ISSN NO: 2770-0003
Date of Publication: 22-05-2022

Automation of Management of Energy Efficient Ventilation Systems

Fatidinov Ziyodulloxon G'ulomidin o'g'li
Master degree, Andijan machine-building institute, Andijan, Uzbekistan

Abstract: Ventilation with air recirculation is a system where part of the air taken from the room is mixed with cold outside air, heated to the required temperature and then fed into the room. This system can be used only if the air coming from the room does not contain harmful substances and toxic impurities. Whereas the volume of outdoor air in this mixture must comply with all sanitary and hygienic standards, and must not be less than the value of the sanitary standard provided for this type of room.

Key words: Automation, ventilation, air conditioning, ventilation, systems, industry.

Main part

The system with air recirculation makes it possible to reduce energy consumption for heating the air, since the thermal power of the heater is mainly spent on changing the temperature of only that part of the air that is taken from the street [1].

However, as the analysis showed, when regulating such systems, it is impossible to be limited only by the temperature obtained at the outlet of the channel. Therefore, to solve this problem, it is proposed to use two-stage regulation. The first control stage is the temperature limits in the supply duct, which are maintained by recirculation dampers. The second cascade is the average values of temperature sensors installed in the warehouse itself, and which are regulated by changing the fan performance.

Thus, due to the two-stage regulation, the required temperature regime will be achieved and the electric energy spent on the operation of the electric heater will be partially saved.

A supply and exhaust system with recirculation and an electric heater is also known, which is organized when additional air heating is required in winter at very low outside temperatures, when the control valve is 100% open, but the dampers do not have enough heat output. In this case, you can heat the air with a heater. The disadvantage in this case may be condensation of moisture or frost in the mixing chamber, freezing of non-insulated elements of the system (valves). In addition, there is also the problem of high-quality air mixing. Consider a system where recirculated air enters the mixing chamber, for example from the top. In this case, the recirculated air presses the cold supply air downwards. As a result, the temperature varies over a very wide range. Thus, air with different temperatures enters different parts of the heater. Automation, using a control valve on the heat carrier, sets the heat output of the heater so that the average air temperature at the outlet of the system corresponds to the desired one. But directly behind the air heater, the air temperature profile remains strongly inhomogeneous as before.

Therefore, when choosing the design of mixing chambers in cold climates with temperatures below -20 C, systems with a small longitudinal length should be avoided. The best option is to mix the air in some way in advance, at a sufficient distance from the heater.

The level of recirculation depends on the temperature at the outlet of the supply duct. The recirculation valve in the cold season operates in antiphase with the main supply valve. For example, if the recirculation valve is 20% open, the main supply air valve will be 80% open. Accordingly, when the unit is in standby mode, the main valve is closed and the recirculation valve is fully open.

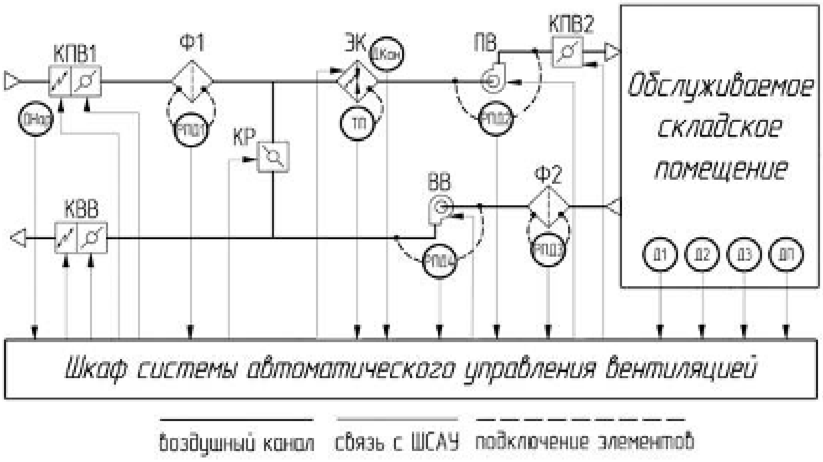
If the recirculation level is maximum and the inflow temperature is insufficient, then the electric heater is switched on.

