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Importance of Technical Textiles as Filtration Media-A Review

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Abstract

Textiles are widely used in our day-to-day needs like filtration of air, liquids, food preparation as well as industrial production in large to keep us healthier from the surrounding environment. A variety of fibres, yarns and fabrics both in woven and nonwoven types are used in the field of filtration techniques. The innovative applications of textile filtration fabrics is widely accepted in the pharmaceutical industry in the process of separation of liquids, gases, powders and suspensions involved in the filtration processes. Textile materials in any form play an important role the industrial filtration. In the present industrial processes, there is hardly any process is left where filtration is not involved. In the filtration process, where any textile material used it is called as the filter media or medium. In general filter media is used either in the solid-gas and/or solid-liquid separation. The use of latest technologies with filters and filtration media, the effective time in filtration is reduced and better quality of products are obtained in pharmaceutical industry. The use of textile filtration materials helps maximum separation of particles from the liquids, although absolute clarity is not always required. The use of membrane filtration fabrics in water filtration process has improved the membrane science.

Keywords: *electrostatic disposition, flow velocity, filter cloth, filter media, nano-filtration, spun-bond, ultra-filtration.*

INTRODUCTION

According to the definition of filtration, it is a mechanical or physical operation which is used to separate solids from liquid/fluid/gases by interposing a medium through which only any liquid can be passed. Filtration technique is used in any process to separate particles from any fluid which can be a liquid, a gas or any super critical liquid. The application of filter fabrics varies according to the end use of the process involved. Filtration is widely used in the chemical engineering processes **[01].** The purpose of using the filter media is to maximise the possibility of collision and the subsequent retention of the suspended particles with fibrous structures while maximising the energy loss of the system. Permeability is an important factor in the filtration process. Therefore, increase in the porosity means increase in the liquid and gas permeability. Permeability of a fabric is affected by the finish applied on the fabric surface. In the filtration process pressure drop decreases with the increase in porosity and when flow rate increases pressure drop also increases. Basically there are five types of filtration techniques and can be applied according to their end-uses.

There are a various types of textile fibres, yarns including DREF yarns, nonwoven fabrics with multifilament and monofilament yarns and some cases blends or combination of more than one of these structures which are involved in the filtration processes. Technical textiles in various forms are greatly employed in the filtration processes and they carry a vital role in profit making as textile products **[02].** The four major classes of nonwoven man-made fabrics used in the filtration processes are (i) needle felt produce from staple fibres, (ii) wet laid fabrics produced from short-cut fibres, (iii) spun bonded

fabrics and (iv) melt-blown. Needle felt fabrics are made from polyester and sometimes polypropylene and other polymeric fibres including meta aramide and PPS. Spun bonded fabrics are much lighter and available in the range of 0.5 to 4.0 oz/sq yd. These are made of polyester, polypropylene and nylon. Melt blown fabrics mostly in large volumes are normally used in the filtration of air and several liquid filtration processes. It is due to their high rate of dirt holding capacity. Wet laid filtration fabrics are made from short-cut man-made fibres, fibre glass and cellulose fibres to use in the machinery for the paper making industry.

The role of the filtration textile fabrics in the category of technical textile groups, have a huge application in various purpose of filtration process. The Application Filtration Fabrics is a positive solution in the engineering methods to meet the requirements of every day as well as sometimes in very specific areas, where it is needed in terms of chemical resistance, temperature resistance with high pressure and durability **[03].** As per the regulations of FDA certain standards have been imposed on the filtrations where they satisfy the quality standards of the products especially in the food and beverages. The development in the filtration fabrics will never be hindered due to the performance demands for filtration solutions.

