PERFORMANCE EFFECTS OF MAJOR DESIGN/STRUCTURE DIFFERENCES IN PRIMARY BARRIER SAFETY CABINETS

LAF, BSC and Fume Hoods are primary physical & air barrier safety cabinets.
International standards provide rules of basic design, operation and performance needs for those cabinets.

Claiming advantages of major design and/or structural changes needs to be evaluated both technically and scientifically.

References;
Basic operation principles of primary barriers
International standards (EN12469 & EN14175)
Official published guidelines
Occupational safety regulations
Scientific literature reviews

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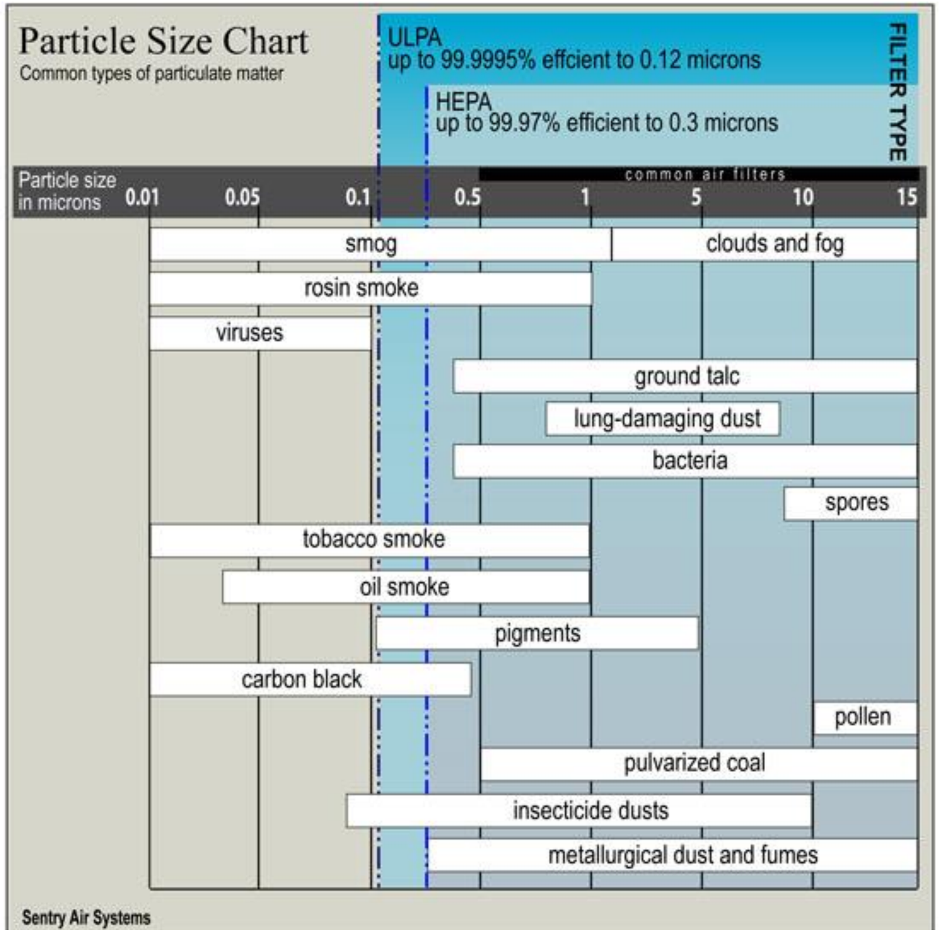
HEPA VS ULPA FILTERS IN BIOLOGICAL AIR SAFETY



EN1822 Sınıflandırması — *EN1822 Classification* — ISPE

Filter Group	Class	MPPS Integral Values		MPPS Local Values		Minimum Efficiency (%) @ DOP (0.3 µm)
		Efficiency (%)	Penetration (%)	Efficiency (%)	Penetration (%)	
EPA	E10	85	15	-	-	95
	E11	95	5	-	-	99,9
	E12	99,5	0,5	-	-	99,97
HEPA	H13	99,95	0,05	99,75	0,25	99,99
	H14	99,995	0,005	99,975	0,025	99,999
ULPA	U15	99,9995	0,0005	99,9975	0,0025	-
	U16	99,99995	0,00005	99,99975	0,00025	-
	U17	99,999995	0,000005	99,9999	0,0001	-

MPPS: Most Penetrating Particle Size (En çok nüfuz eden partikül boyutu)
Efficiency: Verimlilik, **Penetration:** Nüfuz Etme

The filter class description are:

- EPA 10 - EPA 12: Efficiency Particulate Air Filters
- HEPA 13 - HEPA 14: High Efficiency Particulate Air Filters
- ULPA 15 - ULPA 17: Ultra Low Penetration Air Filters

