

Vacuum Filters for Industrial Processing:

What You Need to Know to Select the Right Vacuum Cleaner



Vacuum cleaners are critical components of any industrial cleaning program. Depending on your industry, the right vacuum cleaner can help you:

- **Protect your workers** from exposure to hazardous substances, including silica dust and lead
- **Eliminate your risk** of a combustible dust explosion
- **Keep your products from becoming cross-contaminated** by microorganisms and allergens
- **Ensure you're in compliance** with both regulatory and industrial standards, like those issued by OSHA and the NFPA

For a vacuum cleaner to accomplish all of these things, it needs to have the right filtration system. After all, the filter is heart of the vacuum, responsible for capturing contaminants and other particles in the air and keeping them contained for safe disposal.

This ebook explains what filtration is, how it works, and the types of vacuum filters used for different types of industrial processing. The goal is to provide you with information you need to select the right vacuum cleaner for your application.

Table of Contents

What is Filtration? 2

Particle sizes
Principles of filtration

Types of Filtration 3

Multistage filtration
Mechanical filtration
Cyclonic filtration
Chemical filtration

Nilfisk Vacuum Filters 5

Paper bags
Main filters
Light industrial vacuums
Heavy industrial vacuums
Micro filters
HEPA filters
Upstream vs downstream filtration
ULPA filters
Special application filters

About Nilfisk 8



What is Filtration?

Simply speaking, filtration is the process of using a barrier to remove undesirable particles from the air or from a liquid.



You probably use a filter every morning when you make your coffee.

The holes in the mesh of the filter are smaller than the coffee grounds, which means your cup is filled with a delicious liquid rather than a glob of sludge.

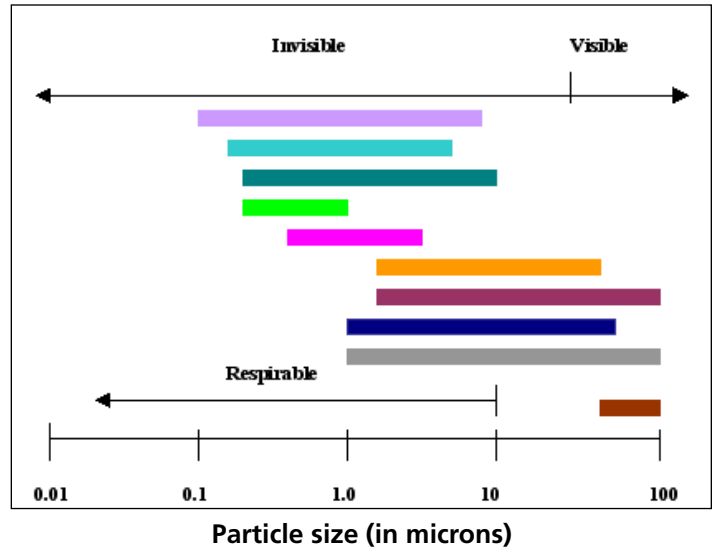
When you drive to work, you're using another type of filter -- the filter that cleans the air in your car to keep your engine running smoothly. And, of course, when you vacuum your home, it's the filter that collects all of the dirt and dust bunnies, usually into a small bag that you throw away.

The basics of vacuum filtration in an industrial context are the same. The main difference is that the dust or debris in a processing plant may be hazardous to your product, your facility, and even your employees' health. With stakes that high, there's no room for error. The filter in your vacuum cleaner must do its job right, every time.

Particle Sizes

The dust and debris in your facility isn't just hazardous, it's microscopic. And under the right circumstances, even the tiniest particles are capable of causing product contamination, creating explosion hazards, and wreaking respiratory havoc.

Particles that are 10 microns or smaller are considered respirable. That means we can breathe them in and they can settle deep into our lungs. Respirable particles make up more than 99% of the 7 million particles in every breath we take. So you can see how easy it is in an industrial environment for hazardous substances to cause health problems.