In the nonwoven filtration process, use of nonwoven fabrics in the filtration methods and the latest technique of using nonwovens in the filtration processes have been reported and discussed detailed **[04].** This report explains the introduction of various types of textile fibres and their speciality in the performance through different nonwovens as filtration materials. The special significance to this report is that it has dealt with various types of textile materials with reference to fibres and their specialty in the performance through different nonwoven fabrics as filtration textiles. It has also described basic raw materials in the form of polymers, other fibres and various fabrics with their construction features in the manufacturing of filtration fabrics and some special finishing processes to be applied on the fabrics **[05].** As per the demand of the market the filtration industry is developing with all round success by out sourcing the demand of the market with wider range of filter fabrics available in the form of natural and man-made fibre-staple staple yarns, in mono and multi filament forms **[06].** Textiles in the form of filtration fabrics have applications in various ways like separating and purifying liquids and solids, cleaning gases and effluents, absorbing dirt, fumes and oil. Filtration fabrics are also used in cars, and other types of transport, building air conditioning systems and personal protection and many other uses at homes **[07].** One of the important issues to improve upon the technical efficiency of filtration fabrics and to reduce the overall cost of their use has become the significant consideration in the development of textile materials in the form of filter fabrics.

The basic principles involved in the process of filtration plays an important role in the development of filtration fabrics to improve the filtration technique (s). The basic principles of filtration are interception, diffusion, the principle of electrostatic disposition and the principle of gravitational force. The processes of filtration are: particle filtration, micro filtration, ultra filtration nano filtration and reverse osmosis **[08].** Different methods of filtration are like solid-solid filtration, solid-liquid filtration, liquid-liquid filtration and liquid-gas filtration. The selection of textile fibres depends on many factors and these are mostly related to their physical properties.

The majority of the industrial filtration process and separation process are

involved with textile materials. The newer techniques in the filtration and separation process both in the industrial and house hold applications help in the innovation of various fibres, polymer, yarns, felts, woven and knitted products **[09].** The use of these products demand a vast range of regulations governing the product design and safety standards for particular product (s) when they will be used in the industrial and house hold applications. The filtration categories requiring textile solutions have been explained in the above mentioned article.

Ultra filtration is a variety of membrane filtration in which forces like pressure or concentration gradients leads to a separation through a semi permeable membrane. Suspended solids and solutes of high molecular weight are retained in the so-called retentive, while water and low molecular weight solution pass through the membrane in permeate. The separation process used in the industry and research for purifying and concentration micro molecules solutions, specially from micro filtration **[10].** Ultra filtration is not fundamentally different from microfiltration. Both of these are separately based on size exclusion or particle capture. It is fundamentally different from membrane gas separation, which separates based on various amounts of absorption and different rates of diffusion.

In some biological process, sometimes filtration is used which is related to water filtration and sewage treatment. In both the processes the undesirable constituents are removed by the absorption in a biological film grown in the filter media as happens in the slow sand filtration technique **[11].** In the cake filtration process the cake accumulated on the surface of the filter is used as a filter. A filter is composed of a coarse woven cloth and through it a concentrated suspension of rigid particles is passed so that these bridge the holes and form a bed.

A filter fabric is used to effect the maximum separation of particles from liquids, absolute clarity is not always necessary. Under certain gravity or vacuum-assisted screening operations the filter fabric is simply designed to capture particles greater than a specific size and in other filtration systems a membrane of solids in filtrate can be tolerated before cake filtration takes over and the necessary clarity is achieved **[12].** Different fibrous structures such as mono, homogeneous over the entire volume and multilayer are manufactured and used for specific purposes. The nano composite membranes showed absence of anti-bacterial activity against gram-negative bacteria.

Nonwovens made from polymers having anti-bacterial activities are another solution to obtain anti-bacterial filters. Water filters containing fibres, especially nano fibres of ion exchange properties have been applied in the field of biotechnology, pharmaceutical processing, producing ultrapure water for the semi-conductor industry, catalytic conversion processing and battery technologies **[13].**

In vacuum cleaners filtration technology is widely used. This is also used in power stations, petrochemical plants, sewage disposal, etc. Textiles in the form of woven and nonwovens structures are especially suitable for filtration purpose due to their complicated structure and thickness of the materials **[14.15].** Because of this they have high filtration efficiency. A filtration fabric intended to use at the high temperatures may not be a good chemical resistant. Therefore, it is totally dependent on the type of filter fabric to be used and the specific end-use of the fabric. Mostly for filtration purpose, synthetic fibres are used because they have many special characteristics for filtration ability. Again nonwovens have certain

advantages over woven fabric filters due to their performance properties.

