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Different types of filtration

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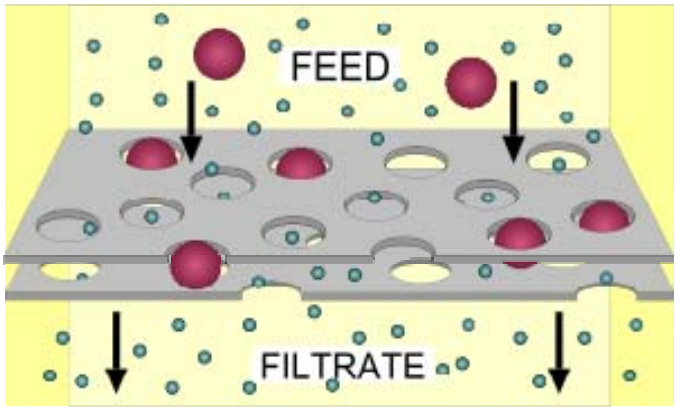
Abstract
Filtration is commonly the mechanical or physical operation which is used for the separation of solids from fluids (liquids or gases) by interposing a medium through which only the fluid can pass. The fluid that passes through is called the filtrate. Oversize solids in the fluid are retained, but the separation is not complete; solids will be contaminated with some fluid and filtrate will contain fine particles (depending on the pore size and filter thickness). Filtration is also used to describe some biological processes especially in water treatment and sewage treatment in which undesirable constituents are removed by absorption into a biological film grown on or in the filter medium as in slow sand filtration.

Keywords: Filtration, contaminated, thickness.

1. Introduction:
Filtration is an enormous issue when it comes to industrial vacuum cleaners. After all, if you take the time to vacuum an area, the last thing you want is the same material that you just vacuumed to be exhausted right back into the airstream. Depending on what you're collecting, the dust or debris may be hazardous to your product, or even your health. We, at Nilfisk CFM, realize the importance of ultra-efficient filtration systems and put our guarantee on every industrial vacuum cleaner we manufacture.

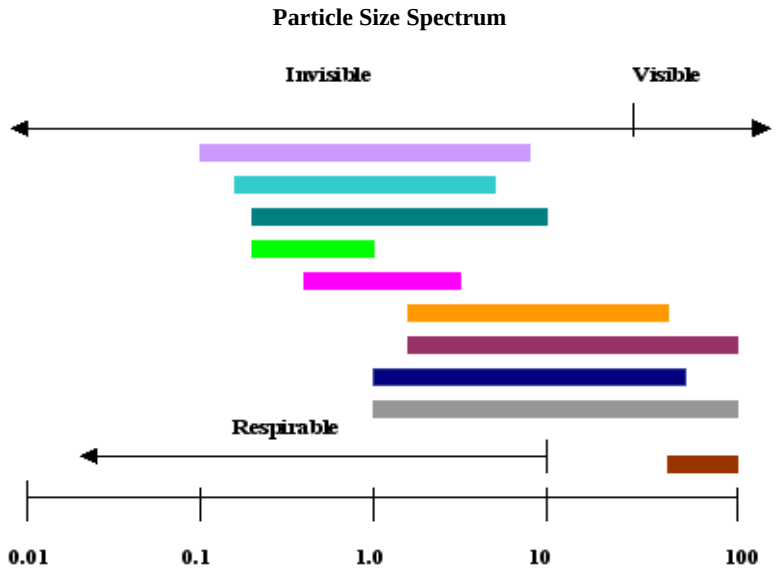


2. Particle Sizes
Small particles in the air, on the floor, and on your machinery can be dangerous for a number of reasons. Most importantly, they can contaminate your product and endanger your workers' health. Nilfisk and Nilfisk CFM industrial vacuum cleaners can filter down to 0.12 microns in size. One micron is equal to one-millionth of a meter, or 1/26,000 of an inch. On average, the human eye cannot see particles that are smaller than 50 to 60 microns. Particles that are 10 microns or less are considered respirable and can settle deep into the lungs – often causing adverse health effects. Respirable particles make up greater than 99% of the 7 million particles in every breath you take.

To give you a better idea of just how small a micron is, consider this: the diameter of a human hair is 80 to 100 microns in size.

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.

Nilfisk CFM industrial vacuum cleaners features filtration systems that are capable of filtering down to 0.12 microns!



3. Principles of Filtration

Now that you have an idea of the types of dust and debris our vacuum cleaners are capable of removing, we should explain how a filter 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: straining or screening, impaction, interception, diffusion, and electrostatic enhancement.

Straining, also known as screening, occurs when the spaces between the fibers of the filter media are smaller than the particles, therefore they are captured.

Impaction takes place when larger particles with adequate momentum are unable to follow the airstream around the fibers of the filter media and therefore collide into it and are captured.

Interception occurs when particles are small enough to follow the airstream, yet come within a half-particle diameter of the fiber. The particle is captured by the fiber by means of molecular surface attraction.