The scheme of operation of the unit is shown in Figure 1. The outdoor temperature sensor is required for automatic switching between the operating modes of the system in the warm and cold periods of the year. According to the readings of the duct temperature sensor, the percentage of opening of the recirculation valve is regulated. Differential pressure switches are used to detect the operation of fans, as well as to detect clogged filters. A fire sensor is required to automatically turn off the ventilation unit in the event of a fire in the room.

ISSN NO: 2770-0003
Date of Publication: 20-05-2022

Based on the parameters of the room, a typical solution for the proposed task will be a supply and exhaust unit with an air recirculation system. The recirculation system includes recirculation dampers and an electric heater (electric heater).

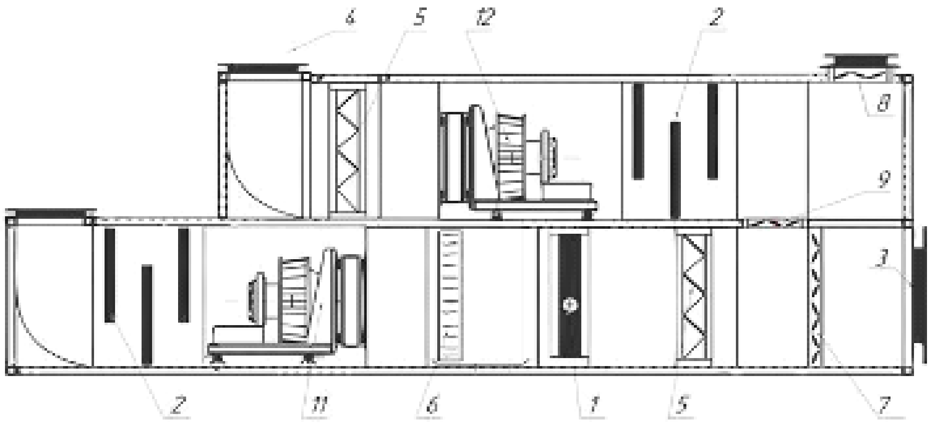
A diagram of such an installation is shown below in the figure. An algorithm for the operation of such an installation has been compiled, taking into account the multifactorial specifics of ventilation operation.



Scheme of operation of the supply and exhaust ventilation unit.

КПВ1 и КПВ2 – supply ventilation valves;
КР – recirculation valve; F1 and F2 - filters;
ЭК – electric heater; PV - supply fan;
ВВ – exhaust fan; Dnar - outdoor temperature sensor;
ДКан – channel temperature sensor;
Д1, Д2 и Д3 – room temperature sensors; DP - fire sensor;
ТП – electric heater overheating thermostat;
РПД1, РПД2, РПД3, РПД4 – differential pressure switch.

When the “Start” signal is given to the controller, the necessary elements of the system are prepared and launched. According to the readings of the outdoor sensor, the controller determines that the system should work in the "Winter" mode. The pre-heating of the dampers is started to protect against breakage in case of freezing. After warming up, the dampers open, a signal is given to start the fan.



Scheme of the ventilation unit:
1 - electric heater; 2 - silencer;
3 - entry into the room; 4 - exhaust channel;
5 - air filter; 6 - drop catcher;
7 - inflow valve; 8 - exhaust valve;
9 - recirculation valve; 11–12 - fan.

ISSN NO: 2770-0003
Date of Publication: 20-05-2022

When the temperature in the duct differs from the temperature of the installation, the recirculation valves change their opening level. At the same time, the temperature in the room itself is also regulated by the fan speed (if it is necessary to heat the air, the fan slows down, if it is cooled, it speeds up). When the temperature in the supply duct and in the room is insufficient, the air recirculation is set to 100% and the fan is set to minimum. If after a certain time the temperature in the inflow duct and the room does not rise, then the electric heater will turn on, which will heat the air. The principle of turning on the electric heater is pulse-width modulation. When the heating element of the heat exchanger overheats, it turns off and is blown by the fan to the working state.

When the outside air temperature is higher than the set temperature, the system switches to "Summer" mode. In this mode, recirculation and electric heater do not work.

When the “Stop” signal is given, all necessary elements of the system are turned off. At the same time, if the unit was operating in winter mode before shutdown, then the electric heater is first turned off, the fan and dampers continue to operate in order to cool the electric heater and prevent possible overheating or even burnout of its elements.

In addition to recirculation, recuperation is often used in ventilation systems. Heat recovery in heat exchangers is based on the transfer of part of the heat from the exhaust air to the supply air. Devices for recovery are called recuperators and are classified according to their device [2].

