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FEATURES OF AIR EXCHANGE SOLUTIONS IN HIGH-RISE RESIDENTIAL BUILDINGS

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ABSTRACT

The article discusses the device of independent ventilation ducts from the chamber to the ventilated room and high-rise buildings with a large number of floors. The exchange rate in kitchens and sanitary facilities should be taken according to calculations and determination of the cross-section of the supply and exhaust ventilation ducts in high-rise buildings

KEYWORDS

Infiltration, through ventilation, damper or throttle valve, channel combination, multiplicity, intermediate floor.

Introduction

The amount of fresh air entering the premises of high-rise residential buildings with the same population density should be the same as in mass-construction residential buildings. However, due to the increased wind speed at high altitudes and the influence of zones located one above the other, the infiltration of fresh air in high-rise buildings is different.

The intensity of infiltration depends on the wind, temperature differences, the tightness of the enclosing structures and many other factors, and for each building, depending on its planning features, the intensity of infiltration will be different.

According to approximate calculations, for three- and four-room apartments without cross-ventilation, equipped with supply and exhaust ventilation and double apartment doors, in a 30-story building divided into three equal zones, the infiltration of outside air at an outside temperature of -5 °C and average wind speeds is expressed by the following average values:

- The first zone (up to 40 m from the ground): wind speed 2–3 m/s; the average exchange rate created by infiltrating outside air is 0.25, with an increase in the lower floors to 0.3 and a decrease in the upper floors to 0.2 exchange /hour.
- The second zone (40–80 m): wind speed 3–4 m/s; average exchange rate 0.35 exchange /h, with an increase in the lower ones to 0.4 and a decrease in the upper ones to 0.3 exchange /h.
- Third zone (80–120 m): wind speed 4–5 m/s; average exchange rate 0.45 exchanges /h, increasing to 0.5 in the lower floors and to 0.4 exchanges /h in the upper floors.

The air exchange rate in living rooms created by supply and exhaust ventilation (given the above data) should be as follows:

- In the first zone:

- on the lower floors: 1.25 – 0.3 = 0.95 rpm /h;

- on the upper floors: 1.25 – 0.2 = 1.05 rpm /h.
- **In the second zone:**
- on the lower floors: 1.25 – 0.4 = 0.85 rpm /h;
- on the upper floors: 1.25 – 0.3 = 0.95 rpm /h.
- **In the third zone:**
- on the lower floors: 1.25 – 0.5 = 0.75 rpm /h;
- on the upper floors: 1.25 – 0.4 = 0.85 rpm /h.

In all intermediate floors of each zone, the exchange rate can be determined by interpolation with rounding to 0.05 vol /h. Thus, the air exchange value for residential rooms of a multi-story high-rise building is determined within the range of 0.75–1 vol /h, which is recommended by the temporary technical conditions.

The exchange rate in kitchens and sanitary facilities should be the same as in mass-produced residential buildings. The amount of air extracted and supplied to the apartment should be the same. The initial value for determining the cross-section of the supply and exhaust ventilation ducts in high-rise buildings should be considered the air velocity, which is taken in such a way that in the event of fan inactivity, the system can operate on natural induction. For these reasons, the radius of action of the ventilation system should preferably be no more than 10-12 m.

To increase the resistance of the ventilation system during normal operation with an active fan, a damper or throttle valve should be installed on each supply and exhaust duct. These control devices are installed in close proximity to the ventilation grille or at the point where a group of ducts joins.

The selection of supply and exhaust ventilation fans is made based on pressures depending on the height of the building: at 20 floors not less than 20 mm H2O, at 30 floors not less than 30 mm H2O, etc.

Otherwise, the calculation of ventilation devices does not have any special features and is carried out in the usual way.

To reduce the number of ventilation chambers in high-rise buildings, it is permitted to connect apartments located in different zones to one chamber.

For ventilation to operate on natural draft, the supply chamber is located below, and the exhaust chamber is located above the serviced rooms. The location of the ventilation chambers can be the basement, technical floors and attics. In order to prevent the draft from reversing when the system operates on natural draft, the air discharge from the exhaust systems serving interconnected rooms must be at the same level.

The installation of independent ventilation ducts from the chamber to the ventilated room and high-rise buildings with a large number of floors causes serious difficulties. Therefore, the following combinations of supply and exhaust ducts are allowed:

a) serving living rooms - into one horizontal channel within one apartment;

b) servicing bathrooms and toilets - into one horizontal channel within one apartment;

c) vertical channels – into one collection channel within one zone.

