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REQUIREMENT OF PRESSURE RELIEF DAMPERS FOR CLEAN ROOMS

POTRZEBA STOSOWANIA KLAP NADCIŚNIENIOWYCH DO POMIESZCZEŃ CZYSTYCH

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Abstract

The clean room is designed and used to minimize the entry, generation and deposition of pollutants. Proper flow control is an important factor in determining the efficiency of clean rooms. It is important that the air stream entrains from the space all the particles that are released when people move, but also from equipment and various materials. Therefore, in the following article we will deal with the need for pressure dampers in clean rooms.

Keywords: clean room, pressure dampers, supply air, pressure drop, air diffusers

Streszczenie

Pomieszczenie czyste jest zaprojektowane i wykorzystywane w taki sposób, aby zminimalizować wnikanie, generowanie i osadzanie się zanieczyszczeń. Właściwa kontrola przepływu powietrza jest istotnym czynnikiem określającym efektywność pomieszczeń czystych. Ważne jest, żeby strumień powietrza porywał z przestrzeni wszystkie cząstki, które są uwalniane podczas ruchu ludzi, ale także ze sprzętu i różnych materiałów. W związku z powyższym w niniejszym artykule zajmiemy się potrzebą stosowania klap nadciśnieniowych w pomieszczeniach czystych.

Słowa kluczowe: pomieszczenie czyste, klapy nadciśnieniowe, dopływ powietrza, spadek ciśnienia, dyfuzory

1. INTRODUCTION

Clean rooms are special enclosed spaces, designed as a prefabricated installation into an existing building. A dust-free environment will serve as the basis for a clean room with high hygienic requirements. Such a clean space is formed by elements that ensure hermetic isolation from the external environment. In order to meet the purity class, the concentration of particles in the room must be sufficiently regulated. The cleanliness and regulation of these environments is ensured by powerful air-conditioning devices with high-quality filtration at the inlet (air intake) and also at the outlet (clean air outlet to the room). The design of clean rooms allows you to control the air quality inside the rooms. The main parameters monitored in a clean room are purity class, number of particles in the air, type of flow – laminar/turbulent, temperature and humidity, pressure, sterility, technology and lighting.

The air conditioning system is the most complex and the most demanding part of a clean room to operate. The basic role of air conditioning in a clean room is to protect not only people inside the room, but

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also products and the environment. Due to the basic role of air conditioning in clean rooms, ie the supply of a sufficient amount of air with defined parameters and especially the emphasis on its cleanliness, air conditioning in clean rooms is provided with three-stage filtration. The final element of filtration are HEPA filters. The parameters of HEPA filters are given primarily by the requirement for environmental cleanliness and air flow. Another and no less important parameter is the pressure drop [1].

One of the most important factors that determine the efficiency of clean rooms is proper flow control. It is important that the air stream entrains from the space all the particles that are released when people move, but also from equipment and various materials. Thus, the air stream must bypass all surfaces in the clean room and remove the particles from these surfaces [2].

2. MEASUREMENT METHODS

The type, number and location of air supply diffusers, as well as the exhaust grilles, are an important factor in a turbulently ventilated clean room. Air to a clean room can be supplied with or without a diffuser. Air diffusers are used in many air-conditioned rooms and are located where the supply air enters the room; they are designed to minimize drafts caused by high air velocities and ensure good air mixing. This is shown in Figure 1.

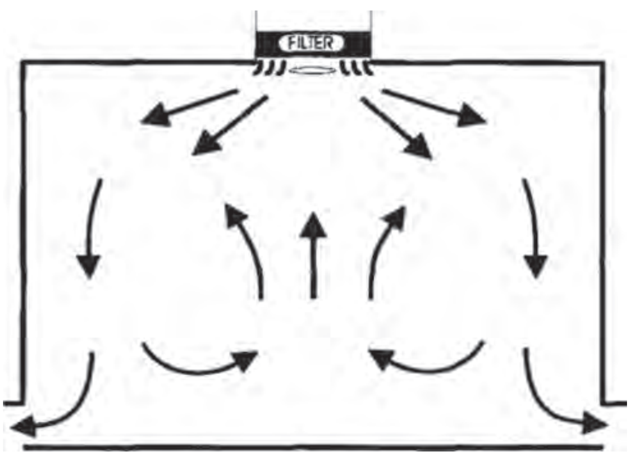

Fig. 1. Airflow conditions produced by a ceiling diffuser (Whyte, 2001)

In some normally ventilated clean rooms, diffusers are not used and the supply air is "discharged" directly from the air filter into the clean room. This method is chosen to obtain a unidirectional flow and good conditions for controlling contamination under the filter; this is schematically shown in Figure 2.

