

UDC 681.5.015.23: 658.264

*Lozhechnikova N.V.*

Odessa National Polytechnic University

*Zhelenko V.O.*

Odessa National Polytechnic University

## THE ANALYSIS OF FORCED-AIR AND EXHAUST INSTALLATIONS WITH HEAT RECUPERATING

*The problem of energy saving concerns, in particular, the agro-industrial complex, where a significant share of energy resources is spent on power supply, heating of heat carriers for various technological needs, lighting workshops, so the use of the most effective energy-saving tools and methods in this area becomes an urgent task. One of the forms of energy saving and creating optimal working conditions for maintenance personnel, as well as efficient storage of equipment at service enterprises is maintaining a comfortable temperature and humidity microclimate. To create these conditions, supply and exhaust systems with a heat recuperator can be used. Modern building materials can reduce the heat loss of the building and at the same time make them airtight, disrupting air exchange. Supply and exhaust units with a heat recuperator restore air exchange without extra costs for heating fresh air; in turn, recuperators can reduce a significant share of losses in heating air. This article deals with the design of industrial supply and exhaust units with a heat recuperator for heating air in the premises of technical service enterprises.*

**Key words:** fan, air heater, air flow, plate recuperator, technical service, supply-and-exhaust system, heat recovery, filter, energy saving.

**The formulation of the problem.** One of the priority directions of the state policy is the rational use of energy resources. In particular, the problem of energy saving concerns the agro-industrial complex, where a large share of energy resources is spent on power supply, heating of heat carriers for various technological needs, lighting of workshops and much more. Therefore, the use of the most effective energy-saving tools and methods in this field becomes an extremely urgent task.

One of the options for saving energy resources is the use of the heat recovery (recuperation) method in ventilation and air conditioning systems in industrial buildings, including technical service enterprises. This method is applicable both in the cold season for heating and in warm for conditioning. Recuperation in ventilation systems is a process where incoming cold supply air is heated by exhausted air.

At present, a number of supply and exhaust units with heat recuperation from the following companies are produced: Daikin (VAM series models), Systemair (VX series models), Ecoterm (UVRK series models), etc., but as rule, with two types of recuperator (rotor or plate structure) [1]. In the plate heat exchanger, in contrast to the rotary heat exchanger, there are no moving parts, it does not mix the incoming and outgoing air streams, without changing the humidity of the supply air.

With countercurrent flow organization the plate heat exchanger alternately heats up and is cooled by heat-releasing and heat-absorbing air currents, therefore the supply and exhaust air must be coordinated and run simultaneously through it.

The plate heat exchanger performs the function of a storage mass, one half of which is heated by a warm air flow, and the other half is cooled by a cold stream flowing in the opposite direction. The air temperature at the outlet of the heat exchanger is not the same and depends on the volume of air passing through it, as well as the outside temperature, the internal temperature and the humidity of the air. Plate-type recuperator with a reliable anti-frost protection system (heating of supply air) practically does not require maintenance (filter change) [2].

**The analysis of recent studies and publications.** Analyzing the articles of O.A. Kolyunov, O.P. Ivanov, O.G. Martynenko, A.A. Mikhalevich, V.K. Shikova on the system of ventilation and conditioning of technical service buildings, it was revealed that most authors pay attention to only one method of ventilation and conditioning, highlighting the disadvantages and benefits, but there has not yet been a comparative characterization of several types of supply and exhaust systems, existing and patented today.

