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Overview of industrial filtration technology and its applications

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Abstract

Filtration is a process where solid particles present in a suspension are separated from liquid or gas employing a porous medium. This article includes some advances in sintered metal filters, different types of filter media and their applications in various industries. Recent applications of ultra filtration and some advances in bag and belt filtration systems have also been discussed. This article also focuses on advantages of self cleaning filters over manual and mechanical cleaning. Thus, advances in filtration technology include the development of continuous processes to replace old batch process technology. Different self cleaning filters reduce product loss, required minimal operator intervention and improves flow consistency. Using programmable logic controllers in humidity ventilation and air conditioning system which often use sensors can cut installation and labor costs. On the global scale, we are surrounded by different filters. Thus by using latest filters and filter media it is possible to apply it in various food, starch and sugar industries, which reduces the time as well as give better quality products.

Keywords: filter media, ultra filtration, bag filtration, belt filtration, HVAC system.

Introduction

Filtration is a process whereby solid particles present in a suspension are separated from the liquid or gas employing a porous medium, which retains the solids but allows the fluid to pass through. When the proportion of solids in a liquid is less, the term clarification is used. It is a common operation which is widely employed in production of sterile products, bulk drugs, and in liquid oral formulation. The suspension to be filtered is known as slurry. The porous medium used to retain the solids is known as filter medium. The accumulated solids on the filter are referred as filter cake & the clear liquid passing through the filter is filtrate. The pores of the filter medium are smaller than the size of particles to be separated. Filter medium like filter paper or muslin cloth is placed on a support. When feed is passed over the filter medium, the fluid flows through the filter medium by virtue of a pressure differential across the filter. Gravity is acting on the liquid column. Therefore, solids are trapped on the surface of the filter medium. After a particular point of time, the resistance offered by the filter cake is high that stops the filtration (Sambhamurthy, 2005).

Types of filtration

Based on the mechanism, three types of the filtration are known.

Surface filtration: It is a screening action by which pores or holes of the medium prevent the passage of solids. The mechanisms, straining and impingement are responsible for surface filtration. For this purpose, plates with holes or woven sieves are used. Example is cellulose membrane filter (Matteson, 1987).

Depth filtration: This filtration mechanism retains particulate matter not only on the surface but also at the inside of the filter. This is aided by the mechanism entanglement. It is extensively used for clarification. Examples are ceramic filters and sintered filters (Stephan, 2003).

Advances in sintered metal filters (Mottcorp, 1999):

- Filtration technology utilizing sintered metal media provides excellent performance for separation of particulate matter. Sintered metal filter media are widely used in the chemical process, petrochemical and power generation industries.
- Advances in filtration technology include the development of continuous processes to replace old batch process technology. Liquid/solids filtration using conventional leaf filters is messy and hazardous to clean and require extended re-circulation time to obtain clean product. Traditional gas/solids separation systems such as cyclones, Electro static precipitators and disposable filters are being replaced by sintered fiber metal filtration systems.
- Sintered metal filters should be operated within the design parameters to prevent premature blinding of the media due to fluctuations in process operations. Use of flow control assures the filter will not be impacted with a high flow excursion. Filter efficiency increases as the filter cake forms. The cake becomes the filter media and the porous media acts as a septum to retain the filter cake. Filter cakes can be effectively washed in-situ and backwashed from the filter housing. A gas assisted pneumatic hydropulse backwash has proven to be the most effective cleaning method for sintered porous metal filters.
- Sintered metal filters can be fully automated to eliminate operator exposure and lower labour costs while providing reliable, efficient operation.

Case study of depth filtration (Carey, 2008):

Several forces have driven changes in filtration technology during the last couple of decades, including environmental concerns, the health and safety of winery workers, and wine quality. The major active component in traditional depth filtration is diatomaceous earth, which has several major problems. First, it is difficult to dispose of because it does not decompose. Second, it can cause symptoms similar to coal miners' "black lung" disease when inhaled over long periods of time. In the United States this problem can be overcome by using cross flow filtration. The main benefit of cross flow filtration is that it uses a membrane with an absolute pore size to clarify wine without the need for media to act as the sieve for removal of particles from wine.