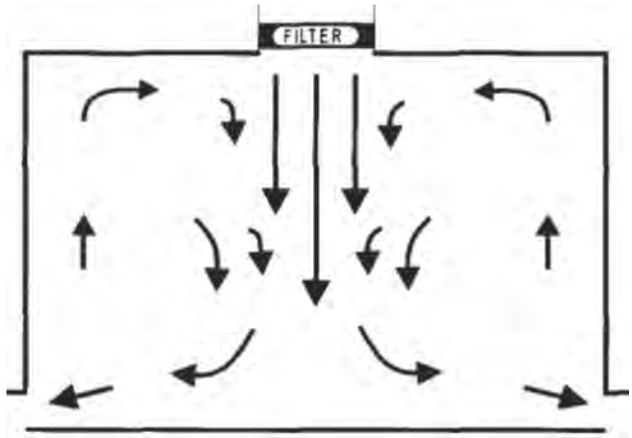

Fig. 2. Aifflow conditions produced by a "dump" system (Whyte, 2001)

In areas of higher cleanliness, the air pressure must be higher than in less clean areas (overpressure ventilation). This is to prevent pollution from entering a cleaner environment into a cleaner space. It is also undesirable for the penetration of pollution from the external environment. Exceptions are clean rooms where hazardous substances are handled. In these clean work areas, the air pressure must be lower than in the surrounding environment (vacuum ventilation) [2].

Areas in which persons reside for a long or short time must be ventilated. This is achieved by either natural ventilation or machine forced ventilation. Ventilation depends on the number of people, their activity, heat balance and the amount of polluted air. The requirements for the minimum amount of air required for breathing, the cleanliness of the indoor air and the removal of degraded air by various odors must be met. Natural ventilation, intended for air exchange, can be used especially in areas without a source of excessive heat and pollutants. These are spaces where one to two changes in the intensity of untreated air is sufficient. In other cases, where natural ventilation is not sufficient, forced ventilation is used. The number of openings, the location of the air supply and exhaust ducts and the type of ventilation shall be determined by expert calculation [3].

3. RESULTS OF THE CLEAN ROOM

In Figure 3, the air will leave the central production room to the clothes change and material transfer areas and further to the outdoor corridor. To ensure that the movement is in the right direction, the air flow can be observed with smoke, water vapor or a stream of air. Although this method is satisfactory in creating a clean room before handover, it is not a possibility

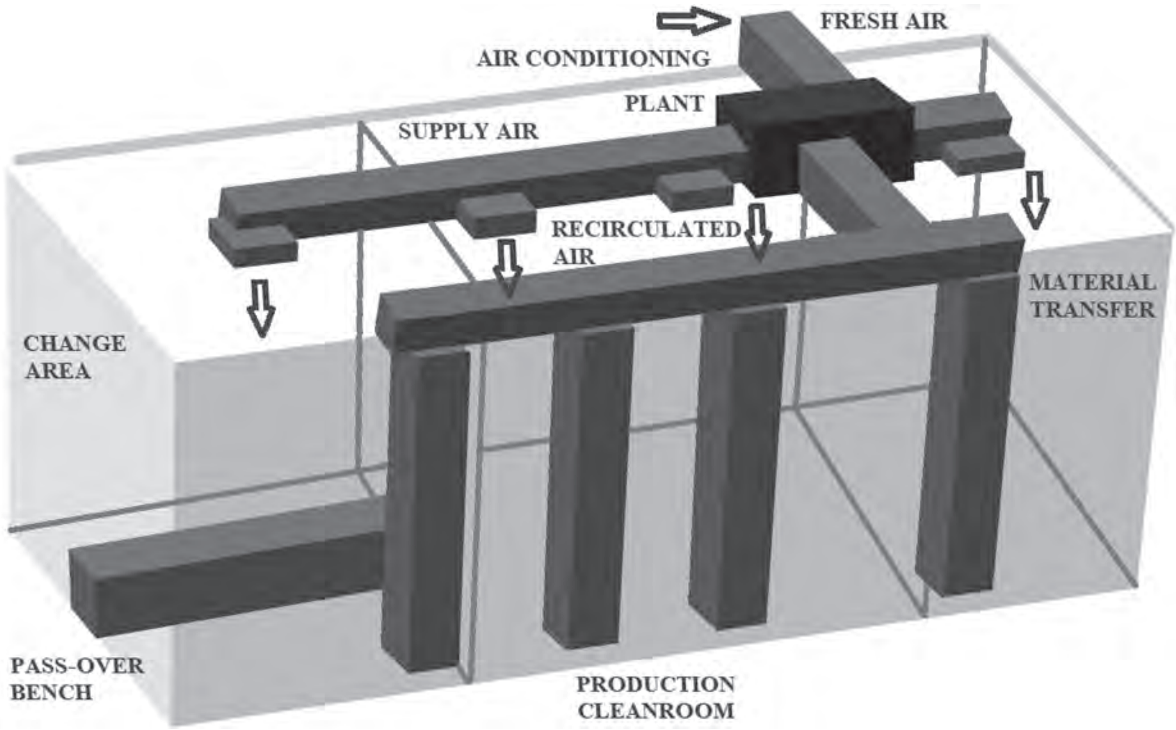

Fig. 3. A turbulently ventilated cleanroom (own source)