Nonwovens are rapidly advancing to help filter media manufactures offer improved efficiency, better pressure drops and overall better performance in the filtration process. At the same time the manufacturers have better choices for the filtration media ever had due to obtaining better performance at the end **[16].** As a substrate choice, the nonwovens have become a better material for cleaner air to breathe, water to drink or more efficient fuel system. The efficiency of filtration in the industrial filtration, technical fabric is affected by its porosity. The Knowledge of air permeability is also important for suitability for the use. The amount and distribution of air space influences a number of important fabric properties including the effectiveness of the fabric during filtration **[17].** Natural randomness of textile structure increases as the probability of the particles being caught the fibres. Therefore, nonwoven fabrics in general provide higher filtration efficiency than woven fabrics or knit fabrics. Nonwovens may give a three layered structure for their larger thickness which increases the distance for the particles to travel during filtration process. Nonwovens are also constructed in layers **[18].**

The advances in filtration techniques include the development of the continuous processes to replace old and obsolete technologies. The introduction of new filters and filter media in pharmaceutical industries reduces the time of processing and produce better quality. The porous medium used to retain the solids is known as filter medium as defined **[19].** Depending on the dispersing medium, filtration is divided in two parts: gas filtration and liquid filtration. In liquid filtration, The Kozeny-Carman 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 **[20].** The yarns of a monofilament constructed fabric are not only impermeable but also fairly smooth and cylindrical orifice analogy and therefore, the drag theory approaches have been most successful in predicting the resistance of these materials to fluid flow **[21].**

Polypropylene felt filter cloths are treated by different finishes including plain, singed and glazed. All of these are specially designed for special filtration processes. In order to further improve upon on its sealing property, latex border can be used to the original cloth. It is also used as duct collection in dust cleaning equipment. Polypropylene felt cloths are also used in the coal industry, steel factory, ceramic printing and dying industry **[22].**

The uses of nonwovens in the air filtration process have some advantages over the woven fabric for dry filtration. This is due to its unique characteristics. Nonwovens made filter fabrics are characterized by their high-tech products **[23].** Therefore, nonwovens are mostly used in the filtration process and as a result give better performance. Moreover, its use is harmless from the view point of environment and also hygienic to the human being to survive hazard free.

APPLICATION OF FILTRATION TEXTILES IN THE INDUSTRIES

Now-a-days textiles are widely employed in the industrial sectors apart from their traditional uses as apparels. According to the report **[03],** rolls goods, sleeves, socks, bags, cloths and sheets are some of the various media types that make up the large family of wet and dry filtration products. Textile filters, due to their versatility, consistent performance, effective particle retention and efficient flow rate are some of the important characteristics to help use in the industrial filtration processes. The

regulations imposed by the FDA in the food and beverage industry made textile filtration media to meet the specific criteria for critical applications when they directly come in contact with the food products. The development of textile fabrics through innovative researches made it possible to use the products in the heavy industries like mining, nuclear, and cement and also in pharmaceutical industry in the separation process of liquids, gases, powder and suspension materials. Due to the use of insulators which do not promote flow of electricity through their structures there may a possibility to inherently developing hazardous static charges in the cases where combustible liquids or powders are present. Therefore, it is recommended that the filter fabric should of such type with anti-static properties to mitigate the risk of ignition. According to the report of Glaxo Smith Kline, a bespoke fabric had been developed with multi-pocket glattbage, which was certified by the Food and Drug Administration (FDA).

The Technical Textile Association's book on Handbook of Technical Textiles, second edition, volume 2, provides a general introduction to the common types of solid-gas and solid-liquid filtration mechanism. The raw materials like polymers, fibres, yarns and fabrics of different constructions are employed in the manufacturing of filter media. In some cases fabric finishes are applied for the development of filter cloths **[05].** The advancement in the filtration technology includes the development of continuous processes to substitute the old technologies.

