

Importance of Hepa Filter Studies in the Pharmaceutical Industry

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ABSTRACT

The purpose of the HEPA filter was to maintain the cleanroom by passing the air to all areas to maintain the proper temperature, pressure, humidity. The pharmaceutical industry needed to maintain the cleanroom and other appliances such as automobiles, medical facilities, aircraft, and homes. The HEPA filters protect the employee from the health problems like allergies and asthma. The importance and uses of HEPA FILTERS were discussed in this work.

KEYWORDS: Cleanroom, manufacturing area, airlock room

I. INTRODUCTION

High-efficiency particulate air (HEPA) ⁽¹⁾ ⁽²⁾ originally called high-efficiency particulate absorber but sometimes called high-efficiency particulate arresting or high-efficiency particulate arrestance, was a type of filter to clean the air in a cleanroom. HEPA filters have many applications, including use in Pharmaceutical industries, automobiles, biomedical facilities, airlines, and homes. The filter must satisfy certain efficiency standards are set by the United States Department of Energy (DOE).

HEPA filter as to qualify standards by US government, 99.97% of the particle (0.3µm size) of should remove by air filter (passes of air through the duct).⁽³⁾

In the 1950s HEPA was commercialized, and the original term became a trademark and later a generic term for highly efficient filters.⁽⁴⁾

It is a safety requirement in everyone's lives, and also environmental and home health concerns. Airborne particulates are controlled to maintain the temperature, pressure, humidity to maintain the cleanroom, and also protect the quality of the product, protect the employees from dangerous chemicals or prevent the health issues from longtime exposure to the allergen and pollutants.

Source of airborne particle

- ✓ Household dust and lint: 0.01-100 microns
- ✓ Mold: 1-50 microns
- ✓ Tobacco Smoke: 0.01-10 microns
- ✓ Hair of humans: 50-150 microns
- ✓ Pollen: 10-110 microns
- ✓ Pet dander: 0.1-10 microns
- ✓ Virus and Bacteria: 0.001-10 microns

If the solid and liquid particle less than 10 microns should be a concern, because which causes health problems in humans like respiratory problems, A healthy human body can filter out particles as small as the 35-micron size, human health issues because it is exposure to smaller submicron particulate matter present in the human body.⁽⁵⁾

HEPA filters are also used in the medical facilities, typically used in the ceiling or HVAC (Heating ventilation and air conditioning) systems used to protect the patients from infection and employees and visitors from airborne particulate matter.

They are even manufacturing for high-temperature applications, up to 2000 degrees (F), which helps in taking care of patients in inpatient rooms and employees in the industry.⁽⁶⁾

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Function

The fibers are arranged randomly in the HEPA filters, (7) the fibers are made up of fiberglass, and the distance between fibers was 0.5 to 2.0 micrometer, 0.3 micrometers or more of air space between the fibers in the HEPA filters. The HEPA filter has a similar mechanism to a sieve, because some vacuum cleaners were stopped the bigger particles like dust, and easily passes through the smaller particles, the smaller particle can be stopped or caught by the use of fine filters, and also keep the filters more and arrange the filters one by one on top to stop the entry of smaller particles.

Mechanism

1. Interception
2. Impaction
3. Diffusion

Interception

In the moving airstream the bigger particles are filtered and small particles flowed through it, and they are flow and move close to the fibers, then the particles are stopped by an interception mechanism.

Impaction

In this mechanism the flowing particle rubbed into fibers of the filter, then the particle was absorbed by the impaction mechanism.

Diffusion

In this mechanism, the small air particle and dust were moving together at a time (particle size was 0.1 micrometer) and both are crashed each other. And some flow to the filter fiber, this flow is similar to the Brownian motion (slow of moving airflow), the flow was in a zigzag motion, hence the airflow velocity at a low level. (8)

The air purifier was used to eliminate the harmful full gases and odor from the indoor environment. Carbon-activated smoke stop filter used instead of normal filter, the presence of activated carbon will change the airflow. (9)

Specification

Most of the American industries are adopted the standards of DOE (Department of Energy), which define that 99.97% of the airborne particle was removed (0.3 micrometers in diameter).

According to the retention the European Union was classified the HEPA filters, for retention given at the most penetrating particle size (MPPS), the several classes were given in the below table.

