CALCULATION OF THE VENTILATION SYSTEM FOR OFFICE BUILDINGS

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Abstract. This thesis presents a study on the calculation of ventilation requirements for an office building. The aim of this research is to determine the optimal ventilation rate necessary to maintain indoor air quality and occupant comfort. Various factors such as occupancy levels, building size, and outdoor air quality are considered in the calculations. The study utilizes mathematical models and simulation tools to estimate the required ventilation rates for different scenarios. The results of this research will provide valuable insights for building designers and HVAC (heating, ventilation, and air conditioning) engineers to improve the overall indoor air quality and energy efficiency of office buildings.

Ventilation – the recirculation of fresh air around a closed space or the system air through the conducting passages between the atmosphere. It is a process of replacement of indoor air with fresh outdoor air. It is movement of indoor air to out and outdoor air to inside a closed area. There are two types of ventilation: Natural ventilation – pressure difference is caused by difference between densities of interior and exterior air given by the temperature difference wind velocity providing on windward facade positive pressure and on leeward negative pressure. Mechanical ventilation – pressure difference is caused by dynamic pressure of a fan and blower. It is systems circulate fresh air using ducts and fans, rather than relying on airflow through small holes or cracks in a home's walls, roof, or windows.

Working principle of mechanical ventilation system

The principle of a mechanical ventilation system is to use mechanical equipment, such as fans and ductwork, to supply and exhaust air from a building. This system helps to control and regulate the airflow within a space, ensuring that fresh outdoor air is brought in while stale indoor air is removed.

– Airflow control: the system is designed to control the flow of air into and out of the building, ensuring that the ventilation rate meets the required standards for indoor air quality.

– Filtration: mechanical ventilation systems often include filters that help to remove pollutants, dust, and other contaminants from the incoming air, improving indoor air quality.

– Distribution: ductwork and vents are used to distribute the fresh air throughout the building and exhaust stale air from occupied spaces.

– Energy efficiency: modern mechanical ventilation systems are designed to be energy-efficient, with features such as variable speed fans and energy-recovery systems to minimize energy consumption.

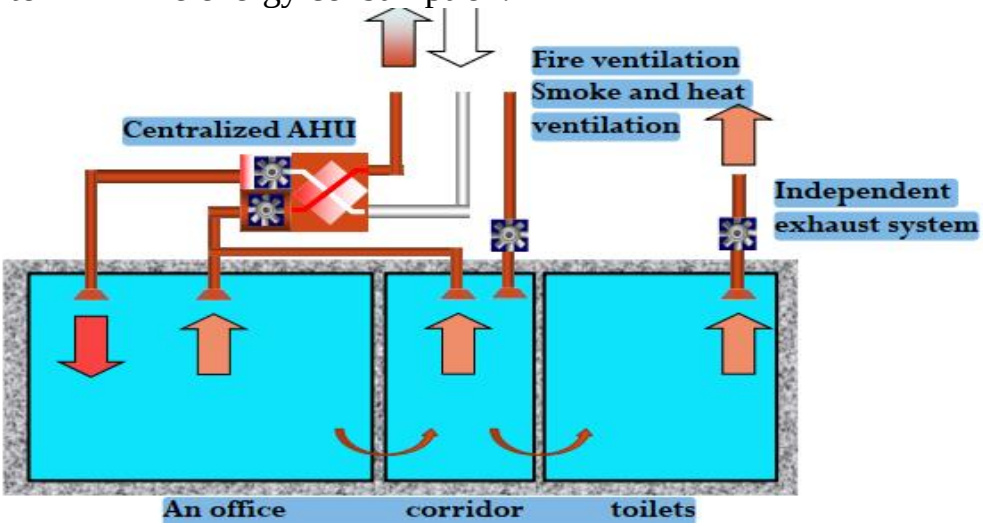

Figure 1. Principle of mechanical ventilation system.