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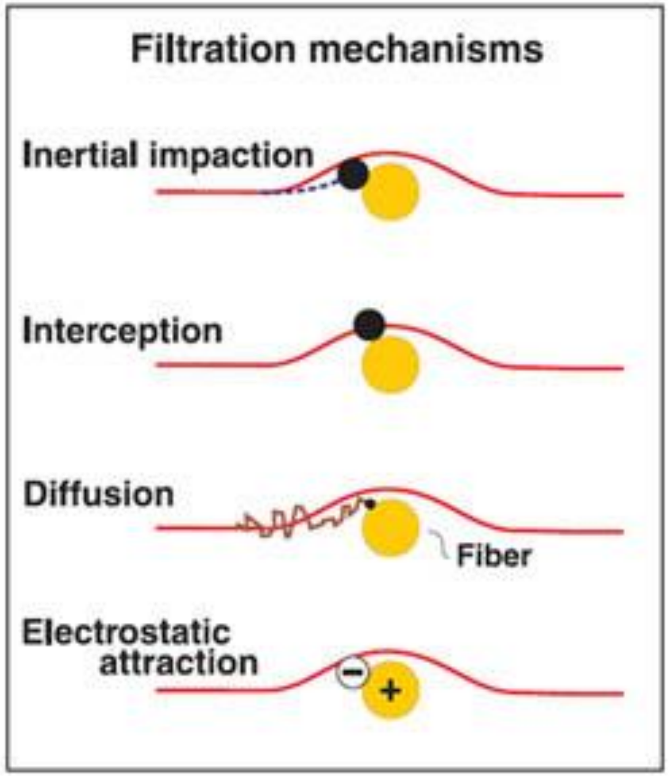