Example of cross flow filtration

- Nanofiltration is a recent membrane filtration process used most often with low total dissolved solids water, with the purpose of softening and removal of disinfection by-product precursors such as natural organic matter and synthetic organic matter.
- It is a cross-flow filtration technology which ranges somewhere between ultra filtration and reverse osmosis. The nominal pore size of the membrane is typically below 1 nanometer, thus Nanofiltration. Nanofilter membranes are typically rated by molecular weight cut-off rather than nominal pore size. The transmembrane pressure required is considerably lower than the one used for RO, reducing the operating cost significantly. However, NF membranes are still subject to scaling and fouling and often modifiers such as anti-scalants are required for use (Hillie, 2007).

Ultra filtration: Ultra filtration is a pressure-driven membrane transport process that has been applied, on both the laboratory and industrial scale. Ultra filtration is a separation technique of choice because labile streams of biopolymers (proteins, nucleic acids & carbohydrates) can be processed economically, even on a large scale, without the use of high temperatures, solvents, etc. Shear denaturation can be minimized by the use of low-shear (e.g., positive displacement) pumps (Goldsmith *et al.,* 1974).

Following types of ultra filtration membranes are used prominently (Smolders, 1980):

- Asymmetric skinned membranes made from synthetic polymers by the "phase-inversion" methods.
- Inorganic membranes, utilizing inorganic porous supports and inorganic colloids, such as ZrC^{*2} or alumina with appropriate binders.
- Melt-spun, "thermal inversion" membranes.
- "Composite" and "dynamic" membranes with selective layers formed in situ.

Recent & developing application of ultra filtration

- Ultra filtration is becoming a powerful separation tool for the rapidly growing biotechnology industry. Examples are cell harvesting, depyrogenation of injectable drugs, and enzyme purification.
- Ultra filtration offers some important advantages over centrifugation for harvesting of bacteria; the asymmetric character of ultra filtration membranes renders them less prone to clogging by cells and debris than micro porous filters.
- Plasma product processing is another promising application of ultra filtration. When human plasma is fractionated by the Cohn process or some new methods, a need arises for concentration of the important protein fractions (albumin & globulins) or for removal of alcohol and salt from these fractions. This can be conveniently accomplished by ultrafiltration.
- Production of a new generation of miniaturized computer microchips has created very stiff acceptance criteria for minimum tolerable particle size in the so-called ultra pure water used in rinsing operations. Thus, increased use of ultra filtration for production of ultra pure water in the computer and electronics industry.

Cake filtration: By this filtration mechanism, the cake accumulated on the surface of the filter is itself used as a filter. A filter consists of a coarse woven cloth through which a concentrated suspension of rigid particles is passed so that they bridge the holes and form a bed. Example is cake made from diatomite. This cake can remove sub micrometer colloidal particles with high efficiency.

Theory of filtration

Depending on dispersing medium filtration is divided in two parts: 1) gas filtration and 2) liquid filtration.

Gas filtration theory

It mainly includes filtration of aerosols and lyosols. Membrane filters and nucleopore filters are based on these below mechanisms.

Mechanism of gas filtration (Wilson & Cavanagh, 1969)

Diffusion deposition: The trajectories of individual small particles do not coincide with the streamlines of the fluid because of Brownian motion. With decreasing particle size the intensity of Brownian motion increases and, as a consequence, so does the intensity of diffusion deposition.

Direct interception: This mechanism involves the finite size of particles. A particle is intercepted as it approaches the collecting surface to a distance equal to its radius. A special case of this mechanism is the so-called sieve effect, or sieve mechanism.

Inertial deposition: The presence of a body in the flowing fluid results in a curvature of the streamlines in the neighbourhood of the body. Because of their inertia, the individual particles do not follow the curved streamlines but are projected against the body and may deposit there. It is obvious that the intensity of this mechanism increases with increasing particle size and velocity of flow.