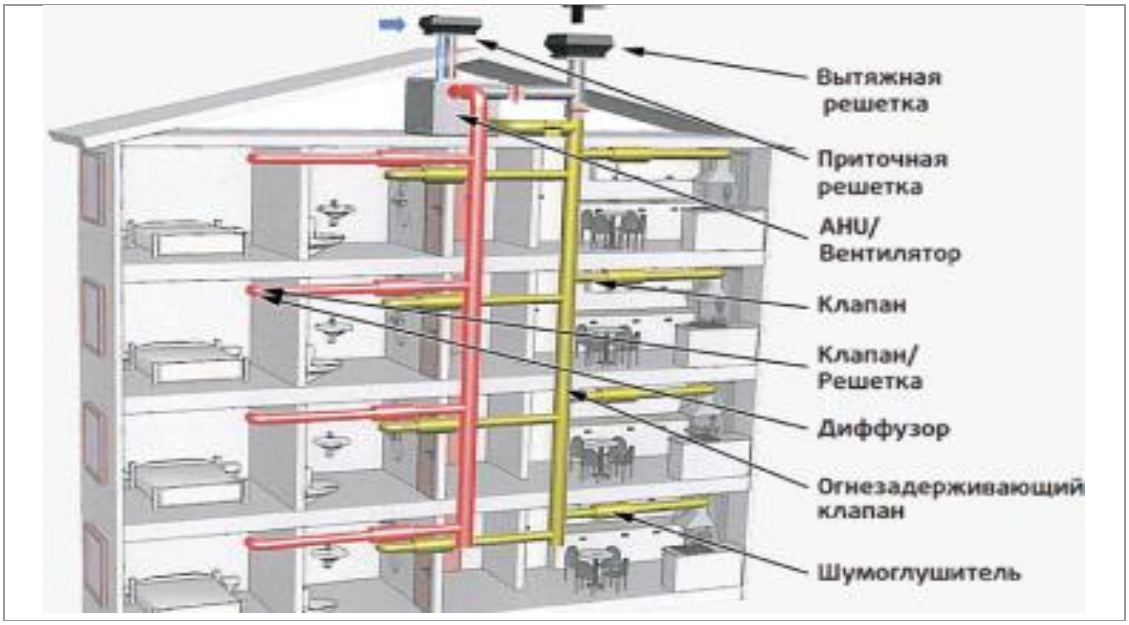

Figure 1. (more details) Combining vertical channels from individual floors into one common vertical channel of the zone

It is also permissible to combine vertical exhaust ducts from homogeneous rooms into one duct with a gap every two floors, as is shown schematically in the section of the building shown in Fig. 1. Such a combination may be allowed in exceptional cases, since under unfavourable conditions air may flow from one apartment to another. In any case, such a combination of ducts serving rooms with windows facing opposite sides should not be allowed.

It is recommended that vertical supply and exhaust ducts be located primarily in walls or in special shafts made of non-combustible materials.

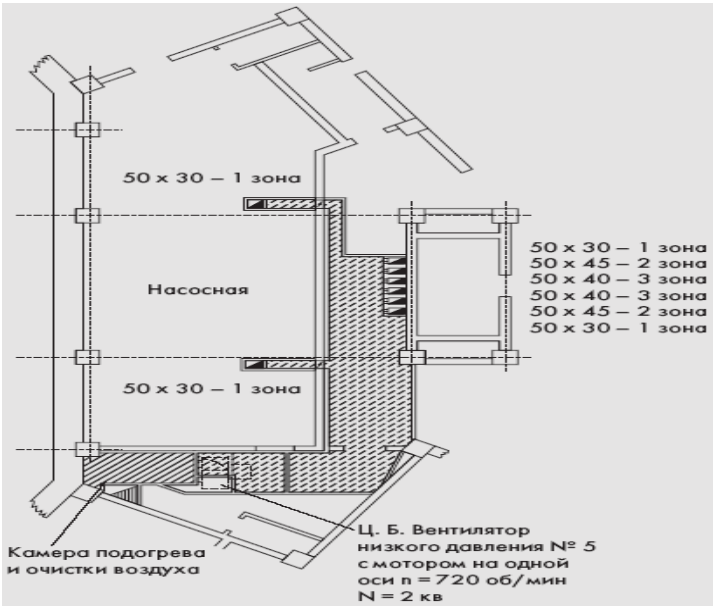

Figure 2 (more details)Ventilation of a high-rise residential building. Basement floor plan

It is recommended to lay horizontal channels mainly in the basement, technical floors and attics.
The following materials may be used for air ducts: cinder concrete for large cross-section ducts and gypsum for dry air in a dry place; asbestos-cement ducts are permitted provided they are protected from destruction in the event of a fire.
The use of metal air ducts is not recommended. Fig. 2 , 3 shows an example of a supply and exhaust ventilation solution for 48 apartments located between two stairwells of a 24-story building divided into three zones.

