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IDENTIFICATION OF A FACTOR THAT SHOULD BE INCLUDED IN AIR QUALITY AND MICROCLIMATIC STUDIES OF AIR-CONDITIONED BUILDINGS

Aleksandar Zunjic[1,a], Xiao-Guang Yue[2,b]
[1]University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia
[2]Wenzhou Business College, Wenzhou, China
[a]azunjic@mas.bg.ac.rs, [b]xgyue@foxmail.com

Abstract Air-conditioned buildings are buildings that are increasingly used for providing adequate working and living conditions for employees. A large number of offices, classrooms and other workrooms are located in buildings of this type. For this reason, the measurement and control of air quality and microclimatic conditions in buildings based on the use of HVAC systems is of great importance. This paper aims to point to an important factor to be considered when assessing air quality and microclimatic conditions in air-conditioned buildings. In many scientific papers and everyday practice, adequate importance has not been given to the above-mentioned factor, first of all in the context of its potential impact on the results of air quality control. Often it was omitted from the consideration, or it was incompletely considered. This paper emphasizes the importance of a comprehensive examination of this two-component factor described in this paper, which essentially represents a combination of a technical and a human factor.

Keywords: Air-conditioned buildings; HVAC; ventilation; air quality; microclimate conditions.

1. INTRODUCTION

Features of indoor air depend on a number of factors. The most frequently studied factors are the types of gases and particles that are present in the air, as well as microclimatic factors. Comfort, health, safety and performance of people who live and work in these rooms to a great extent depend on the air quality and microclimatic factors. For this reason, the provision of adequate properties and quality of air in the work premises, such as, for example, offices, has a special significance. In view of this, adequate measurement and control of air quality in buildings, especially in office space, is of great significance, bearing in mind the vast majority of the human population working in them.

This paper aims to point to one important factor that has not been taken into consideration when providing and controlling the air quality in the working rooms, or is taken into account partially and incompletely. Before contemplating the mentioned factor, it is necessary to mention the crucial determinant for controlling and providing adequate air quality, which relates to the provision of air in the closed rooms. There are three basic ways in which the air circulation can be ensured in enclosed spaces. The oldest way for providing the fresh air in the rooms is through natural ventilation. Based on diffusion, stack effect or difference in air pressures outside and inside the room, air circulation is ensured. This way of providing air in the workspaces has certain advantages and disadvantages in relation to other ways of ventilation. The primary advantage of natural ventilation in relation to the mechanical is the price. Natural ventilation is almost free. The basic drawback of natural ventilation is the inability to precisely control the microclimate (air temperature, relative humidity, flow rates) in

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relation to the mechanical ventilation system. However, regardless of the advantages and disadvantages of this way of providing air in the workspaces, it is considered to be the most natural.

The other way of providing air in closed rooms is solely through the HVAC system. There are several types of HVAC systems that are being applied today. When designing such systems, it is assumed and foreseen that the windows, doors and other openings on the buildings are closed, i.e. that there is no natural ventilation. It is believed that the first commercial building in America (where such a system of air supply in the workspaces is mostly used) with the mentioned system was built in 1928 (Milam Building, San Antonio, Texas). This way of providing air in the premises also has certain advantages and disadvantages. The main advantage of this system is the possibility to strictly control the microclimate in the room. In addition, when the system is adequately designed for environmental conditions, it is possible to control the particles and gases entering the room. The basic disadvantage of this system is its price. Designing, installing and implementing this system can be a significant financial expense for the company. In addition, this system may have additional disadvantages, which will be discussed later.

Mixed mode ventilation (hybrid ventilation) is the third way of providing indoor air. This method is based on the combination of the two previous methods. Therefore, a combination of natural and mechanical ventilation is used (mechanical ventilation here implies a system that includes filtration, as well as temperature and humidity control, i.e. HVAC system). In this case, mechanical systems can be used as a supplement or to control the natural stream. It is considered that the basic advantage of this ventilation mode is a significant possibility of financial savings that can be achieved, above all in relation to the mechanical ventilation mode.

2. FACTOR OF THE PROCEDURE OF MEASUREMENT AND AIR QUALITY CONTROL IN THE AIR-CONDITIONED BUILDINGS

Air-conditioned buildings are buildings that are designed for a mechanical type of ventilation. In most cases, this means that the windows on the buildings cannot be opened. Window glass, in this case, serves primarily to provide natural lighting inside the room. It should be mentioned that the concept of windows that cannot be opened at all is being applied in recent times, and one of the main reasons for its application is the economic savings, based on lower electricity consumption that is realized on account of the reduced need for temperature and relative humidity control in the room.