Gravitational deposition: Individual particles have a certain sedimentation velocity due to gravity. As a consequence, the particles deviate from the streamlines of the fluid and, owing to this deviation; the particles may touch a fiber.

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Electrostatic deposition: Both the particles and the fibers in the filter may carry electric charges. Deposition of particles on the fibers may take place because of the forces acting between charges or induced forces.

Liquid filtration theory (Melia & Weber, 1972)

The term solid-liquid filtration covers all processes in which a liquid containing suspended solid is freed of some or the entire solid when the suspension is drawn through a porous medium.

Kozeny-Carman equation:

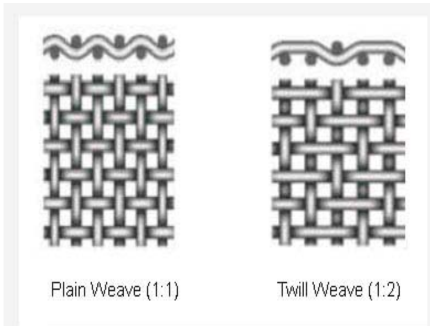
$$\frac{1.dv}{A.dt}=\frac{\Delta P}{r\mu(l+L)} \quad (1)$$

Where, A = filter area; V = total volume of filtrate delivered; t = filtration time; ΔP = pressure drop across cake and medium; r = specific cake resistance; μ = filtrate viscosity; l = cake thickness;
L = thickness of cake equivalent to medium resistance.

Table 1. Minimum cake thickness for discharge (Andrew et al., 2002).

Filter type	Minimum design thickness
Belt	3.0-5.0
Roll discharge	1.0
Standard scraper	6.5
Coil	3.0-5.0
String discharge	6.5
Horizontal belt	3.0-5.0
Horizontal table	19.0

Fig. 1. Plain & twill weave monofilament.



Limitations of Kozeny-Carman equation (Chowdiah et al., 1981)

This equation does not take into account of the fact that depth of the granular bed is lesser than the actual path traversed by the fluid. The actual path is not straight throughout the bed, but it is sinuous or tortuous.

Poiseulle's law: This Law considered that filtration is similar to the streamline flow of a liquid under pressure through capillaries.

$$\frac{1.A}{dv.dt}=\frac{\Delta P}{\mu(R_M+R_C)} \quad (2)$$

Cake resistance:

$$RM=\frac{\alpha W}{A} \quad (3)$$

Specific cake resistance

$\alpha=\alpha'\Delta P^{s}$ (4)

The filter resistance is much less than the cake resistance.

Rc
<<
Rm

$$\frac{1.A}{dv.dt}=\frac{\Delta P}{\mu(\alpha'\Delta PSWA)} \quad (5)$$

Where,
V=Filtrate volume; A= Filter area; t=Time; ΔP=Pressure driving force; μ=Broth viscosity
W=Mass of filter cake; R=Resistance; α=Specific cake resistance; S= Compressibility factor.

Filter media (Subramanyam et al., 2005)

The filter medium acts as a mechanical support for the filter cake and it is responsible for the collection of solids. Minimum cake thickness of discharge for different types of filter is presented in Table 1.

Materials used as filter media (Rushton, 2008)

Different types of materials used as filter media are presented in Table 2.

Woven materials such as felts or cloths: woven material is made of wool, cotton, silk & synthetic fibers etc. are used. Synthetic fibers have greater chemical resistance than wool or cotton. The choice of fiber also depends on the physical state & chemical constitution of the slurry. It includes mainly of two types.

Monofilament woven cloth (Fig.1): The yarns of a monofilament fabric are not only impermeable but also fairly smooth and cylindrical. Orifice analogy and drag theory approaches have been the most successful in predicting the resistance of these materials to fluid flow.

Multifilament woven cloth: The chief difficulty encountered when dealing with multifilament media is the highly complex geometry of the fibers and yarns that make up the cloth. Even in a fabric of apparently simple weave and construction, such as a plain-weave, continuous-filament cloth, some of the flow takes place in the highly tortuous channels present in the yarns (Wardsworth, 2007).