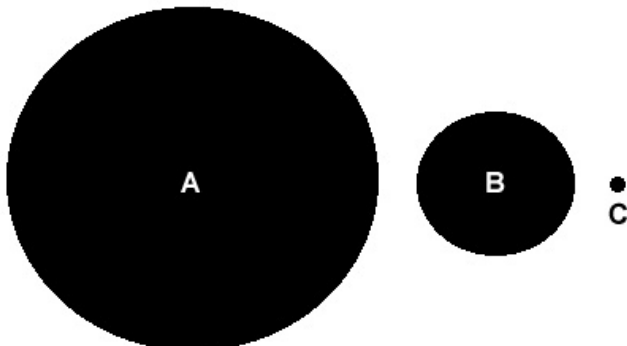
As an example, silica dust, which causes the lung disease, silicosis, is frequently found in human lungs in particles of between 0.5 and 0.7 microns. Even particles as small as 0.2 microns can have adverse health effects. Bacteria ranges from 0.35 to 10 microns, while mold ranges from 20 to 200 microns.

How big is a micron?

1 micron = 1/26,000 inch

50 microns = The smallest particle visible to the human eye

80 microns = The diameter of a human hair



If A is the diameter of a human hair (100 microns), then B is the size of the smallest particle visible to the human eye (50 microns), and C is the size of a 0.5-micron particle.

Principles of Filtration

Now that you understand a little more about the dust and debris hazards found in an industrial environment, let's look more closely at how the filter inside a vacuum cleaner works.

For particle filtration, the airborne particles that have been vacuumed must come in contact with the filter media. There are five basic mechanisms by which this can happen.

Mechanisms of Filtration

- **Straining:** Also known as screening, straining occurs when the fibers of the filter media are smaller than the particles. Thus, the particles are easily captured. (This is how your coffee filter works.)
- **Impaction:** This method is applicable to larger particles that have good momentum, but are too heavy to follow the airstream around the filter. Instead, they collide into the filter fibers and become captured.
- **Interception:** Smaller particles that can follow the airstream, yet come within a half-particle diameter of the fiber, are captured by the fiber via molecular surface attraction.
- **Diffusion:** Also called Brownian movement, diffusion works on the smallest particles, which don't have sufficient momentum to follow the airstream. Instead, they're bombarded by air molecules, which interrupt the particles' pathway, causing them to move about randomly. The irregular path of the particles increases their likelihood of being captured by the fibers of the filter. The smaller the particle, the stronger this effect.
- **Electrostatic enhancement:** This occurs when fibers have a permanent electrostatic charge. Since particles are attracted to the opposite charge, they gravitate toward the filter fibers, allowing the fibers to capture the particles.

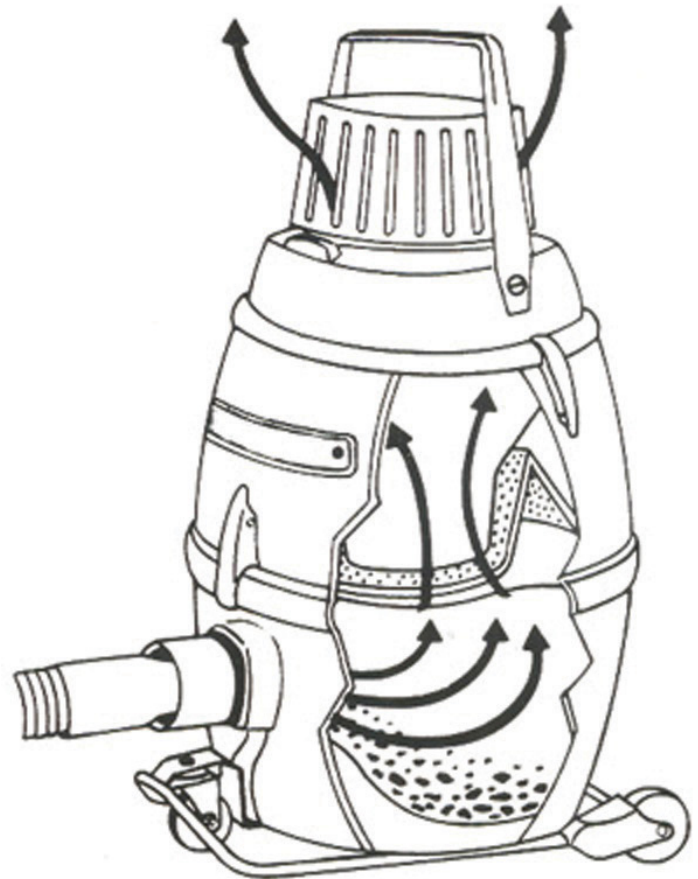
Types of Filtration

The previous section described the principles behind filtration. Here and in the next section, we look at how that filtration is accomplished.

