x = 200$	99.5%
$\beta x = 1,000$	99.9%

Table 1. Beta Ratios and Their Efficiency Percentage

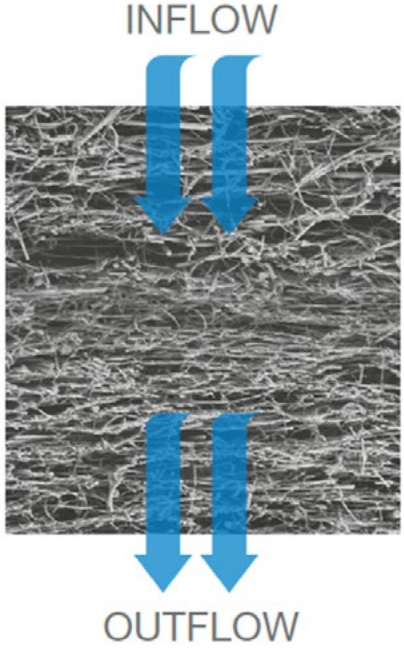
Contaminant Challenge (particles/ml)	Downstream Fluid Quality (particles/ml)	Beta Ratio	Percent Efficiency
1,000,000	500,00	2	50
	50,000	20	95
	13,000	75	98.7
	5,000	200	99.5
	1,000	1,000	99.9

Table 2. Effect of Filtration Ratio (Beta Ratio) on Downstream Fluid Cleanliness

Particle Counters

Particle counters are used to test a filter. These counters measure the size and quantity of particles upstream (before passing through the filter) and downstream (after passing through the filter). The upstream particle count is divided by the downstream count, resulting in the beta ratio.

It must be considered, when comparing filters, that beta ratios do not account for actual operating conditions. Filter performance can be influenced by factors like flow surges and temperature changes. Additionally, beta ratios do not indicate a filter's dirt-holding capacity or long-term stability. Beta ratios serve best as an indication of a filter's expected performance.



TTI's Dual Phase Filtration

TTI filters use Dual Phase filtration that delivers superior filtration efficiency and dirt holding capacity with a low pressure drop.

Pre-Filter Phase

Pre-filtration phase provides high dirt holding capacity for capturing larger particulates in fluids, extending the life of the filter element.

Final Retentive Phase

Fine denier fibers provide high efficiency polishing to remove the finest particulates.

FILTER FAILURE MODES

Channeling

Filter media passages can enlarge (typically due to high differential pressures) to a point where unfiltered oil can pass through without an efficient contaminant capture. Enlarged passages can also release particles that were previously captured by the filter.

Fatigue Cracks

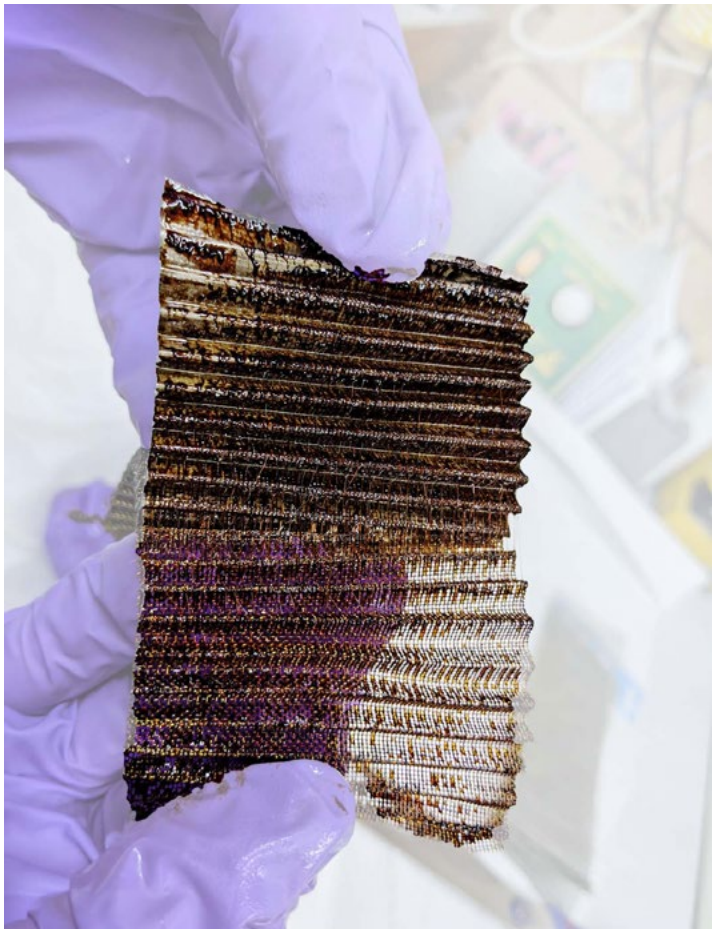
In cyclic flow conditions, cracks can form within the filter media, allowing a breach of oil to pass through unfiltered.