Perforated sheet metal: stainless steel plates have pores which act as channels as in case of Meta filter.

Bed of granular solid built up on a supporting medium: examples of granular solids are gravel, sand, asbestos, paper, pulp & kieselguhr.

Prefabricated porous solid unit: sintered glass, sintered metal, earthenware and porous plastics are material used for fabrication.

Membrane filter media: it includes surface & depth type of cartridges.

Criteria for choice of filter medium (Purchas, 2000)

There are three criteria for choice of filter medium.

1. Size of particle retained by the medium.
2. The permeability of the clean medium.
3. The solid holding capacity of the medium and the resistance to fluid flow of the used medium.

Measurement of pore size & particle retention (Lach & Wright, 2004):

In some cases, the desirable component in the slurry is the liquid, which may be required in clarified form e.g., beverage filtration; here the choice of deep-bed elements of precoated candles of large solids-holding capacity may

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Table 2. Type of filter media, characteristics and their application.

Type of filter media	Characteristics	Application	References
Metal fiber media (non-woven metal fiber)	Excellent durability, corrosion & abrasion resistance	Polymer & gas industry	Wardsworth (2007)
Multilayer sintered mesh	It can be reused	Gas industry	Wardsworth (2007)
Stainless steel (plain, twill & Dutch type)	Water proof inside & plastic woven cloth outside	Oil, chemical, food, pharmaceutical & aviation industry	Hunt (2001)
Anthracite filter media	It has high efficiency	Water purification	Hunt (2001)
Filter media treated by graphite	Made up of fiberglass	Used in cement & steel industry. Used as filter cloth for air filter	Wardsworth (2007)
Activated carbon fabric (non-woven type)	Little air current resistance, strong strength	Used in air conditioner as auto air filter or carbon air filter	Wardsworth (2007)
Biocell	High biological activity	Sanitary sewage& industrial waste processing	Hunt (2001)
Aramide filter fabric	Easiness of cake peeling, high stability, anti-distortion	Used in ore dressing, chemical & brewing industry, equipped in filter presses, vacuum filters etc.	Hunt (2001)
Autoroll filter media	It has metal structure, saves energy & work stably	Used in air filtrate	Hunt (2001)
Laminating PTFE membrane	Felt type of filter	Used in cement company & incineration fields	Hunt (2001)
Air filter	Pocket type of filter	Air conditioner & electronic industry, food industry, applied to the pre-filtration of coarse efficiency	Hunt (2001)

be indicated. While, where the solids are valuable, a sieve like mechanism is favored, so that information about the pore size of the medium may be of more direct use in media selection. The pore structure of the medium will determine the feasibility of a separation.

The pore size of a medium particularly for filters of the edge, simple wire or monofilament type is of use in deciding the upper limit of aperture size required by a particular process. In filters composed of random fibers, sintered or porous elements, staple or natural fiber cloths, the mean pore size will have less significance and use in predicting media behaviour. In certain cases, the geometry of septum allows direct measurement of aperture or pore size. In random situation, where complex weave pattern produce a distribution of pore sizes, such as a bubble point test or a permeability test are used.

Filter aids: It forms a surface deposit which screens out the solids and also prevents the plugging of the supporting filter medium. They are also used as filter media in recoat filtration. Some of the properties of filter aid material are presented in Table 3. The ideal characteristics of filter aid materials are chemically inert to the liquid being filtered & free from impurities, low specific gravity (so that filter aids remain suspended in liquid), porous rather than dense (so that previous cake can be formed) and recoverable (Hunt, 2001).

Filtration equipments: Different forms of equipment are employed for filtration. The factors which should be considered, while selecting the equipment and operating conditions are given below.

Equipment selection is done on the basis of Shirato (1978): Material related: Properties of the fluid: viscosity; Nature of the solids: particle size, shape, size distribution etc; Concentration of solids in suspension; Quantity of material to be handled.

Equipment & process related: Flow rate; the limit to size of particles passing through the filter should be known; It should be sterilized by heat, radiation or gas; It should be economical.