Multi-Stage Filtration

Unlike your home vacuum cleaner, which probably has only one filter, all Nilfisk industrial vacuum cleaners have multi-stage filtration. This means the vacuum contains a series of progressively finer filters that capture increasingly smaller particles as the air travels through the system.

Multi-stage filtration not only provides superior efficiency, but also minimizes wear and tear on the motor, which extends the life of the equipment.



Nilfisk GM80 vacuum cleaner with multi-stage filtration

Mechanical Filtration

The most common type of filtration is mechanical. In this method, particles are captured and retained by a physical barrier, usually a filter made of cloth, polyethylene, or paper. (See the next section for different types of mechanical filters.)

When assessing a vacuum cleaner, keep in mind four factors that determine the performance of a mechanical filter.

Factors Affecting Mechanical Filtration

- **Particle size:** The smaller the particle, the more difficult to filter. Small particles can easily penetrate filter media that is too porous for the particulate.
- **Air speed, or velocity:** This is the pace at which particles move through the hose and into the vacuum cleaner. The faster the particles travel, the deeper they will penetrate the filter media. A particle traveling at a high speed may have the force to push through the pores of the filter material. However, a particle traveling at a slower speed is easier to capture on or between the fibers or weave of the filter media.
- **Filter media:** Filtering efficiency is affected by the relationship between the surface area of the filter media and the volume of air trying to pass through it. This relationship is known as the air-to-cloth (ATC) ratio. The lower the ATC, the more efficient the filtering system. Likewise, the higher the ATC, the less efficient the filtering system.

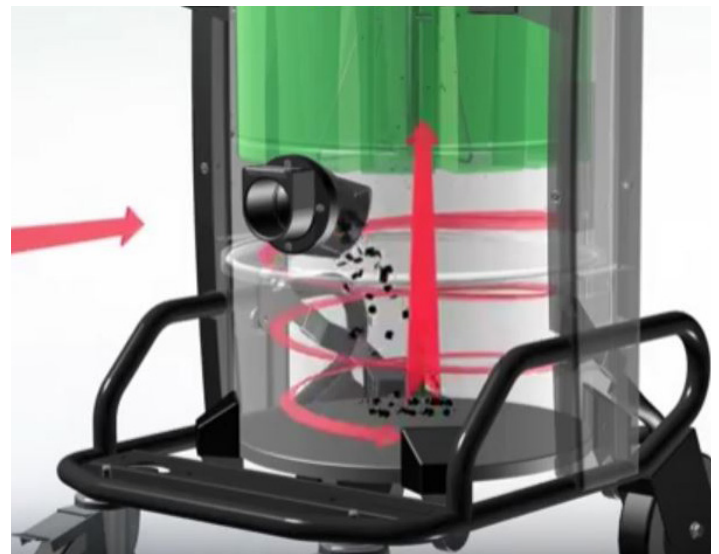
The larger the filter area, the more efficiently a vacuum cleaner filters because there's more area to trap particles and less frequent filter clogging. Small filters clog quickly and a large airflow through such a filter will cause the debris to penetrate the filters. The optimum condition is a slow airflow through a large filter.

- **Running time:** Over time, debris will build up on the surface of a filter and embed itself into the filter material. This clogging action is known as filter blinding, or loading. A filter is most efficient just before it clogs because the pores of the filter are smaller; therefore, it's a finer filter. However, performance of the vacuum cleaner does not increase because there is little or no airflow to lift and move the debris.

Cyclonic Filtration

In some vacuum cleaners, the first stage of filtration isn't mechanical, but cyclonic. In this system, air coming into the vacuum is deflected to the side and slightly downward. This creates a spinning column of air. The larger particles that can't keep up with the airstream fall to the bottom of the canister. The smaller particles travel toward the next stage of filtration, which usually is mechanical.

Cyclonic filtration also slows down the air before it reaches the first mechanical filter. As we mentioned above, slower-moving particles are easier to capture, so this step increases the overall efficiency of the filtration system.