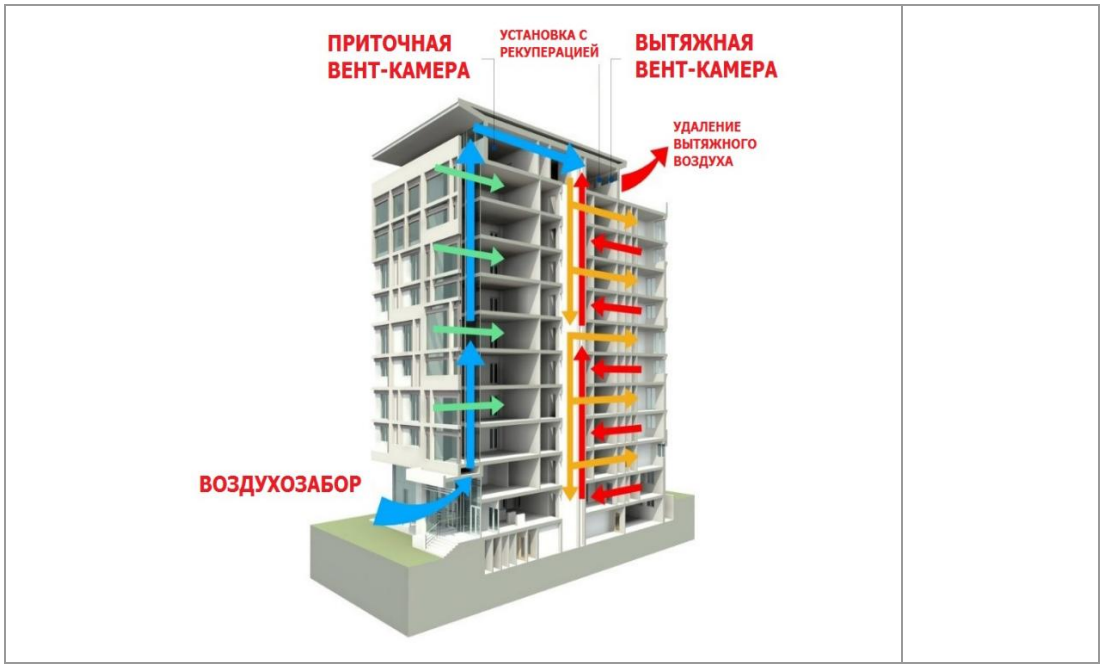

Figure 3. (**more** details) Ventilation of a high-rise residential building.

Heating of the supply air, carried out in the supply chamber, can be done by a plate heater or a heater made of smooth radiators or pipes. A plate heater is more compact than a heater made of smooth radiators or pipes, but the resistance in it is significantly greater, which eliminates the possibility of heating the air when the fan is inactive, when the ventilation system operates on natural motive power. The installation of air heaters should be done in such a way that it is possible to clean its entire surface from dust.
Air is cleaned from dust using oil paper or fabric filters. The former, more difficult to operate, provide better cleaning than the latter, easier to operate.
It should be noted that the air resistance when passing through the filters reaches 10 mm H2O, which eliminates the possibility of normal operation of the system when the fan is inactive.
If the intake of outside air for ventilation is carried out at a height of more than 50 m, then special cleaning from dust is not necessary.
The duct diagram of both the supply and exhaust ventilation systems must provide for the possibility of air passing, in addition to the fan, through a bypass valve, so that when the fan is inactive (accident or temporary interruption), the system can operate on natural motive power.

Taking into account the above , it is recommended:

- To reduce noise, install fans with a motor on one axis, and if this is not possible, on a textrop transmission. The circumferential speed of the wheel of centrifugal fans should not exceed 18 m/s when installed in the basement and 15 m/s when installed on technical floors.
- To prevent noise transmission, a separate foundation not connected to the walls of the building is installed under the fan and motor, sound and vibration insulation pads are installed between the foundation and the fan, and the fans are connected to the air ducts using elastic pipes. To eliminate sound transmission through the air tract, sound mufflers are installed in the air ducts.
- To facilitate the maintenance of a large number of ventilation units located in different places, the push-button starters of all electric fans should be concentrated in one control center. There, the devices for monitoring the operation of the fans should be included in the electrical circuit.
- It is most advisable to place hatches on the technical floor, in the attic or on the ground floor, at the point where vertical channels are connected to the common collecting air duct.

The installation of ventilation ducts and supply and exhaust grilles in high-rise residential buildings is carried out in the same way as for mass-produced residential buildings.

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