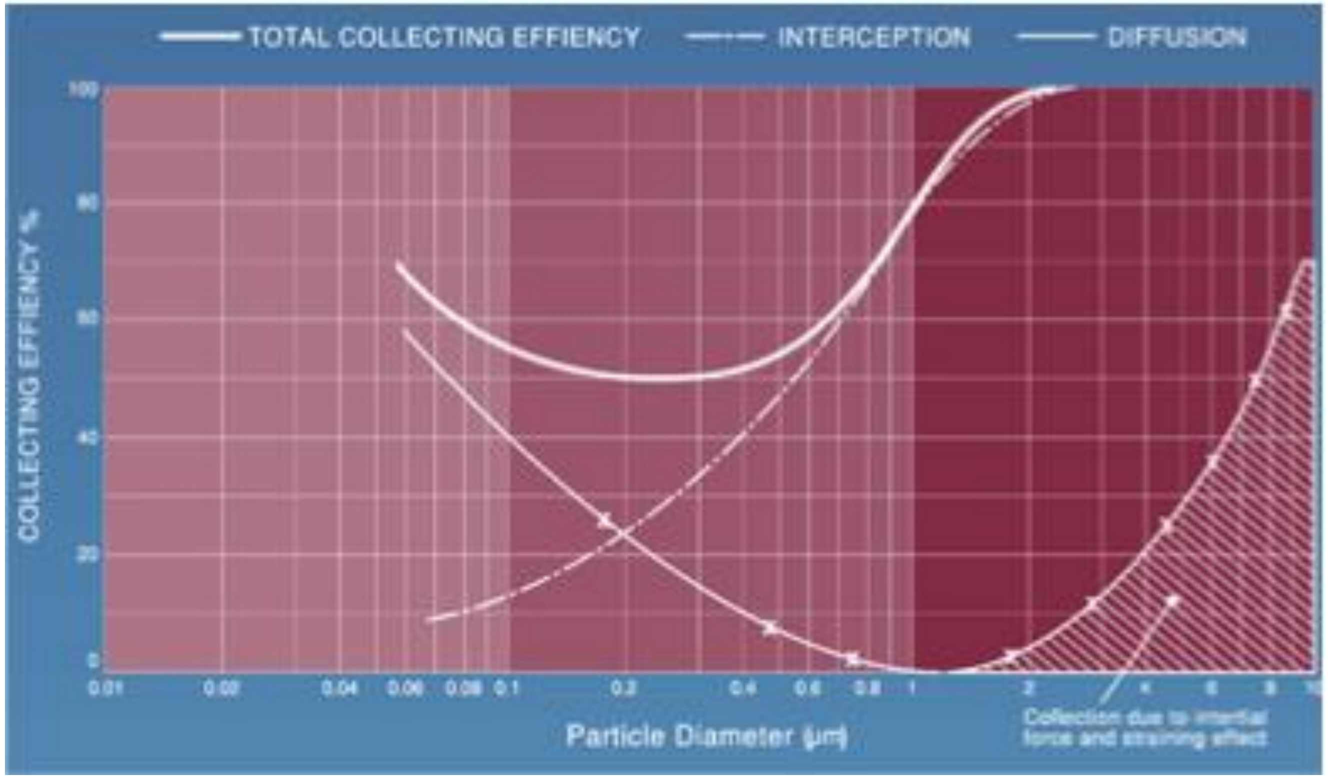

- ➢Particles less than 0.1 micrometers are easily trapped due to diffusion
- ➢Particles larger than 0.4 micrometers are trapped by inertial impaction.
- ➢Filter's efficiency drops within between 0.1 and 0.4 µm; too large for effective diffusion, too small for inertial impaction and efficient interception. Particles around 0.3 micrometers are most difficult to filter.

Specifying a HEPA filter's efficiency at 0.3 µm, standards bodies describe filter's *minimum efficiency.*

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0.3 microns is the size particle at which penetration of particles through the filter is highest

In biological applications, HEPA filters used in those cabinets must effectively trap hazardous bacterium and viruses to provide personnel protection.

Viruses (0.005 - 0.1 micron) generally travel through the air as part of larger particles (0.3 micron or larger), for example, attached to mucous particles.

Single viral particles can not be dispersed or aerosolized and because of the particle collection mechanisms of HEPA filters

Particles larger and smaller than a filter’s most penetrating size are collected with greater efficiency.

As air passes through a HEPA filter;

1. Air comes into contact with the bends and folds of the pleated filter media, the volume of airflow breaks off into numerous smaller air streams
2. Those smaller air streams as its own velocity and the velocity of the air upstream forces the air through the filter.
3. Some particles become trapped because they are larger than the pores of the filter media, throughout the filter media
4. Particles greater than 1.0 micron, Impaction occurs when air traveling through the filter and the particles suspended in entrapment.
5. For small particle entrapment in the 1.0 micron or smaller particle size range, diffusion is the primary collection mechanism. Small aerosolized particles behave similarly to gases in that they move from an area of higher concentration to an area of lower concentration.
6. Particles are removed from the air stream as they settle in areas of low air stream concentration at the fiber surface where other particles are already trapped.
7. The combination of aforementioned collection mechanisms results in effective removal of particles from a HEPA filtered air stream.

The combination of those mechanisms results in effective removal of biological particles from a HEPA filtered air stream.

https://www.tradelineinc.com/reports/2008-12/air-filtration-and-use-hepa-filters-biological-safety-cabinets

HEPA VS ULPA FILTERS IN BIOLOGICAL AIR SAFETY

ULPA and Super ULPA filters have a higher efficiency rating from 99.999 to 99.9999 percent at a smaller micron size (0.1, 0.2 or MPPS). It is a common misconception that ULPA filters given their smaller MPPS rating are somehow better than HEPA filters for biological applications. Microorganisms and viruses are not airborne in single particles, but rather are grouped together in larger particles or are attached to other particles in air.

For biological applications, there is no gain in using an ULPA filter compared to a HEPA filter.

Disadvantages of using ULPA filter in a biological safety cabinet;

1. Creates more resistance in the airflow dynamics of the cabinet, requiring a larger blower motor to maintain proper airflows. ↑ **Energy**
2. A larger blower motor will add increased noise level to the cabinet, and potentially increase vibration levels. ↓**User comfort**
3. ULPA filters require a different testing protocol with equipment that is generally not maintained by BSC certification companies. ↑**Maintenance cost**

Properly designed BSC must meet performance standards for airflow velocities, structural requirements and proven product containment capabilities to ensure user safety. HEPA filtration, biological safety cabinet design and user technique combined provide occupational safety in the biological laboratory.

It is evident why HEPA filters are the industry standard in biological air safety.

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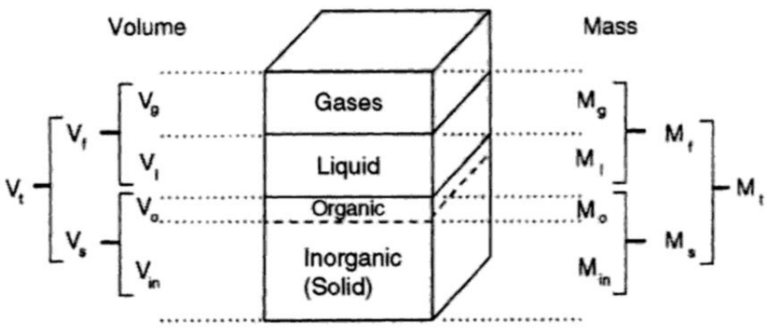
HEPA VS ULPA FILTERS IN BIOLOGICAL AIR SAFETY