Cyclonic filtration

Chemical Filtration

Finally, chemical filtration is used to filter gases or vapors, such as toxic mercury vapor. This process changes the physical characteristics of the toxic substance and then exhausts clean air back into the environment.

Nilfisk Vacuum Filters

By now, you should be feeling pretty confident that you get how vacuum filters work. In this section, we'll review the different types of mechanical filters that Nilfisk offers for industrial applications.

Paper Bags

Just like the filter in your vacuum at home, the first stage of mechanical filtration in many industrial vacuums is provided by a paper bag.

Nilfisk offers paper bag filters made of a two-ply material. The inner lining captures particles, while air passes through the outer cellulose layer. The paper bag will capture the bulk of large particles for easy collection and disposal. Particles smaller than 3 microns move through this standard paper bag toward the next filter. For dust-free disposal, the container can be lined with a disposable polyliner.

Main Filters

Recall that earlier we said larger filters are more efficient. That's a principle we put into action in every vacuum we make.

Nilfisk main filters are oversized by design to provide maximum surface area for filtering. The extra-large filtering surface, coupled with the vacuum's powerful suction, maintains a steady, even airflow, prolonging filter life and ensuring optimum vacuum performance.

We use different filters in vacuums for light versus heavy industrial applications, and also have specialty filters available.

Light Industrial Vacuums

Standard main filter: The standard main filter is an oversized, napped cotton filter. The napping of the cotton provides additional filtering area by furnishing depth to the filter.

Specialty main filters: Specialty filters come in two options.

- Gore-Tex® filters are non-stick, and their smooth PTFE membrane keeps fine dust particles from passing through the filter. Gore-Tex main filters are ideal for fine powder filtration and can be used in conjunction with Gore-Tex microfilters.

- AES Polycomposite filters are capable of achieving a high separation efficiency when removing particles from the airflow, while at the same time, maintaining a high airflow rate and low pressure. As a result, this filter provides a longer running time because less filter loading is occurring. This filter is excellent for abrasive particles, such as cement, steel, and lead, and can be combined with an AES Polycomposite microfilter.

Heavy Industrial Vacuums

Standard main filter: The standard main filter is polyester. The star-shaped pleats of the filter add surface area, which lowers the air-to-cloth (ATC) ratio and increases the efficiency of the filter.

Specialty main filters: This line features several specialty main filters.

- PVC Membrane filters are ideal for the collection of fine powders and are capable of quick release during purging.
- Anti-static main filters are ideal for environments where static electricity is a problem, such as environments that contain combustible dust.
- Nomex filters can withstand temperatures of up to 220°C, so they are used in applications in which the material being vacuumed is a higher than normal temperature, such as baking or hot oven applications.



Hot oven cleaning with Nilfisk S2 industrial vacuum equipped with a Nomex filter and hot oven accessory kit

Microfilters

The microfilter is an important part of the graduated filtration system of Nilfisk vacuums. Microfilters are available for Nilfisk light industrial vacuums.

- **Standard microfilter:** The standard felt microfilter fits over the bottom of the motor, protecting it and acting like a barrier to even bacteria-sized particles.
- **Specialty microfilters:** Gore-Tex microfilters can be used in conjunction with a Gore-Tex main filter, and AES Polycomposite microfilters can be used with an AES Polycomposite main filter.

HEPA Filters

The final stage of Nilfisk's multi-stage filtration is usually a HEPA (high efficiency particulate air) filter. HEPA filters are invaluable for industrial processing applications for many reasons:

- They remove the vast majority of potential contaminants
- They protect your workers and facilities from hazardous dust and debris.
- They help you keep in compliance with regulatory standards.

What many people don't realize is that HEPA isn't just a label that vacuum manufacturers can apply to their products. It's a designation that requires filters to be individually tested and verified that they are 99.97% efficient at trapping and retaining particles down to and including 0.3 microns.

Only certified HEPA filters will provide the efficiency you need and keep you in compliance with regulatory standards.

Filters labeled HEPA-type, HEPA-like, or something similar, are NOT certified.

A HEPA filter is required for collecting most toxic and hazardous dusts, like those found at industrial worksites. For example, OSHA's new silica dust rule identifies several conditions in which a vacuum with HEPA filtration is mandatory. And the FDA recommends HEPA filters for facilities that process refrigerated or frozen ready-to-eat (RF-RTE) foods.