Figure 1 shows that the principle of mechanical ventilation system of centralize for the office building. In office area centralize ventilation system has two fans first is supply fan, which is extract air from atmosphere and supply to the office area and second is extracting air from office area and throw it to the atmosphere. There is a corridor area supply air duct is installed at that corridor area, but there is a fire ventilation a smoke heat ventilation fan is also installed separately. For the toilet exhaust system, there is a separate or independent exhaust systems installed in toilet so that there is no smoke or a smell is coming out in the office area or corridor. By this example given a above that explain the ventilation system of the building and how it's work. By following these principles, a mechanical ventilation system can effectively provide the required airflow and maintain a healthy indoor environment for building occupants.

Calculation methodology

Air change is simply the number of times that the volume of air in a room gets replaced each hour. In the context of HVAC service work, it's a measurement of the amount of air flow and ventilation in a room, as supplied by air conditioning or air purification equipment.

There are following points that explaining the calculation:

– determine the occupancy of the office building: find out how many people will be working in the office space on a regular basis;

– calculate the total floor area of the office building: measure the total floor area of the office space in square feet or square meters;

– determine the ventilation rate: the ventilation rate is typically measured in air changes per hour (ACH) or in cubic meter per hour (CMH). The recommended ventilation rate for office buildings is usually around 20 CMH per person;

– calculate the required ventilation airflow: multiply the number of occupants by the ventilation rate to determine the total airflow required for the office building;

– determine the type of ventilation system: there are different types of ventilation systems that can be used in office buildings, such as natural ventilation, mechanical ventilation, or a combination of both. Choose the most suitable option based on the building design and requirements;

– consider additional factors: factors such as outdoor air quality, humidity levels, and potential sources of indoor air pollution should also be taken into account when calculating ventilation requirements.

It's important to consult with a qualified HVAC engineer or building professional to ensure that the ventilation system meets all relevant codes and standards for your specific office building. The sizing procedure is ventilation rate, decide on number of fans and grilles/diffusers.

The following formula may be used:

– for general mechanical ventilation

Ventilation rate (m^3/h) = Air change rate (/h) x Room volume (m^3)

Ventilation rate (m^3/s) = Ventilation rate (m^3/h) /3600

Example 1. An office building has area 25mx15m and height is 3m space of room and the number of people is 12. At the 2.5 air change per hour in the office calculate the rate of ventilation?

Volume of room - 25m x15 m x 3m =1125 m^3, Air Change - 2.5 per hour

Ventilation rate =Air change rate (/h) x room volume (m^3)

Flow= Q, Air change= A, Room Volume= V

$$Q = A \times V = 1125 \times 2{,}5 = 2812{,}5 \ \frac{m^3}{h}$$

Example 2. Let's walk through an example calculation for determining the ventilation requirements for an office building:

– determine the occupancy: let's say the office building has 50 employees working in the space;

– calculate the total floor area: assume the total floor area of the office building is 1000 square meter;

– determine the ventilation rate: the recommended ventilation rate for office buildings is typically around 40 CMH per person;

– calculate the required ventilation airflow:

Total airflow = Number of occupants x Ventilation rate

Q= 50 people x 40 CMH/person ***Note***- *cubic meter per hour (CMH)*

Q= 2000 CMH or Q =2000 m^3 /h

– determine the type of ventilation system: let's assume we will use a mechanical ventilation system to provide the required airflow;

– consider additional factors: make sure to account for any specific requirements or factors that may affect the ventilation system design, such as outdoor air quality, humidity levels, or potential sources of indoor air pollution. By following these steps and calculations, you can determine the ventilation requirements for an office building and ensure that the indoor air quality is maintained at a healthy level for occupants.

Conclusion

In conclusion, the calculation of ventilation requirements for an office building is a critical aspect of ensuring indoor air quality and occupant comfort. This study has highlighted the importance of considering various factors such as occupancy levels, building size, and outdoor air quality in determining the optimal ventilation rate. By utilizing mathematical models and simulation tools, we have been able to estimate the required ventilation rates for different scenarios. The results of this research provide valuable insights for building designers and HVAC engineers to improve the overall indoor air quality and energy efficiency of office buildings. Moving forward, it is essential to continue exploring innovative ventilation strategies to enhance occupant well-being and sustainability in office environments.

References

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