Belt filter: The belt filter is an industrial machine, used for solid/liquid separation processes, particularly the dewatering of sludge's in the chemical industry, mining and water treatment. The process of filtration is primarily obtained by passing a pair of filtering cloths and belts through a system of rollers (Fig. 2).

Operation: The feed sludge to be dewatered is introduced from a hopper between two filter cloths (supported by perforated belts) which pass through a convoluted arrangement of rollers. As the belts are fed through the rollers, water is squeezed out of the sludge. When the belts pass through the final pair of rollers in the process, the filter cloths are separated and the filter cake is scraped off into a suitable container.

Improvements in belt filters (*US Patent, 1996*)

1. The effectiveness of the operation can be increased by creating a pressure difference across the filter cloth. The filter cloth is directed though a zone where either pressure or vacuum pushes water from the filter cloths and ultimately to drain.
2. The sludge can be combined with a filter aid or flocculants which help the filtration process and reduce blinding of the filter cloth.

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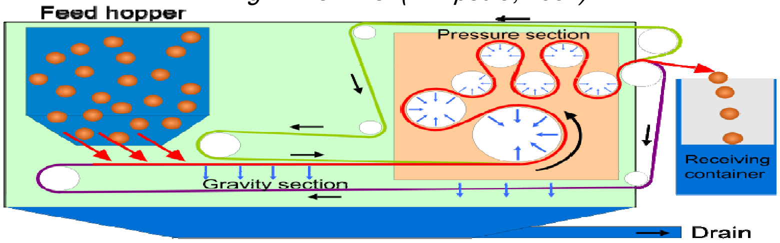
Fig. 2. Belt filter (Wikipedia, 2002).



3. Filter cloths can be cleaned throughout the operation of the process by means of water sprays positioned on the return section of the belt.

Bag filter (Parksanfilters, 2010)

- Filter Bags are made of felt material, which has the advantage of providing three dimensional filter media and offers both, a surface and depth filtration effect.
- Filter Bags are available in different types of filter media in different ratings. Polypropylene filter bag offers a broad range of chemical compatibility and is suitable for many applications. Polyester filter bags are suitable for high temperature with compatibility for acids and petroleum based fluids.
- Bag filter is mainly used for the preparation of adhesives, fruit juices, petroleum products and high viscosity fluids (Fig. 3).

Fig. 3. Bag filter (Advantec, 2006).

Advances in bag filtration system

- Innovations in both the filter housing and the bag filtration media now make it possible for Eaton bag filters to be used in applications that previously required more costly types of filtration equipment.
- Eaton filtration's new patent pending HAYFLOW(TM) filter element. This element combines the best of both bag and cartridge filters into one single filtration element for enhanced performance.

Self cleaning filters (Parksanfilters, 2010)

Various methods for cleaning the filters are used.

1. Manual cleaning: Manual filters are cleaned manually and this is usually done by jet of water. Sometimes the filters have to be soaked in chlorine or detergent.
2. Mechanical cleaning: In this the cleaning is done by brush or knife.

Automation minimizes disposable waste and labor costs.

Self-cleaning filter systems

- Reduces product loss.
- Required minimal operator intervention.
- Improves flow consistency.

A wide variety of self-cleaning filters:

1. MCF magnetically coupled industrial filters
2. DCF Self-cleaning Filters
3. Tubular backwashing filters including clearamine and reactogard filters (Fig. 4).

Mainly 3 types of flushing are there.

Direct flushing: this method causes the water to flow at high velocity at a tangent to the screen and removes the filter cake from filter element.

Back flushing: it is used for flushing sand and gravel filters in these filters the direction of filtration is from top to bottom. During flushing, water flows in the opposite direction. The water pressure which operates from bottom to top causes suspension of the bed inside filter. Light particles are washed out with water. The particles which are heavy stay in the vessel. At the end of flushing the sand settles & recreates the filter bed.