HEPA class	Retention (total)	Retention (local)
E10	>85%	-
E11	>95%	-
E12	>99.5%	-
E13	>99.95%	>99.75%
E14	>99.995%	>99.975%
E15	>99.9995%	>99.9975%
E16	>99.99995%	>99.99975%
E17	>99.999995%	>99.999975%

Nowadays, the rating of HEPA filters applied to another highly efficient filter, that provides minimum and equivalent to respiratory filters, which have an efficiency performance standard of N100 rating. The United Institution For Occupational Safety and Health Energy (DOE) has regulated the application for the requirements of HEPA filters, "TRUE HEPA" is the marketing

term used by the companies to give a consumer was confidence about the air filters are meet the specific standard. (10)

Products like "HEPA-TYPE", "HEPA - LIKE", "HEPA-STYLE" OR 99% HEPA" which are not tested in the laboratories, other filters cost was reasonable closely meet the HEPA filtration,

and while other filters were fallen significantly low, making them truly inferior.⁽¹¹⁾

Safety

It was a mechanical air filter, it works as a fine mesh that holds or stops harmful particles by forcing the air from the filter, hence HEPA purifiers have fewer effects like asthma and allergies.⁽¹²⁾

Biomedical application

- The HEPA filter was used in the hospital to protect the patient from pathogen and airborne particles.
- A high level of the filter was used (99.995% effect level) to reduce the microorganism to protect the patients from the diseases.
- Incorporating a high level of energy like ultra-violet light was used to kill the virus and bacteria directly in the filter media.
- Filters were used in the hospital to avoid the spread of disease from patients to patients by the viral and bacterial organism.

Vacuum cleaners

HEPA filters are also used as a vacuum cleaner in the part of the filter system. This is useful for allergy and asthma patients because HEPA filters prevent the pollen and dust of fine particles, which help cause the symptoms such as allergy and asthma. The crucial role of HEPA filter in a vacuum cleaner, in the vacuum cleaner flow of the air, passes through the filter, and there is no sign of air leakage past it. Then it was called "Sealed HEPA" or "True HEPA" filters, because if any sign of leakage in the filter silicone sealant is used to seal the filter. The vacuum cleaner is called "HEPA" because it may have HEPA filters, but not all air was passed through it. Hence, the vacuum cleaner filter is called a "HEPA-like" filter, because vacuum cleaner filters used a similar type of HEPA filter and they have less filter efficiency. Because true HEPA filters need extra density, for the adequate cleaning effect, HEPA vacuum cleaners require more powerful motors to clean the area.

The first model was the "Washable" filter, these washable true HEPA filters are expensive, hence compare to the first model filter other filters are better. The another filter such as the "HEPA 4" standard MERV rating (Minimum Efficiency Reporting Value rating), these are removed dust particles from the air filter by using the rating. These standards are used to measure the overall filter efficiency. The scale range of MERV is from

1 to 20, and also measures the ability of a filter to remove particles in the range of 10 to 0.3 micrometer in size. The higher rating of the filter was used to remove a smaller particle and not only the use of removing more particles from the air.

Vehicle

Airlines

HEPA filters are used in modern airliners because re-circulated air spread the airborne pathogens in the air to cause the aircraft, by the use of HEPA filtering was reduce the spread of airborne particles. In the airplane air was recirculated in the cabin, the air is coming from outside and circulate through the cabin and then pressurized through outflow valves in the rear of the aircraft reason, hence they thinking about the strength, effectiveness, and quality of the filtering system, because of this reason HEPA filters was used in the modern airlines.

Motor vehicles

The world's first HEPA-grade filter was the Tesla Model X.⁽¹³⁾ Release of the Model X was followed, Model S was updated by Tesla, which also has an optional HEPA air filter.⁽¹⁴⁾

Cabin air filters were used in the vehicles, the primary function of the cabin air filters was to clean the cabin inside the vehicle. In modern vehicles which are located behind the glove compartment or under the hood or dashboard. Its job was re-circulate the air and filter all air that comes through the car's HVAC system to prevent dust, smog, pollen, and mold spores from entering. This filter helps clean the area and prevent allergies.⁽¹⁵⁾

II. CONCLUSION

The HEPA filter was used in a controlled environment to maintain the temperature, pressure, humidity to maintain the cleanroom, and also prevent dust, airborne particle in the cleanroom, and also used to protect the employee from health problems such as allergy, asthma. The HEPA filter was used in automobiles, medical facilities, aircraft, and homes. HEPA filters were used to remove 99.97% of particles from the air filter.

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