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Antibacterial HVAC filter media

Environmental impacts of growing industrialization on to our only living space, the atmosphere, are increasing every day. In order to meet the changing demands in parallel with the increase in the world's population, new consumer materials are needed to be produced in greater quantities. Instead of long-lasting durable materials and devices, weak and disposable culture products that keep economy moving, from the beginning to the end of their life cycle resulted in high energy consumptions and pollutions which cause progressive pollution of our air and world. The pollutants we release into the atmosphere are much higher than nature's self-renewal process. For this reason, filter systems are of great importance both in the formation of exhaust emissions and in the sense of improving the quality of inhaled air.

The HVAC systems are referred as the 'respiratory system' of modern buildings (Liu et. al, 2018), adjusting indoor temperature, humidity, air- flow and cleanness. The term HVAC used for all heating ventilation and air conditioning systems. HVAC systems are mainly needed to make shopping centres, residences, all indoor places that we live-collectively and whole industrial working place, suitable for more effective working-living according to the properties of the work done and requirements.

During all these conditioning processes, the air taken from outside and circulated inside is filtered. If the temperature of the air is also adjusted, in order to reduce the energy consumption, the conditioning device would use about 85% of indoor air. Because of today's life and working styles, people spend more than 80% of their daily lives indoors (Liu et al. 2018; Al-abdalall et al. 2019). For this reason, the proper filtration of circulating indoor air become more important in order to increase the quality of indoor air. The filters in HVAC systems should remove the airborne particles from the indoor air we breathe and make it more breathable, healthy, and comfortable. However, in densely occupied buildings, airborne microbial contaminants can result in many significant adverse effects on human health (Schmidt et al. 2012). Possible microbial growth in HVAC systems with the subsequent contamination of indoor air is of increasing concern (Schmidt et al. 2012).

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During HVAC operation, the microorganisms may obtain suitable environmental conditions such as temperature, moisture level and nutrient conditions to grow. When these microorganism contaminations grow to some certain level, they can diffuse in HVAC filter components in the form of bio-aerosols or accumulated dust and then spread into the indoors with supply airflow (Liu et al. 2018). Studies have shown that microorganisms can easily grow especially within the filter materials used in HVAC systems (Al-abdalall et al, 2019; Liu et al. 2018). Therefore, it is expected from the HVAC system to purify the air from allergens, dust, accumulated airborne particles and control the microbial contamination on them. This could be possible by using filter systems that show antimicrobial activity (Lee et al. 2011, U.S. Patent No. 7,942,957).

Filter systems

A filter medium is that part of a filter that does the filtering or separating. There are two important aims of filtration and separation. One of them is to protect people from the environment and the second one is to protect the environment from people. People need clean water to drink, fresh air to breathe and healthy foods. Often, the only way to meet these needs is to filter out toxic and harmful contamination that are existed in the sources (Hutten, I. 2007).

The filtration industry is constantly evolving to cope with these needs. New designs in filters allow to separate complex contaminations. Cleaning the air by filtering is gaining increasing importance to get our working and living space more suitable.

Similar to the protection provided in personal protective masks, here it becomes possible to clean the indoor air by passing it through special systems. Filtration processes enable the arrestment of many particles that present in the suspended in the air. In the filtration industry filters are classified according to the efficiency level of the filter of the specified particle sizes, and are selected according to the environment and usage purpose. Many kinds of filter materials could be used for cleaning the air, however, the filtering properties of these materials are closely related to the fiber structures. In some applications, only coarse dust is filtered, while in some special applications, even very small airborne particles should be arrested by the filter. Typically, in filtration processes, the size of the items to be separated needs to be matched by

the size of the fiber or pores of the media, so that the removal of particles or microorganisms at diameters of less than 1 micrometer is possible (Akduman and Kumbasar, 2018). Nowadays, the requirement for finer filtration could be achieved by media with finer fibers. So, the filter material must have both the desired level of efficiency (capturing particles), clean the air from its contamination with finer fibers, and be able to pass enough air. It is very important to balance the filtration efficiency and pressure drop (resistance to air passing). High pressure drop across a filter leads to the undesired high energy consumption while driving the air flow through the filter. When fiber size is reduced the efficiency of total filtration becomes higher. The increase in filtration efficiency due to the large surface area per volume with smaller pore sizes for higher particle capture, especially for small submicron meter particles encouraged a wave of small fiber innovation and commercialization that boost the filtration (Yang et al., 2012) and leads to the development of nanofiber filtering media. As an important part of emerging Nanotechnology, nanofibers and nanofiber webs in filter medias are the key elements for improving the filtration efficiency. High efficiency air filter could be developed by using nanofibers with fiber diameters smaller than 0.5 µm (500 nm). Nanofiber filter media have enabled new levels of filtration performance in several diverse applications within a broad range of environments.

Nanofiber webs formed by nanofibers are able to capture very small particles with their small pores and provide low pressure drop due to their high porosity. By adjusting the amount of nanofiber on the filtration material, the target particle sizes can be kept at the desired fractional efficiency levels and the air can be cleaned at the desired rate. HIFYBER is one of the few companies in the world which can produce filter materials with nanofibers.

Bacteria or viruses do not move in the air on their own and are usually accumulated on dust, saliva or droplets. Airborne-sized particles were considered to be particles <5 µm in size and droplet-sized particles were considered to be particles >5 µm in size (Gralton et al., 2011). Challenge controls are maintained at 1700 – 3000 colony-forming units (CFU) with a mean particle size (MPS) of 3.0 ± 0.3 µm at “Bacterial Filtration efficiency (BFE) EN 14683 Standard” (Nelson Lab, 2020). HIFYBER HVAC products at F7 level can hold more than 90% of 3 µm particles. By increasing the efficiency level of filter media in HIFYBER HVAC

products, bacteria filtration capacity can be increased to over 99%. Additionally, it is possible to purify allergens in the air at 99% levels.

HIFYBER Antibacterial filter media

Because of the nature of the life on Earth and biological life, the air we breathe will always contain bacteria and viruses. With the increasing indoor technology utility and frequent device usage, indoor air quality is worse than outdoor air. The emergence of the deadly virus Covid-19 points to the need to move the efficiency level of indoor ventilation systems to the next level.

Antibacterial textiles can cut off the pathways of bacteria to prevent the propagation on textiles, so as to effectively avoid the contact between pathogens and the human body, and reduce the risk of cross-infection rates (Liu et al., 2019). It is also possible to use a similar application in the filtration. Application of similar antibacterial materials onto the filter material can create toxicity for bacteria, and able to prevent the growth. HIFYBER cleans the air during the ventilation of the living space with the filtration products by its nanotechnological products, removing bacteria and viruses, on the other hand, it prevents the growth of these microorganisms with its antibacterial filter media. Thanks to nano-fiber technology, HIFYBER products capture very small particles such as bacteria with the efficiency level more than 99% and can end the life cycle of the captured microorganism with its antibacterial properties.

Properties of the HIFYBER SPP65-AB product

HIFYBER SPP65-AB is an innovative product that combines nanofiber with antibacterial technology. In addition to its very good pleatability, it has 4 times more air permeability at the F7 level than non-antibacterial and widely used glass fiber products in the HVAC market. Filtering more air means lower energy consumption and more fresh air in the living area. Thanks to its antibacterial properties, it minimizes the risk of disease spread indoors.

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