**The aim** of the paper is to consider several types of supply and exhaust units, existing and patented for today.

**The exposition of the main material of the study.** Let's consider some kinds of supply and exhaust installations.

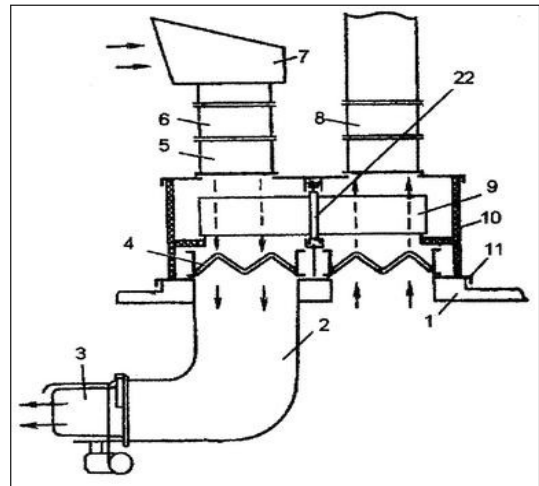
There is a supply and exhaust system (Figure 1), designed for heat recovery. It consists of a warmed case 5, channels for supply 6 and exhaust 8 of air, in each of which there are air purification filters 4, a fan 3, chambers 10 with a rotating regenerative heat exchanger 9, the camera is installed on the roof of the building on reinforced concrete cup 1 and represents the case in the form of a parallelepiped, the walls of which are made of insulated panels interconnected by high-speed locks, and the base of the case is a metal frame 11, with the upper part of the chamber containing a mountain umbrella rotary regenerative heat recovery device 9, which is a retractable frame divided into two cavities by a partition, in which the supports of the core of the drum formed by corrugated aluminum foil strips densely wound on the core 12 are fixed, where the pulley of the V-belt drive is fixed to the core of the drum, and the partition of the frame with the drum fixed on it forms channels for the supply and exhaust air, in each of which air purification filters are placed 4.

A supply-exhaust system 1 (figure 2) [3] comprising a vent 8 connecting the room to the outside environment, comprising a recuperator 13, filters 7, a fan unit 4 comprising an electric axial reversible fan 3 and electric motor shutters 6, a control unit 5 comprising an input terminal 10 for connecting to an electrical network, an external grate 2 and a remote control panel 15, and also contains an air humidity sensor 11 connected to the control unit, a light sensor 12 connected to the control unit, and the control unit is located in the fan unit and is complemented comprises an output terminal 9.

There is a supply and exhaust system (Figure 3) [4] with a plate recuperative heat exchanger, which has inlet and outlet openings for supply air in the casing, inlet and outlet openings for exhaust air to the respective exhaust air inlet zones in the unit and exhaust air outlet from the unit, inlet air inlet filter element, supply air outlet heating element, condensate drain pan from the plate-type recuperative heat exchanger, connected to the control unit bypass valve, the supply and exhaust fans.

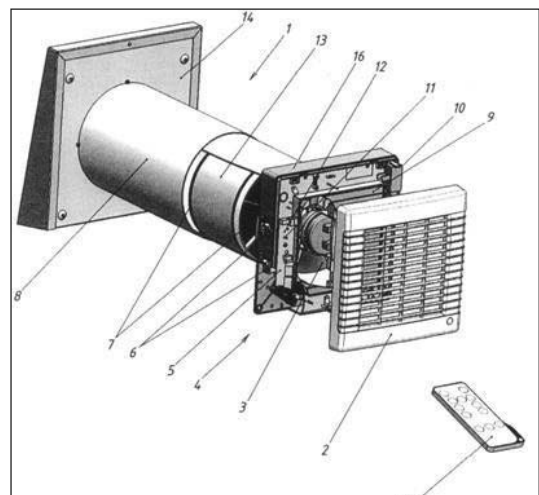
A distinctive feature of the installation is that the bypass valve is located between the exhaust air exit zone of the plant and the exhaust air inlet zone to the plant with the possibility of circulating exhaust air through the plate recuperative heat exchanger in a closed loop when the bypass valve is open in the

defrosting mode of the plate heat recovery unit, control is connected to the supply fan with the possibility of switching it off in the indicated mode. In this case, the control unit, which is a microprocessor, is connected to the supply fan through the switching means, and a heating element for the exhaust air is installed in the housing.



**Fig. 1. Supply and exhaust unit (patent No. 2282794)**

- 1 – a cup; 2 – the channel;
- 3 – the fan;
- 4 – air purification filter;
- 5 – a warmed case;
- 6, 8 – channels for supply and exhaust of air;
- 7 – air intake;
- 9 – heat exchanger;
- 10 – the chamber;
- 11 – frame; 12 – core.