Volume (V) Mass (M) relationship of components



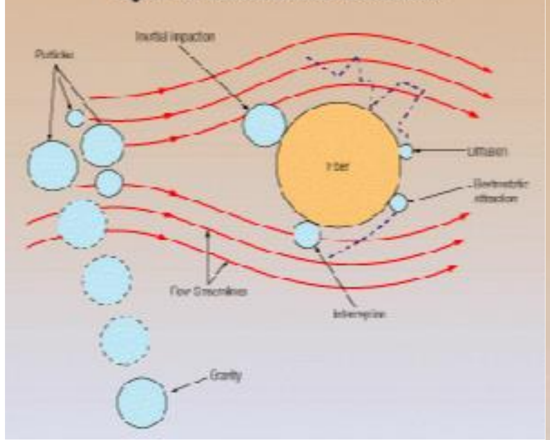


Figure 1: Particle collection mechanisms

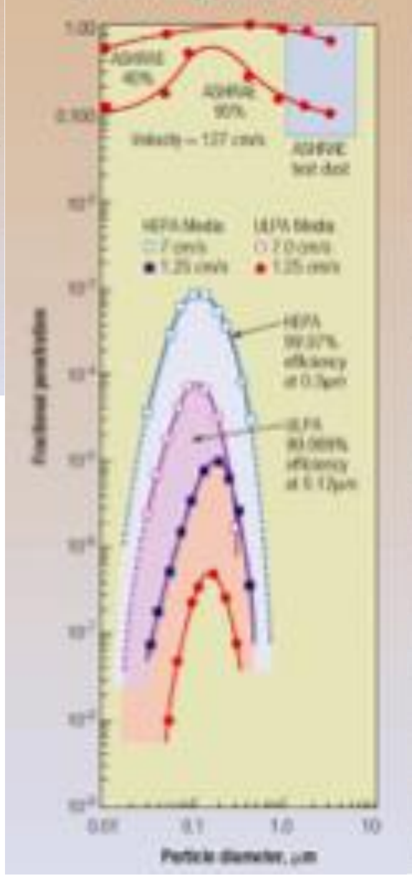


Figure 2: The most penetrating particle size

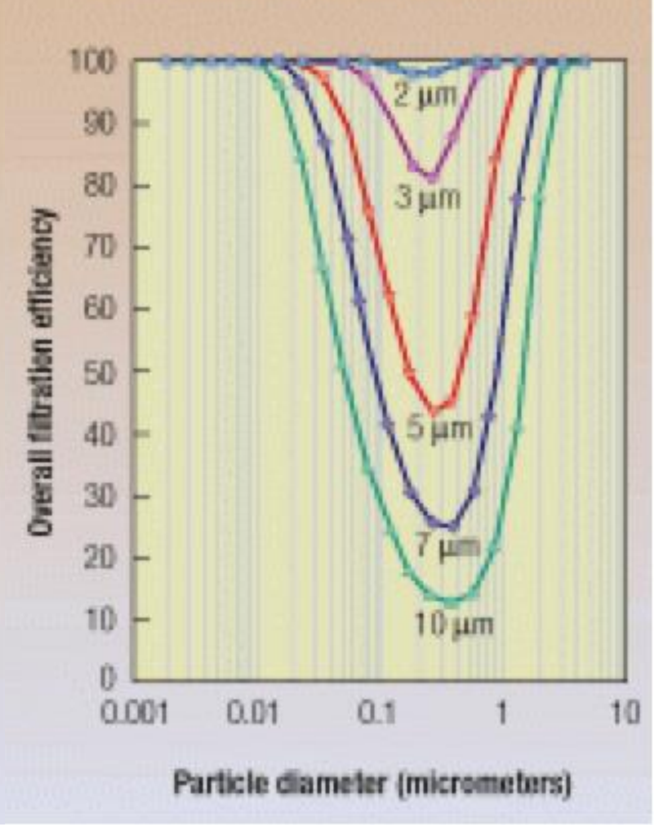


Figure 3: Efficiency as a function of fiber diameter

ULPA filters are intended for use in industries such as the semiconductor industry where the types of particles, especially conductive particles, that are detrimental to semiconductor manufacturing and development are dispersed at smaller submicron sizes.

For biological applications, besides of its disadvantages there is

no gain in using an ULPA filter

compared to a HEPA filter in primary air safety barriers.

HEPA filtration, biological safety cabinet design and user technique combined provide occupational safety in the biological laboratory.