In a filtration process, the porous media used to retain the solids is known as filter medium. Filtration is also applied to describe some biological processes especially in water filtration and sewage treatment in which undesirable constituents are removed by absorption into a biological film grown on or the height that stops the filtration process **[11].** Filtration is supposed to be the essential process in pharmaceutical industries and it may simultaneously combine with other units' operations to process the feed stream, like bio-filter which is a combined filter and biological digestion device. According to the basis of theory on filtration mechanism, there are three types of filtration, which are such as (i) surface filtration, (ii) depth filtration and (iii) advances in sintered metal filters.

Surface filtration is a technique in which screening action is done by porous or holes of the filter medium which prevents the passage of solids through filtration process. The filtration process in depth filtration technique retains particulate matters not only on the surface but also at the inside of the filter. In the sintered filtration process, sintered metal is utilized as metal media to provide excellent performance for separation of particulate matters **[19].** This technique is used in chemical separation, petro-chemical and power generation industry. Nano filtration ranges in between ultra filtration and reverse osmosis. The nominal pore size of the membrane is typically below one, between nanometer, hence so called nano filtration. Ultra filtration is a pressure driven membrane transportation process which is applied in both at laboratory and industrial scale. Ultra filtration offers systems which have been developed to match the requirement of the pharmaceutical industry and biotechnology for numerous applications.

Depending on the dispersing media filtration processes divided into two classes, gas filtration and liquid filtration. Gas filtration includes filtration of aerosol and lysol. Membrane filters and nucleon pore filters are based on three mechanisms. The first is the diffusion deposition, the second one is the direct interception and the third one is martial deposition. 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. The Kozeny-Carman equation does not take into account of the fact that 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 **[20].** Different types of materials used as filter medium are be woven materials such as felts or cloths. Woven materials are constructed from wool, cotton, silk, and synthetic fibres, etc. Synthetic fibres have greater chemical resistance than wool or cotton. The choice of fibre also depends on the physical state and chemical constituents of the slurry. The choice includes mainly of types: monofilament woven cloth and multi-filament woven cloth. The yarns of the mono-filament 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 **[21.**

The filtration resistance of a filter cloth may increase with the warp and weft density and twist of the yarns. Porosity and air permeability of fabrics also play important role in the filtration process. Filtration media made of textiles are used in separation and purifying liquids and solids, cleaning gases and effluents, dirt, fumes and oil. Uses are also in industrial processes, in cars and other types of transport, building air conditioning systems, personal protection and homes **[22].** Filter cloths made from polypropylene is extensively used in liquid-solid filtration for its excellent filter cake release and good resistance to moist acids and alkalis. Due to super low moisture absorption, polypropylene is a preferred choice for production of dyes. Woven polypropylene fabrics can be fabricated by mono-filament, staple and multi-filament in twill, satin and plain patterns to meet the purposes required for the filtration process. These are widely used in mines, metallurgy and waste water fields. They are also used in chemical, pharmaceutical, sugar, nonferrous metal smelting, sewage treatment, etc. Some of the advantages of using this filter cloth are like shortening the filter cycles, excellent gas permeability, free of mildew and oxidation. In air filtration, the nonwoven fabrics have some advantages over the woven fabric filters for dry filtration applications due to their unique characteristics as high-tech products. Nonwoven is highly used in the filtration and it gives the best result. The use of these materials is harmless for environmental pollution and hygienic to human life **[23].**