Media Migration

Inadequate fitting of a filter or improper placement of filter housing can generate damaging vibrations, deteriorating the filter media. Such deterioration leads to the production of new contaminants made of filter fibers and materials. Embrittlement from incompatible oils or extremely high differential pressures can also result in media disintegration.

Plugging

When a filter's dirt-holding capacity is exceeded, the filter media can become plugged, restricting oil flow. Excessive moisture, coolant, and products of oxidation (sludge and varnish) can also cause plugging.



TTI Filter Carts are ideal for small to mid-sized applications for mineral-based fluid filtration. Our lightweight, portable design offers an ideal solution for maintaining fluid cleanliness in facilities with multiple applications.

Standard Features

- Dial pressure gauges
- Pop-up filter replacement indicators
- Manual filter bypass
- Minimess® sample valve
- Y Strainer
- UL listed motor, and electricals
- 1" and 3/4" hoses

Customizable Features

- Fluid flow rate (2GPM, 5GPM, 10GPM)
- Hose connectors (ISO-A, ISO-B, MNPT)
- Filters (3µm, 6µm, 12µm, 25µm, Water Removal)

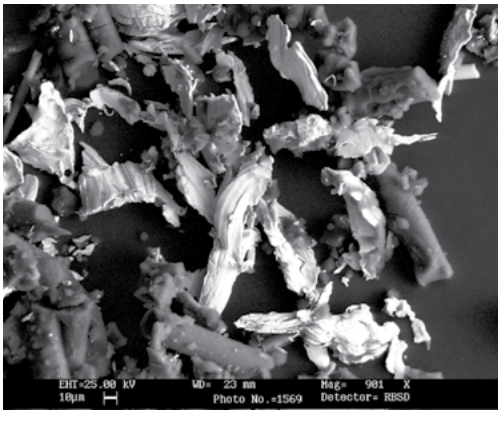
TTI PARTNERS WITH FILTRATION INDUSTRY LEADERS

TTI has partnered with Germany-based FG Industrial Filtration (Formerly Mahle) to produce the PowerGuard Element line. Together, we are leveraging over 58 years of German filter design and manufacturing expertise to supply world-class products for the North American marketplace. We have replicated FG Industrial manufacturing processes on-continent in our facility in Boulder, CO.

TTI has an exclusive media partner for all of our microglass. TTI has chosen this partner for its flagship Dual Phase media which we have made our standard for the entire TTI product line. The Dual Phase microglass media is produced on state-of-the-art automated wet laid production equipment, which offers unparalleled quality control and custom capabilities for hard-to-solve filtration applications.

> "Thank you again for the support that you have given. The filters have been working out great. We have begun using these filters in both filtration and dehydration machines with great satisfaction.
>
> My only wish is that we would have begun partnering sooner!"
>
> ***— Lubrication Specialist at Gaubert Oil***

Analyzing the Filter



Besides their ability to keep oil clean, filters can also be used to determine what is occurring within a machine system. Analysis of a filter's contamination contents can be used to determine why a machine is malfunctioning or be used to portend impending issues.

Typically, laboratory analysis is needed to determine problems based on a machine's filter. Occasionally, clues to an issue can be seen with the naked eye. Changes in oil appearance can be indicative of metal contamination, a suspicion that can be confirmed by cutting a filter open and using a strong magnet to extract metal particles, which can then be more easily identified. Metal contamination is a sign of more significant problems.

If a machine is experiencing problems, the filter should not be discarded; rather, it should be maintained in its removed condition and analyzed by the manufacturer or a laboratory. The filter is a bank vault of information that has been collected and stored through its service life.

Conclusion

As we've seen, filters are more than just a way to keep our lubricants cleaner; they protect our investments, not only in our oils and fluids, but in our machines themselves. Finding the right solution partner to deliver high-quality filters at a competitive price with quick turnaround times can make a major difference in day-to-day operations and long-term profitability. Choose a partner that understands your needs, so you can trust that your filters are optimally matched to your applications as well as your maintenance and reliability goals.

The TTI Difference

High Quality

Our product quality compares favorably vs all our competitors (large and small). Our desiccant line is directly interchangeable with industry leaders, and offers 20–25% greater performance.

Partnership

Our customers truly enjoy working with us. We are timely in our responses and do what we say that we will do, one of the many reasons we have yet to lose a customer.

Divers Product Offering

Our products range allows us to offer solutions to problem applications in a wide variety of industries.

Flexibility

We invite end users to bring us their most challenging applications. We have the ability and are willing to customize products to fit specific customer needs.

Superior Value

We offer excellent price points, coupled with our outstanding product performance making us the best overall value in the industry.

Exceptional Lead-Times

Typically a fraction of the competition. We measure in 1-3 days, our competition measures in weeks – this is extremely valuable.