However, with regard to air-conditioned buildings, there are certain exceptions to the previously described concept. In connection with this, first of all, it should be noted that most previously built air-conditioned buildings have windows that can be opened [1]. Of course, this does not mean that new buildings are no longer being constructed, which can be classified as buildings with mechanical ventilation, where there is the possibility of opening the windows.

There are several reasons for the existence of an option that relates to the ability to open windows on air-conditioned buildings. One of the reasons is the possibility of a malfunction of an air-conditioning system [2]. If the windows on the building cannot be opened, depending on the length of repair time and the number of people working in the building, the problem can become significant. In addition, the greater the ability to control the climate by people living and working in a particular building,

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such as the case with the possibility of windows opening, there are fewer complaints about the climate in the building [3]. Opening windows also facilitate the possibility of their regular washing in buildings with mechanical ventilation [4]. The possibility of opening windows has an additional positive psychological effect because in this way the feeling of discomfort in people working in air-conditioned buildings is reduced [2]. The number of open windows [4] is also taken into consideration in certain calculations related to the design of air-conditioned buildings.

Figure 1. An example of an air-conditioned building with windows that can be opened.

Previously mentioned indicates that in some air-conditioned buildings there is a possibility and practice of opening of windows. If employees practice opening of windows, especially in areas where outdoor air is clean, then the way of heating and air-conditioning of such buildings is approaching the way of heating and air-conditioning of buildings with hybrid ventilation. The degree of matching, in this case, depends primarily on the level of climate control in the building in the described manner, i.e. primarily from the number of open windows and the time in which they are open.

The window opening process in air-conditioned buildings can affect the climate and air quality in the room to a greater or lesser extent. However, the problem is that, until now, the aspect of opening the windows in air-conditioned buildings has not been adequately taken into consideration when measuring and controlling air quality. In connection with this, a number of scientific studies were carried out covering the air-conditioned buildings. These studies [5, 6, 7, 8] dealt with the problem of air quality and the microclimate conditions. However, in these studies it is not explicitly stated whether air-conditioned buildings had windows that could open and close. Also, it was not stated the data whether practice of windows opening existed, as well as the information to what extent this option was used by the persons residing in such premises.

2018, Volume 2, Issue 1, 1-5, DOI 10.6723/TERP.201806_2(1).0001

The non-existence of these data may to some extent affect the validity of air quality control in air-conditioned buildings. In this way, it can be called into question the assessment of the efficiency of the system based on the measurements, in terms of adequacy of obtained results concerning the type and concentration of purified particles and gases in the air. For example, the assessment of health risks based on changing ventilation rates or air filtration efficiency without information about the practice of opening windows in air-conditioned buildings may be incomplete. This also applies to the measurement of microclimate parameters in such buildings. The management of most companies forbids the opening of windows in order to save energy that the HVAC system can additionally consume if the windows are open. However, there are also exceptions to this rule. Occasionally or continuously, employees can also practice opening of windows in cases when they feel it is necessary, even if a formal ban exists.

3. CONCLUSION

When studying and measuring air quality in rooms, it is important to determine the source of air contamination (if there is one). There are three basic sources of air contamination of enclosed premises. These are the sources located in the room itself (things, people, technological processes, etc.), sources outside the building (i.e. outside air) and the HVAC system (primarily if it is inadequately maintained). In order that we can exclude the direct influence of external unfiltered air from the consideration as a cause of the air contamination in air-conditioned buildings, for interpreting the results of the measurement and making the conclusions, displaying of the data concerning the possibility and practice of using and opening the windows is of big importance.

Windows enable natural ventilation. In this respect, in the environments where, due to different sources of pollution, the outside air is not clean (such as urban environments with developed industry and where also exist sources of pollution from traffic), air contamination in the room is possible, if there is a practice of opening the windows and doors in the air-conditioned buildings. If there are no internal sources of contamination, while the factor of opening and closing the windows has not been taken into account, then the wrong conclusion may be made that the HVAC system is inadequately designed, implemented, or that its maintenance is inadequate. However, in certain situations, the HVAC system can be adequately designed, implemented and maintained, whereby the true source of pollution can be external unfiltered air entering through the window and other openings. Estimating the efficiency of the HVAC system from the aspect of providing adequate microclimatic conditions also depends on the mentioned factor.

In addition, mentioning only the information that windows in an air-conditioned building can or can not be opened is also not enough. Complete information on this topic in a procedural sense implies examining and presenting information people's behavior about opening windows in such buildings. Information on the practice of people regarding the opening of windows in air-conditioned buildings will contribute to the formation of a complete picture regarding this occurrence and the adoption of adequate conclusions and decisions regarding air quality.

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