TECHNICAL TEXTILES IN FILTRATION

Today, hardly a modern industry exists without some filtration operation. Textiles are considered as porous medium and by any porous medium means a material which has in its structure certain number of cavities or empty spaces interconnected or not and can establish a direct communication in the boundary of opposed surfaces. In order to satisfy complete demand of out sourcing market a wide range of filter fabrics available in natural and synthetic fibres, staple yarn, continuous yarns and mono-filament yarns to cater the need of different industries **[06].** Fibres selected for filtration should be capable of withstanding harsh environmental conditions such as temperature, abrasion and chemical stability. Usually synthetic fibres are suitable for filtration process and preferred due to certain advantages. Some of these are high strength, flexibility, easy partition of filtration cake, low fabric weight, rot resistance, high-temperature resistance, etc. The important tests to be carried out for filtration fabrics are air permeability,

filter efficiency, bursting strength, tensile strength, chemical stability, etc **[08].**

The knowledge of science related to fabric permeability or flow through fabrics needed to engineer specific characteristics into a functional fabric depending on the desired out come and the specifications of the solids being filtered. The filter media used in most of the cases is to develop a cake which is the real filtering medium. The choice of the fibre and textile construction is critical to the performance of a given filter cloth and its processing capabilities with a slurry composition **[09].**

The textile materials used as the filter fabrics are usually nonwoven, woven or knitted. The vast majority of the filter media supplied to the filtration and separation industry are used in the industrial and commercial sectors. New polymers are used almost as soon as they become available in the market. With the increasing sophistication comes, the need for greater education for the material properties of various fibres, polymers, yarns, felts, woven and knitted poducts for use in the filtration and separation industries. Filtration categories requiring textile solutions are summarized as cartridge filtration, centrifugal separators, chemical filtration, electrostatic filtration, liquid filtration, membrane filtration, nano filtration, pressure filters, reverse osmosis, water filtration, wet/dry filtration and ultra filtration.

NONWOVEN AS FILTER FABRICS

Filtration fabrics are widely used in vacuum cleaners, power stations, petrochemicals plants, sewage disposal, etc. Textile materials, particularly woven and nonwoven are suitable for filtration because of their complicated structure and thickness. Dust particles have to follow a tortuous path around textile fibres and thus due to their structure they have high filtration efficiency. The usage of filtration fabrics varies according to their end uses. This depends on the properties the filters have and ultimately depends on the characteristics of the raw materials used for the manufacturing of the filter fabrics **[01].** While designing any filter for a particular end use, some important factors are to considered and which are summarised as, flow velocity, size and concentration of particles to be filtered out, nature and component of the suspension filtered. Selection of fibres should be according to the nature which can withstand the harsh environmental conditions such as temperature, abrasion, chemical conditions, etc. The nonwoven filter fabrics have advantageous over the woven filters due to the following properties such as high permeability, high filtration efficiency, less bleeding tendency, no yarn slippage and good casketing characteristics. As the fibre diameter increases filtration efficiency decreases **[14].** The other important factors that are needed to consider include the rate of filter choking, service life of the filter cloth, filtrate purity and cake removal. The important tests to be performed for filter fabrics are permeability, differential pressure, efficiency, strength and chemical resistance **[15].**

One of the largest market segments in the nonwoven industry is the application of nonwoven filtration fabrics as filter fabrics. This segment utilizes man-made polymer and inorganic fibres to produce the filters. Polyester and polypropylene dominate with nylon, fibre glass, meta-aramides, fluropolymers and polyethylene sulphide and other polymers used due to their special characteristics. The four types of most widely used nonwoven from man-made fabrics are: needle felts from staple fibres, wet laid from short cut fibres, spun bond and melt blown fabrics. **[02].** Houston based Filtration Technology Corporation (FTC} produces platinum filters capable of holding extremely large quantities of contaminate using nonwoven

fabrics. FTC supplies liquid filters in many configurations but none can be comparable to the products of the platinum series filters, which can retain up to several hundred pounds of contaminants. This has a longer life also, and having lower filtration costs, lower maintenance costs, and minimal down time. Precision woven monofilament fabrics have applications as medical filters in open heart surgery, automotive transmission filters, air conditioning and fuel injection filtrations, in shifting screens in flour and wheat processing and heavy fabrics as sludge dewatering and belts. Woven glass fabrics are found in high-temperature end-uses, primarily in bag house constructions. The combined global filtration media market for woven and wet laid glass fabrics are huge as compared to other types.