**Fig. 2. Supply and exhaust unit (patent No. 140092)**

- 1 – supply and exhaust system; 2 – external grate;
- 3 – the fan; 4 – ventilation unit; 5 – control unit;
- 6 – blinds; 7 – filters; 8 – ventilation duct;
- 9 – output terminal; 10 – input terminal;
- 11 – air humidity sensor; 12 – a light sensor;
- 13 – recuperator; 14 – base; 15 – control panel;
- 16 – casing

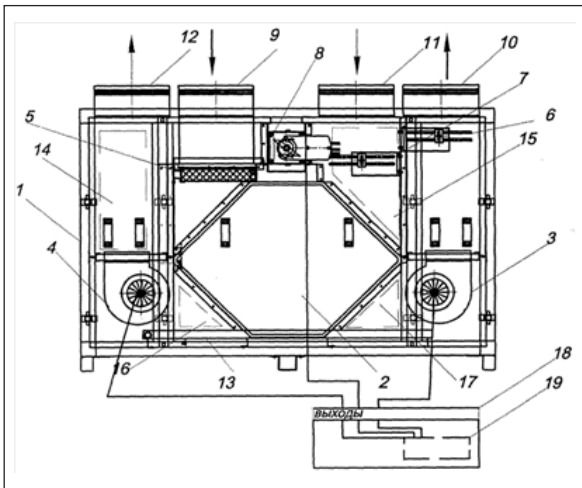


Fig. 3. Supply and exhaust unit (patent No. 134619)

A supply and exhaust system was designed (Fig. 4) [5] for ventilation and air conditioning, containing a housing installed in the through-hole of the external wall of the building, the inner surface of the housing covered with heat-insulating material, a stationary regenerative nozzle and a reversible axial fan, differing in the housing cavity the fact that the unit includes a mobile air conditioner, and the wall of the body is bifurcated along its length to form an annular channel between the parts of the wall having the outlet to the external air atmosphere at one end and the muffled end at the other end thereof, the annular channel being connected to the duct of the mobile air conditioner through a pipe mounted in the outer part of the housing wall and having a valve latch, the housing cavity associated with the outside air atmosphere and placing by nipples with valves, with an air heater installed in the cavity of the housing.

In this case, a filter is installed in the cavity of the housing for the air entering the room, and the ends of the housing are provided with protective gratings. In addition, the stationary regenerative packing is made of corrugated aluminum foil.

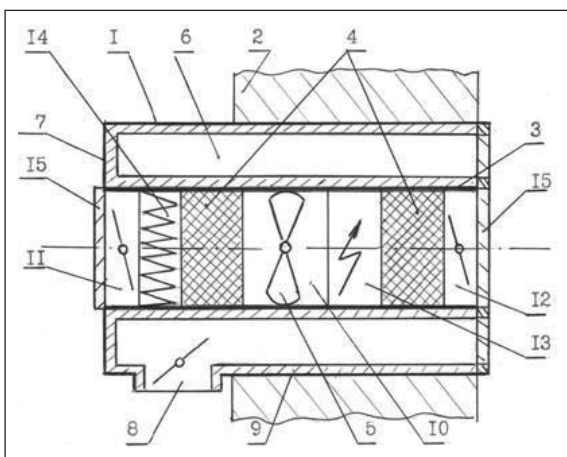


Fig. 4. Supply and exhaust unit (patent No. 127875)