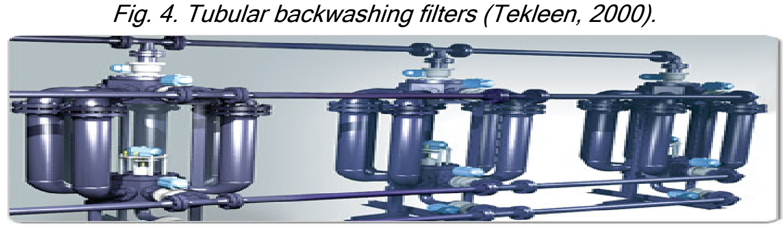
Forced back flushing: in these filters there is a suction device which scans the screen and causes a local forced back flushing.

Application of filtration

In heating, ventilation & air conditioning (HVAC) (Dorman, 1964): Poor IAQ (indoor air quality) significantly influences the occurrence of communicable respiratory illnesses and allergy, asthma and sick-building symptoms. Some of the airborne triggers for these illnesses include microorganisms, respirable particles such as dust and smoke; volatile organic compounds and allergens.

- Ideally, these triggers are eliminated or reduced significantly by the air filters in a building's HVAC system. Advances in air filtration have led to the development of systems that provide superior IAQ while reducing energy costs and helping commercial and institutional buildings achieve green-building milestones.
- Filtration efficiency is defined by how well a filter cleans indoor air by removing airborne particles. Low-efficiency filters – those that are 25% efficient in removing particles 3 to 10 µm in size – typically are used to keep lint and dust from clogging the heating and cooling coils of HVAC systems. Medium and high-efficiency filters – those that are up to 95% efficient in removing particles measuring 3-10 µm in size–typically are used to remove mold, pollen, soot, and other small particles.

Fig. 4. Tubular backwashing filters (Tekleen, 2000).



Advances of HVAC (Dorman, 1964)

Using PLCs (programmable logic controllers) in HVAC is the trend nowadays. Companies are adopting wireless

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technology after they found out that networking HVAC controllers, which often use sensors, can eventually cut installation and labor costs. A lot of engineers are also focused on further improving this technology through the use of mesh wireless setup, which will work for both the wireless sensor and wireless controller networks.

Advances in filtration technology are making new products possible in food & beverage (Higgins, 2003):

Micro filtration has served the food industry in a variety of areas for years, but refinements in membrane technology and a better understanding of the impact membranes have on the molecules that pass through are opening up a new world of possibilities. For e.g., bacteria and spoilage organisms in milk are easily removed by micro filters with pore sizes ranging from 0.1 to 20 microns. Canada's dairy land dairy, now a unit of Saputo, promotes this benefit with pure and fresh micro filtered milk. Ultra filtration units with pores ranging from 0.01-0.2 microns have been shown to affect the appearance and sensory properties of fluid milk because of the protein molecules that can be retained and then added back. Molecules that manage to work their way through the membrane exhibit different organoleptic properties, with a richer mouth feel attributed to the squeezed proteins. A significant body of research on the sensory, nutritional and bacteria-removal effects of membrane filtration has been compiled in the last decade by David M. Barbano and other food scientists at the northeast dairy foods research center at Cornell University.

Application of filtration in cane & beet sugar industries

- The sugar industry in developed countries has been under pressure for some time due to high-energy and labor costs, and environmental challenges. Many technologies are being constantly explored to improve sugar yields and quality with reduced energy consumption.
- Membrane filtration technology offers economic and technical advantages, when used either as a standalone process or in combination with other more established technologies such as ion exchange and chromatographic separators.
- Ultra filtration/ Micro filtration process in cane sugar production acts as a pretreatment prior to other separation technologies by removing impurities from the raw juice, including starch, dextran, gums, waxes, proteins and polysaccharides.

Application of filtration in starch & sugar industry

In a very short duration, cross flow membrane filtration has become a mainstream unit operation in the starch and sweetener industry. Membrane filtration processes, namely reverse osmosis, nanofiltration, and microfiltration by their versatility have gained acceptance. Microfiltration of saccharification tank liquor removes unliquified starch, polysaccharides, proteinaceous matter and other impurities. The process has been successfully applied to sweeteners derived from various starch sources–corns, wheat, tapioca, potatoes or cassava. The process eliminates use of diatomaceous earth (kieselgur) in rotary vacuum filters, while at the same time producing a superior quality product. Microfiltration is used for clarification of maltodextrins, depyrogenation of dextrose, final filtration of dextrose and fructose syrups. Reverse osmosis is used for concentration of dilute sugar streams and in some cases as a pre-concentration step prior to an evaporator.

