Air filtration system of safety cabinet, SAFE, for collecting biological specimens with airborne pathogens – construction principles

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Abstract

SAFE is a safety cabinet for collecting biological specimens with airborne pathogens and assures full safety against any biological contamination coming from inside or outside the cabinet, especially for people suspected with anthrax, tuberculosis or pulmonary anthracosis infections (Figure 1). SAFE cabinet is a cleanroom class ISO 5. The air filtration system is essential to ensure biosecurity. The paper presents the construction principles of the filtration system of the air inside the cabinet.

Construction

Figure 2 shows the air circulation sketch. There is a single fan which is controlled by a servocontroller and ensures a constant air speed regardless of the clogging of the HEPA filters. An air speed sensor permanently measures the speed, the processing unit compares this speed with the preset one (in the range 0.32 ... 0.48 m/s), and adjusts the rotational speed of the fan so that the air speed remains constant at all times. In case of clogging the filters, the calculation unit sends audible and visual warning, being mandatory to change the filters

In the lower part of the cabinet there are cutouts covered by dust pre-filters where air enters under the floor, and between the double rear walls the air rises in the compartment of the fan and HEPA filters.

The two HEPA filters in this compartment have active surfaces in a ratio of 1 to 4. Because of this, 25% of the air comes out through the HEPA exhaust filter and 75% enters the cabin and is recirculated, the pressure in this compartment being positive compared the environment and the working area.

Air inlet pre-filters do not make a significant contribution to air circulation, they have the role of stopping large dust particles, over 10 microns in size, to protect HEPA filters from premature clogging.

Air circulation is influenced by the movements of the person inside, especially regarding the laminarity of the air jet, for this reason it is important to draw the attention of patients so as not to make sudden and unnecessary movements. A motion sensor monitors the movements.

During specimen collection, the cabinet door must be closed, a sensor monitors this and the computer does not allow the fan to start with the door open

Material and method – principles construction

The air circulation in the cabinet is essential and ensures: (i) supplying fresh air from outside with a minimum flow of 12 air changes/hour, by achieving negative pressure compared to the environment, (ii) hinders the exit from the protected environment of pathogens, and (iii) creates clean air, free of airborne dust and laminar flow from top to bottom, from the ceiling to the floor, by forcing the air jet through HEPA filters to the working area.

For the circulation of the air in the cabinet, a laminar flow must be ensured because otherwise, in case of turbulence, the air exchange could not be ensured efficiently; the dust would rotate inside the cabinet instead of being evacuated. The laminar flow is obtained by fixing the air speed in the range 0.32-0.48 m/s, ensured by the HEPA filters of porosity and adequate construction

Figure 1. SAFE - Safety cabinet for collecting specimens contaminated with airborne pathogens

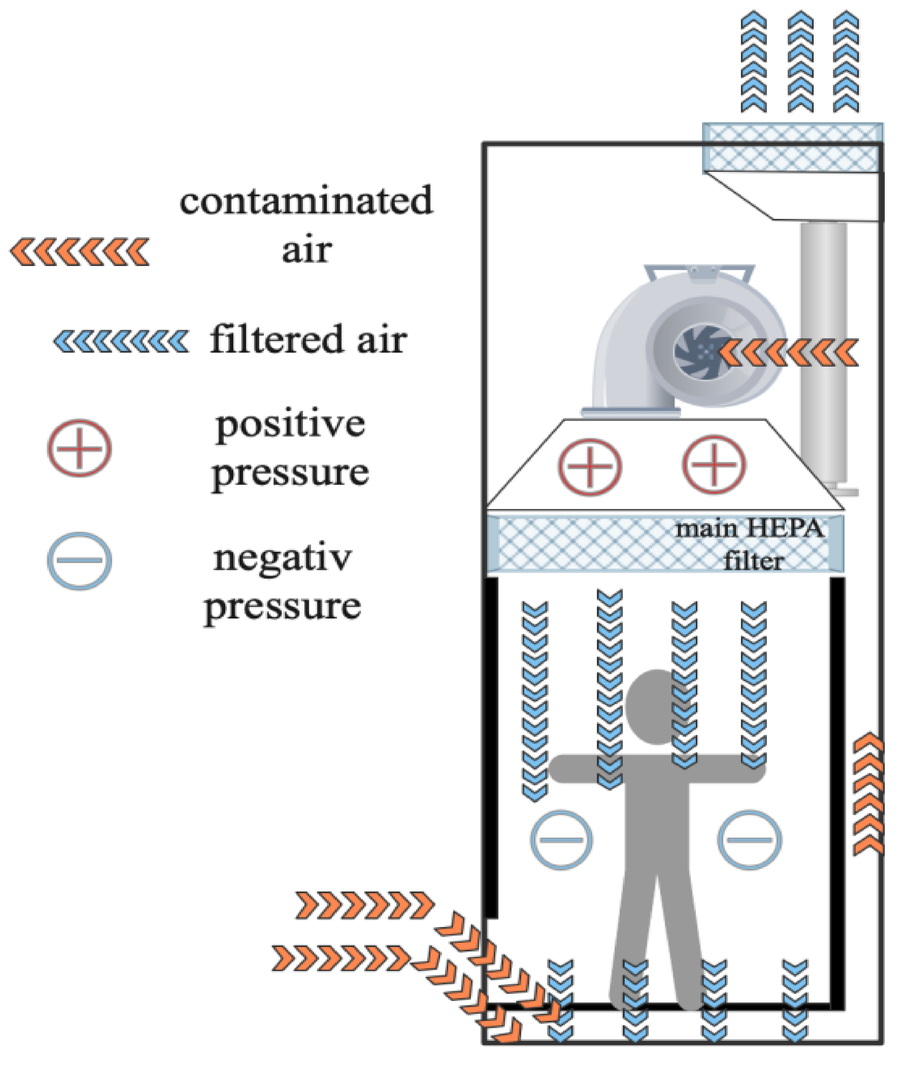

Figure 2. Air circulation in the SAFE safety cabinet

Conclusions

A method of air circulation has been developed for a safety cabinet designed for biological sampling that simultaneously ensures the protection of the patient, medical staff and the environment.

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