of long-term monitoring. To monitor a clean room, it is common practice to check that cleaner areas are under positive pressure than less clean neighboring areas. If the pressure in a clean room is higher than in the adjacent area, air will flow from the clean room to the adjacent area. Differential pressures of 10 Pa between two clean rooms and 15 Pa between a clean room and an unclassified area are appropriate design pressures (12 Pa, 0.05 inch water meter). Where practical difficulties arise in achieving these pressures, e.g. where there is a supply tunnel connecting the two areas, a minimum pressure difference of 5 Pa may be acceptable. In a clean room suite, the air pressure should be adjusted so that the air moves from clean to less clean areas. This means that the highest pressure should be in the production area [3].

Figure 4 is a diagram of a set of clean rooms, which is slightly more complicated than Figure 3, because it has two rooms in the area of changing clothes, and therefore it is necessary to maintain another pressure difference. In this suite, the production room would be set to a pressure of 35 Pa compared to the external access corridor. This is necessary to achieve a pressure difference of 10 Pa between the production room and the changing room, a difference of 10 Pa between the changing room and the changing room and 15 Pa between the changing room and the external access corridor; it gives a total of 35 Pa.

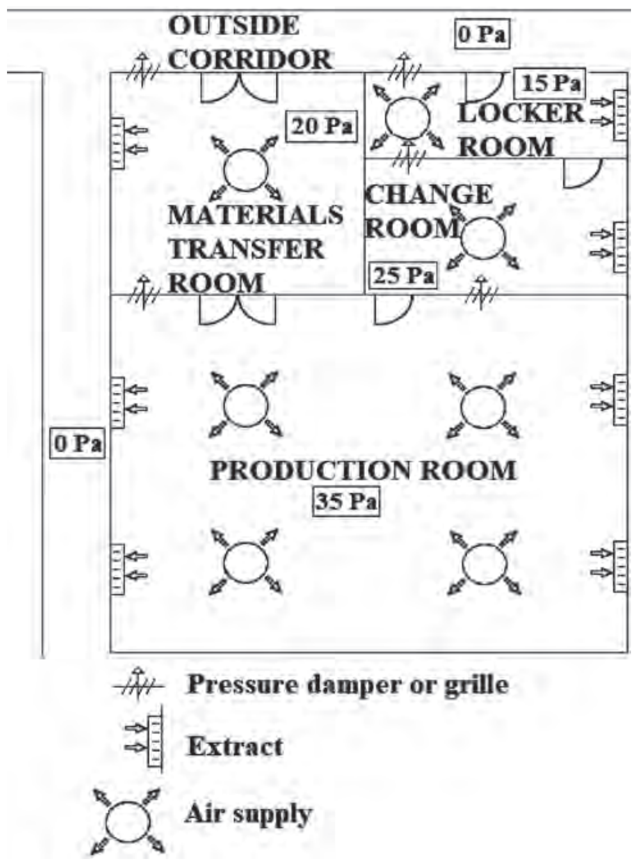

Fig. 4. A simple cleanroom suite showing pressures and aifflow between areas (own source)

environment

Because a pressure difference of 35 Pa is set between the production room and the external corridor, the same pressure is available in the material transfer room.

The material transfer area can therefore be 15 Pa smaller than the production area and 20 Pa larger than the outer corridor; this pressure difference is greater than required but quite acceptable. However, if too large a pressure difference is used, additional energy costs will be incurred. Problems can also occur when trying to open and close a door, as well as "whistling" through cracks [3].

4. CONCLUSION

A clean room must be designed to ensure that contaminated air does not enter the room from dirtier adjacent areas. Therefore, the air should always move from a clean room to less clean adjacent areas. Standards and guidelines set requirements for pressure drop. A pressure drop below 5 Pa is not practical because it cannot prevent air backflow. In addition, such a small pressure difference is difficult to control and is maintained due to the sensitivity of the control elements. Increasing the pressure to more than 20-25 Pa (except for insulator technology) is not rational, because it does not improve the characteristics of the clean room and means a significant increase in costs. There may also be difficulties in opening and closing the door. Due to the high pressure in the air flow, noise can be generated through various types of exhaust grilles or through other air leaks. The pressure drop must be sufficient in size and stability to prevent unforeseen mixing of the air streams.

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