Nilfisk-ALTO
Industrievvej 1, DK-9560 Hadsund

Alto Deutschland GmbH
Guido-Oberdorfer-Strasse 2-8
D - 89287 Bellenberg

Nilfisk

**Test Certificate
Prüfbescheinigung**

according to / nach
DIN EN/IEC 60335-2-69 A.3/AA.22.201.2
and / und
EN 1822-5 Hepa Filters and MIL-STD 282 Type: C

For Filter Element Type
Für Filterelement Typ **107400372**

Identification number of tested filter element:
Identifikationsnummer des geprüften
Filterelements: **43/09 0402**

**Result (filtration efficiency):
Prüfergebnis (Abscheidung):** **100,000%**
at / bei 0,3 µm DOP(DEHS)

The test showed compliance with the requirement.
Die Prüfung wurde erfolgreich bestanden.

The required filtration efficiency for Dust Class "H" has to exceed 99,995 %.
Für die Staubklasse "H" ist eine Abscheidung von mehr als 99,995 % erforderlich.

MAHLE
Industrial Filtration

Tested by: NICO.W
Prüfer:
Date: 22.10.2009
Datum:

Sample HEPA filter certificate

ULPA Filters

ULPA (ultra low penetration air) filters are used for applications that require even finer filtration. For example, ULPA filters are commonly used in cleanrooms because they are even more efficient than HEPA filters, to capture and retain the finest dust, preserving the integrity of the environment. ULPA filters can remove at least 99.999% of dust, bacteria, and any airborne particles down to 100 nanometers (0.1 microns).

Upstream vs. Downstream Filtration

Most of the filters defined so far are installed upstream of the motor. This protects the motor from excessive wear and tear, so it can maintain peak performance.

In Nilfisk's multi-stage filtration system, you'll often find an additional HEPA filter downstream of the motor. This filter ensures contaminant-free exhaust, so that contaminants collected by the vacuum aren't simply released back into the environment. For critical processing applications, a downstream HEPA filter is absolutely essential.

Special Filters

Finally, Nilfisk offers filters for specialized needs.

- **Conical cartridge filter:** With a particulate capture size of 4.0 microns, this filter is available in large, continuous duty vacuums. The conical shape makes the filter easy to clean using our PullClean and InfiniClean air systems. Because of this efficient cleaning, conical cartridge filters are ideal for collecting ultra-fine dusts. The filter is available in conductive PTFE material, suitable for residual amounts of water or solvents.
- **Porous polyethylene filter:** This type of filter is used in several Nilfisk wet/dry vacuums. Made up of microporous plastic material, this filter works especially well collecting liquids because the material is water-, mildew-, rot-, and corrosion-resistant. This filter features 105 filter “fingers” with pores arranged in a labyrinthine design that traps particles on the surface but also in its deep channels. This filter is completely washable and captures particles down to 1 micron in size.



Nilfisk VHW 421 industrial vacuum cleaner with conical cartridge filter

Filtration is a complex topic. But for industrial processors, it's critical to understand. The right vacuum cleaner can help ensure the continued safe and efficient operation of your plant. The wrong one could mean health and safety incidents, financial penalties, or worse.

Nilfisk is committed to helping you stay safe and compliant via an effective housekeeping program. Contact us to find the right vacuum for your application.

About Nilfisk Industrial Vacuums

Nilfisk Industrial Vacuums (Morgantown, PA), a division of Nilfisk, Inc., is one of the largest providers of cleaning equipment in North America. Equipped with exceptionally efficient filtration systems and user-friendly features, the company's vacuums play a critical role in thousands of manufacturing facilities and industrial processes across North America. Supported by a direct sales force and an extensive dealer network, Nilfisk Industrial Vacuums helps customers solve a variety of cleaning challenges, including combustible dust, general maintenance, overhead cleaning, abatement, process integration, laboratory/cleanroom control, and more.

Nilfisk, Inc. Industrial Vacuum Division

740 Hemlock Road, Suite 100
Morgantown, PA 19543
Phone: 1-800-645-3475
Web: www.NilfiskIndustrialVacuums.com
E-mail: questions@nilfisk.com