Diffusion, or the Brownian movement, takes place when small particles that don't have sufficient momentum because of their low mass are bombarded by air molecules, interrupting the particles' pathway, therefore causing them to move about randomly. The irregular path of the particle increases the likelihood of being captured by the fibers of the filter. The smaller the particle, the stronger this effect. Electrostatic Enhancement 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.

To ensure that your vacuum cleaner meets the dust control requirements for your specific cleaning application, Nilfisk-Advance America offers a complete line of filters. Each filter is designed to optimize the performance of your Nilfisk or CFM vacuum cleaner. They are ideal for the control of food ingredients, grains, ultra-fine pharmaceutical powders, powder paint, lead, asbestos, silica, pesticides, and other nuisance and hazardous dusts and debris. For critical environments, our filters meet clean room standards up to and including ISO 4 (Class 10) standards.

Nilfisk CFM's filters meet or exceed all standards for filtration efficiency. These filtration systems, including our HEPA (High Efficiency Particulate Air) and ULPA (Ultra Low Penetration Air) filters, can increase retention efficiencies up to 99.999% of particles, down to and including 0.12 microns in size.

4. Application of Filtration

- Filtration is used to separate particles and fluid in a suspension, where the fluid can be a liquid, a gas or a supercritical fluid. Depending on the application, either one or both of the components may be isolated.
- Filtration, as a physical operation is very important in chemistry for the separation of materials of different chemical composition. A solvent is chosen which dissolves one component, while not dissolving the other. By dissolving the mixture in the chosen solvent, one component will go into the solution and pass through the filter, while the other will be retained. This is one of the most important techniques used by chemists to purify compounds.
- Filtration is also important and widely used as one of the unit operations of chemical engineering. It may be simultaneously combined with other unit operations to process the feed stream, as in the biofilter, which is a combined filter and biological digestion device.
- Filtration differs from sieving, where separation occurs at a single perforated layer (a sieve). In sieving, particles that are too big to pass through the holes of the sieve are retained (see particle size distribution). In filtration, a multilayer lattice retains those particles that are unable to follow the tortuous channels of the filter. Oversize particles may form a cake layer on top of the filter and may also block the filter lattice, preventing the fluid phase from crossing the filter (blinding). Commercially, the term filter is applied to membranes where the separation lattice is so thin that the surface becomes the main zone of particle separation, even though these products might be described as sieves.
- Filtration differs from adsorption, where it is not the physical size of particles that causes separation but the effects of surface charge. Some adsorption devices containing activated charcoal and ion exchange resin are commercially called filters, although filtration is not their principal function.
- Filtration differs from removal of magnetic contaminants from fluids with magnets (typically lubrication oil,

coolants and fuel oils), because there is no filter medium. Commercial devices called "magnetic filters" are sold, but the name reflects their use, not their mode of operation.

5. Types of Filtration:

5.1 Mechanical Filtration: Many Nifisk and CFM vacuum cleaners utilize mechanical filtration. In mechanical filtration, particles are captured and retained by means of a physical barrier. Our vacuum cleaners accomplish this by a series of cloth, polyethylene and/or paper filters that cleanse the vacuum's working/intake air of particulate and exhaust clean air back into the surrounding environment.

5.2 Factors Affecting Mechanical Filtration

Four factors affect mechanical filtration of a substance in a vacuum cleaner: the particle size of the substance being collected, the air velocity or speed at which the substance is traveling, the filter media capturing the substance, and finally the running time or amount of time the filter has been used.

5.3 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.

Nilfisk and CFM filtration systems are designed to capture microscopic particles, down to and including 0.12 microns at 99.999% efficiency. This includes invisible particles that can adversely affect your product or enter your lungs and cause medical problems.

5.4 Air Speed

Air speed, or velocity, refers to the pace at which particles move though 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.

A vacuum cleaner naturally moves air at a high velocity, but in a relatively low volume. Nilfisk and CFM vacuums utilize cyclonic filtration which, combined with an oversized main filter, slows the air down as it enters the machine before impacting the filter. This enables a more efficient filtration system.

5.5 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 efficient a vacuum cleaner filters because there is 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. Designed with this in mind, Nilfisk and CFM vacuum cleaners are equipped with oversized main filters to lower the air-to-cloth ratio.

5.6 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 becoming a finer filter. However, performance of the vacuum cleaner does not increase because there is little or no airflow to lift and move debris.

5.7 Chemical Filtration

Several Nilfisk vacuum cleaners utilize the method of chemical filtration. Chemical filtration actually changes the physical characteristic of a gas or vapor. For example, Nilfisk mercury vacuums work on this type of filtration principle, adsorbing toxic mercury vapors and exhausting clean air into the environment. For more information on chemical filtration, and which Nilfisk vacuum cleaners utilize this method, contact your local Nilfisk Representative, or our Customer Service Department.

5.8 Multi-Stage Filtration

A multi-stage, oversized, graduated filtration system is built into ALL Nilfisk and CFM vacuum cleaners. This series of progressively finer filters capture increasingly smaller particles as the working air travels through the vacuum cleaner.

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