An important role is being played by textile materials in the industrial filtration processes. Any filtration process involves two jobs, one is the filtration and the other is the cleaning of the filters. Textile materials in the form of woven, nonwoven and knitted structures are employed in different types of filtrations. Depending upon the required performance various types of nonwoven fabrics are used **[04].**
The present scenario in the filtration industry is the advancement of nonwoven fabrics in various forms due to their improved efficiency, belt pressure drop and overall better performance. Manufacturers have always better choices for nonwovens as filter fabric due to their better performance. Textile filters are used in the filtration of air, liquids, in food particles and in many industrial filtration purposes. Nonwoven filters are especially suitable for filtration due to their complicated structural configurations and thickness also. The main reason of using nonwoven filters is that the dust particles have to follow the tortuous path during filtration for much better performance **[16].** In terms of some structural features some of the synthetic fibres and fabrics are better for their chemical/fuel resistant, flame retardant character, thermal insulation, water proofing and UV resistant properties **[17].** A filter fabric is designed for many purposes like, to keep the air in our rooms clean, an operation theatre clean for sterilization, to remove oil and dirt form the cars before it reaches to the engine etc **[18].** Textiles made filters are better used in the medical purposes, like in any operating room to keep out pathogens, bacteria or microbes that might otherwise contaminate a sterile the working environment. The purpose of using nonwoven filters in the cars is to help remove contaminates from the engine oil, transmission oil and lubricating oil.

NONWOVEN FILTERS IN WATER FILTRATION:

There are five different processes in the water filtration for drinking purpose and these are removal of sediment, mechanical, chemical, mineral and bacteria. Any standard water filtration process involves with the removing of the concentration of particulate matters including suspended particles and many more. Keeping in mind the requirements of avoiding the fibre shedding in the filtration process, nonwoven filters made from continuous fibres such as melt blown, spun bonded, hydrogenated nonwovens and electro spun/centrifugal spinning comprising of both micro fibres and nano fibres are widely used. Their uses are restricted to as an independent micro filtration media or pre-filters to remove high contaminants content within the fluid to protect membrane of the filters **[13].**

Filters used for the water filtration purpose and containing fibres especially nano fibres with ion exchange properties have been applied in the bio-technology , pharmaceutical processing, producing ultra-pure water for the semi-conductor industry, catalytic conversion processing and battery technologies. It has been reported that a nano fibre filter containing

liquid filtration medium that simultaneously exhibits high liquid permeability and high micro organisms. Nonwovens made of polymers having anti-bacterial activities are another possible method to achieve anti-bacterial filters. Due to the tremendous development in the membrane technology use of membrane filters in the water filtration process has been benefitted. The present world scenario in water filtration process is to have significant development for the economic and energy level reduction. With the limited options available, the following materials are used in the filtration processes as filters like, ceramic, polyvinylidene fluoride, cellulose acetate, polysulfone, polyethersulfone and cross lined polyamide have been successfully attempted. With respect to the design and optimization of structure and morphology to enhance the filtration performance of existing membrane, it is necessary to briefly review the current state-of-the-art membrane technology.

CONCLUSIONS

In order to achieve a good manufacturing practice, it is very important that filtration operation in the production to processing of chemicals and in research laboratories also the purification of water is must. Among the various classes of filter clothes, plate and frame filter press, can filter, disc filter, centrifugal filter and bag house filter are very common. Filter fabric is related to its manufacturing technique, selection criteria, filtration efficiency and filter performance for end use. Some important factors should be considered while designing any filter fabric. One of the basic tools which have at the disposal of the technologists is the knowledge of the technical fibres and textiles in order to produce various types of filter clothes to be used in the filtration processes throughout the world. Filter fabrics for filtration purposes play an important role in daily life and it is recommended that filter fabrics are used as per the requirement of the filtration process. The present day industries welcome the innovative ideas, polymers, and filtration media to meet the ever ending needs of the market segments. Needle felt nonwovens are mostly used as filtration fabrics. Nonwoven fabrics are perfectly engineered to meet the exact requirements and significant regulatory criteria for filtration purposes. Water filtration is to produce safe and clean water for a specific purpose, such as drinking, medical and pharmaceutical purposes.