The risk of frostbite is always present during the cold period of the year when the ventilation system is operating with a heat exchanger, so the need is for sensors to control the operation of the heat exchanger.

At the moment, there are two main principles for controlling a plate heat exchanger: pressure drop control and temperature control [7].

Pressure control. As described above, when a large amount of condensate falls out or when it crystallizes on the surface of the heat exchanger, an obstacle is created for the flow of exhaust air. Measuring the pressure drop before and after the heat exchanger in the exhaust duct is a solution to the problem of controlling heat exchanger frostbite. When a pressure drop signal appears, the bypass channel of the heat exchanger opens or the performance of the supply fan decreases to change the mass ratio of the air flows. This principle of operation is the simplest and does not require large expenditures. Although this method is the most popular in Russia, it has a number of disadvantages.

1. When using a differential pressure switch, it is difficult to adjust the sensor, because. at the stage of commissioning, the simulation of heat exchanger frostbite is extremely unlikely, and the theoretical calculation is complicated due to the influence of many factors.

2. The use of a relay does not give a full guarantee of a timely signal of heat exchanger frostbite, because The pressure created by the ventilation system is influenced by several factors, such as the dustiness of the filters, the performance of the fan, the contamination and tightness of the air ducts.

Temperature control. The principle of temperature control is based on determining the efficiency of supply air heating, this is carried out by measuring the temperature in the supply duct before and after the heat exchanger. In the cold period of the year, after commissioning and turning on the ventilation system in normal mode, it is possible to determine the average heating on the heat exchanger corresponding to normal operation. When the efficiency of the heat exchanger decreases, it is possible to protect the heat exchanger by changing the degree of opening of the bypass channel or the performance of the supply fan. The disadvantage of this method is the high cost compared to the pressure drop control method and the indirectness of temperature determination. The main cause of heat exchanger frostbite is a decrease in the temperature of the exhaust air after the heat exchanger, so measuring the supply air temperature may not provide all the necessary information about the state of the system [5].

The heat exchanger will save a significant part of the heat (up to 90%), but its correct operation is possible only under certain conditions. To do this, the authors proposed a scheme in which air is heated before and after the heat exchanger.

The heater in front of the heat exchanger is required to heat the air at the inlet to the heat exchanger, which will reduce the risk of freezing of the heat exchanger. Also, the heater can be used for heating low temperatures (below –30 C) and reaching the calculated temperatures for the heater after the heat exchanger.

The heater after the heat exchanger allows maintaining the required temperature at the duct outlet by heating the air after the heat exchanger. There is a need for this heater, since the heat exchanger is a passive

ISSN NO: 2770-0003
Date of Publication: 20-05-2022

heater, and its operation cannot accurately maintain the desired temperature, the heat exchanger also has the risk of frostbite, due to which its efficiency may drop sharply and the outlet temperature may be low.

References

1. Ананьев В.А.и др. Системы вентиляции и кондиционирования. Теория и практика. Учебное пособие. М. Евроклимат, Арина, 2000. 216 с.
2. Павлов Н.Н., Шиллер Ю.И., «Справочник проектировщика. Внутренние санитарно-технические устройства, ч. 3, Вентиляция и кондиционирование воздуха. Книга 2, М. Стройиздат. 1992 г. 416 стр
3. Волков О.Д., Проектирование вентиляции промышленных зданий, Харьков, Высшая школа, 1989, 249 стр.
4. Климатические и вентиляционные системы [Электронный ресурс] – Режим доступа: URL: http://www.vipvozduh.ru/ index_page_161.html – (Дата обращения 20.02.2015).
5. Приточная и вытяжная вентиляция [Электронный ресурс] – Режим доступа: URL: http://delta-grup.ru/bibliot/97/21.htm – (Дата обращения 20.02.2015).
6. Системы вентиляции и кондиционирования [Электронный
7. ресурс] – Режим доступа: URL: http://www.fvrklimat.ru/catalog – (Дата обращения 20.02.2015).
8. Соснин А.Л. Автоматизация управления энергоэффективных вентиляционных систем [Электронный ресурс] / А.Л. Соснин, В.А. Трусов, С.П. Максимов – Режим доступа: URL: http://www.fvrklimat.ru/catalog – (Дата обращения 20.02.2015)