Filter evaluations & testing

Integrity testing: Integrity testing sterilizing filters is fundamental requirement of critical process filtration applications in the pharmaceutical industry. Two classifications of integrity testing are destructive and nondestructive. There are three types of non-destructive testing which are available to show that the system has no leaks and is correctly assembled. These are referred to as the bubble point test, the fixed pressure test, and the gas diffusion test.

Bubble point test: The bubble point is a direct measure of the largest pore in the filter. The membrane or cartridge is first wetted and the inlet side of the housing drained free of liquid. The outlet, still containing liquid, is connected via tubing to a vessel containing the wetting liquid. Air pressure is then applied at the inlet until a continuous stream of bubbles appears in the vessel. The pressure at which this occurs is the bubble point. The size of the largest pore may then be related to the pressure via Darcy's law. The bubble point will vary with pore size, wetting liquid, filter media, and temperature (Choa *et al.,* 2009).

Fixed pressure test: The basis for this test is the ability of the filter of cartridge to hold a certain level of gas pressure applied at the inlet. The filter is wetted and the inlet side drained. A fixed pressure, about 70% of the bubble point, is then applied to the inlet side. The pressure level is then observed. And any changes over a period of time are indicative f small leaks in the inlet side of the system. An instrument that is capable of both the bubble point and the fixed pressure tests.

Diffusion test: This test is usually recommended for multicartridge or other systems with high filtration areas. When pressure is applied to a wetted membrane filter, air dissolves in the liquid, diffuses through the film, and is released on the low pressure side in the form of bubbles in an inverted burette.

Pore size measurement of filter (Chu, 2004): There are two main methods of measuring the pore sizes in a filter: challenge testing and porometry.

Challenge testing: It is a simplistic and easy to understand process of challenging a filter with a liquid suspension or dust cloud of particles. Measuring the relative concentration of particles before and after the filter determines the filter efficiency while measuring the

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largest particles passing determines the cut point of the filter.

Disadvantage: Challenge testing has been perceived as being limited and inaccurate in that it could not measure pore size distribution, only the cut point or maximum pore size. The inaccuracy stems from the fact that test dusts had been used in the past. The test dusts were wide in particle size distribution and irregular in shape, which led to large variations from lab to lab.

Porometry: It is a process which relies on the interpretation of gas flow through a 'wetted' filter. Wetting the pores effectively 'blind' the filter making it impervious to the passage of gas. However, as the gas pressure is raised, it overcomes the surface tension of the liquid and blows through the pores starting with the largest and finishing with the smallest. The gas pressure/flow rate curve can then be interpolated to determine the pore size distribution in the filter. It has had an advantage over the challenge test method in that it can measure a pore size distribution, not just the maximum pore size. One of the disadvantages is in the theory used to convert flow rate through pores to pore sizes. In the critical application in the pharmaceutical industry, uncertainty in pore size measurement of filters can be fatal.

Advances in porometer (Iboro, 2002): The latest instrument from Benelux scientific1 incorporates state of the art flow meters and pressure transducers enabling the pore size range to be extended down to 14 nm and up to 300 µm.

Conclusion

There are few areas in our lives that are not touched by filtration. We are surrounded by filters in the home, from tea bags and coffee makers to dish washers, food products in our cupboards from mustard and flour to sugar and cereal, all of which involve some form of filtration. Thus, a self cleaning filter reduces product waste and minimizes time. Sintered metal filters which is discussed here is continuous type of process which replaces old batch process. Many patent pending filters are also available which combines the best use of any two filters like HAYFLOW system which combines both types like bag and cartridge types. In this way, by using innovative filter equipments we can reduce labor cost and can get better quality products, maximize the yield in lesser time.

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