REFERENCES

1. 1“Filtration in textile: A review”, The Indian Textile Journal, https://www.indiantextilejournal.com/articles/FAdetails.asp?id=3557.
2. “Fibres, Textiles and Nonwovens In Filtration”, Edward C Gregor, (Textile World, March 21, 2017),https://www.textileworld.com/textile-world/features/2017/03/fibres-textiles-and-nonwovens-in-filtration.
3. ”The Role of Filtration Textiles in Industry”, https://www.arvile.com/news/the-role-of-filtration-textiles-in-industry/
4. “Application of Nonwovens in Filtration”, https://www.technicaltextiles.net/articles/application-of-nonwovens-in-filtration-6193.
5. “Textiles in Filtration”, Hand Book Technical Textiles, 2nd edition, Vol 2, 2016, T. H. Shah and A. Raul, https://www.sciencedirect.com/science/articles/pii/B97817.....
6. “Filter Fabrics”, https://www.technicaltextile.net/articles/filter-fabric-4757
7. “Technical textiles in Filtration”, 12th august 2001, Key Issues, suppliers of Technical textiles in Filtration Sector, https:/www.yarnsandfibres.com/preferredsuppliers/report....
8. “Filtration Fabrics-Principles, Classification and Application”,

https://www.textilemats.com/filtration-fabrics-principles/...
9. "Roles and Functions of Technical fibres and Textiles in Filtration", October 2009, Robert Bell (Robert G Bell Projects), Filtration and Separation Association, Robert@filtrationsociety.com.all
10. "Nonwoven for Filtration", Prof. L. G. Patil, Ankit Bhate and Pradinv Bhallale, Textiles Today, https://www.textilestoday.com.bd/non woven-for-filtration/
11. "Review of Some Recent Advances on Filtration in Pharmaceuticals Industry", S. O. Majekodunmi and E. O. Olorunsola, dept of Pharmaceuticals and pharmaceutical Technology, University of Uyo, Nigeria.
12. "A Review Article on Application of Filter Cloths", Israt Zerin and Eshita data, dept of textile engineering, South West University, Dacca, Bangladesh.
13. "Nonwoven fabric Filters", N. Mao, Advances in Technical Nonwovens, 2016. https://www.sciencedirect.com/topics/chemical-engineering/water-filtration
14. Dr. Srinivasan and S. Katharvelu: Nonwoven Fabric Filtration Media, Synthetic fibres, April and June, 2006.
15. Kothari V K, Das A and Singh S., "Filtration Behaviour of Woven and Nonwoven fabrics", IJFTR, June, 2007.
16. Prof. U. J. Patil, "Filtration in Textile", Indian Textile Journal, March, 2010, 81-86.
17. https://www.india.org/about-nonwovens/nonwoven-markets/filtration
18. www.Wikipedia.com
19. R. Patel, S. Devarshi, G. Bhupendra, P. Patel and m.patel, "Overview of Industrial Filtration Technology and its Applications", Indian Journal of Science and Technology, Vol 3, No 10, 2010, 1121-1127.
20. C V S Subramaniam, T J Setty, S Suresh and K V Devi, "Filtration in Pharmaceutical Engineering Principles and Practices", Vallabh Prakashan 2005, Delhi 9, 248-250.
21. I C Wardsworth, "Handbooks of nonwoven filter media", J Engineered Fibre Fabrics, 2 (1), 2007, 61-63.
22. S J Russel, "Handbook of Nonwoven", 1st Edition, Wood Head Publication, 2006.
23. India association of the Nonwoven Fabrics Industry Available: https://www.india.org/about-nonwoven/nonwoven-markets/filtration.

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