A supply and exhaust device (Fig. 5) [6], comprising a fan unit supplying an air duct, one end of which is communicating with the atmosphere, and the other located in the lower part of the ventilated room and equipped with an air heater, and the exhaust duct is located in the upper part of the ventilated room, and its outlet end is provided with a vertical outlet branch, characterized in that the fan unit comprises a supply fan positioned at the receiving opening of the supply conduit at the supply pipe after the supply fan is divided into first and second channels so that the cross-section of the first does not exceed 0.15 of the cross section of the second one, the first channel through the exhaust ejector being connected to the vertical outlet of the exhaust duct, and the second channel through the supply ejector connected to the inlet the heat-receiving circuit of the heat exchanger whose outlet is communicating with the vertical downward channel of the supply duct, in addition, the exhaust duct in front of the heat exchanger is divided into a third and a fourth channel. That does not exceed the fourth section 0.15 of the third section, the third channel is connected to the input of the heat emitting coil circuit whose output communicates with an exhaust suction pipe of the ejector, wherein the fourth channel is connected to a suction pipe of the ejector feeder.

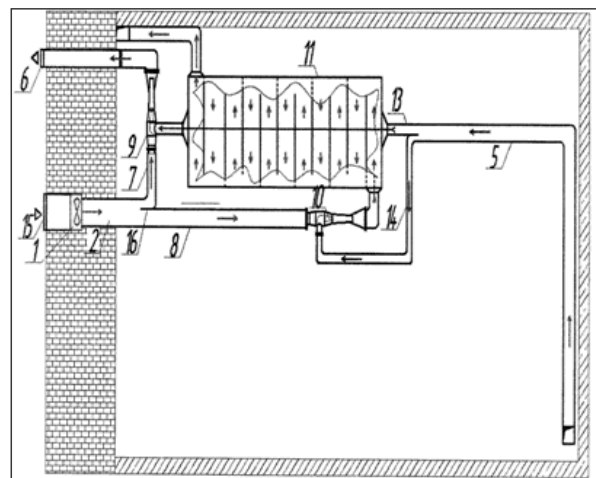


Fig. 5. Supply and exhaust unit (patent No. 102764)

The installation for heat supply, cooling and ventilation of premises, including a heat pump connected to a storage tank and heat supply pipelines, a ventilation system with supply and exhaust air ducts, is characterized by the fact that it contains a recuperator, a flat solar collector, external and internal temperature sensors premises and the device of the control and management of elements of installation according to indications of gauges.

A supply-and-exhaust device containing a fan unit, a vertical ventilation shaft, an exhaust air duct located

in the shaft, exhaust ducts communicating with the rooms, and an upper end with a discharge branch that allows the discharge of outgoing air into the atmosphere. Moreover, the device is equipped with a heater of air supplied to the premises.

**Conclusions.** Currently, the industry offers a wide range of supply and exhaust units, existing and patented for today. However, the most efficient are the units with a plate heat exchanger, since they do not

contain moving parts, are easy to maintain, do not mix incoming and outgoing air, and are energy efficient.

The analysis of the constructions of the units with a plate heat exchanger showed that, as a rule, they differ in the design of the heat exchanger, in the direction of the air flow, and in the list of additional equipment. Therefore, the improvement of the design with the change of these parameters creates a great potential for increasing the efficiency of the supply and exhaust systems.

#### References:

1. Ivanov O.P., Rymkevich A.A. A methodology for a comprehensive assessment of the efficiency of utilization of heat and cold utilization in air conditioning systems. Refrigerating machinery. 1980. № 3. P. 34–38.
2. Kolyunov O.A., Ivanov O.P. Energy saving in ventilation and air-conditioning systems due to utilization of heat of exhausted air. Refrigeration and cryogenic equipment. 2003. № 1. P. 16–19.
3. Patent for utility model No. 140092 of the Russian Federation. A supply and exhaust unit with a heat sink / A.S. Klapishevsky, A.M. Tsyomyk (RF). 1c: ill. Publ. 04/27/2014.
4. Patent for utility model No. 134619 of the Russian Federation. Supply and exhaust unit with a heat recovery aggregate / A.A. Kavygin, S.A. Kolyadyazhny (RF). 1c: ill. Publ. 11/20/2013.
5. Patent for utility Model No. 127875 RF. Supply-exhaust system for ventilation and air conditioning / V.A. Pronin, A. P. Verboloz, A.V. Tsygankov (RF). 1c: ill. Publ. 05/10/2013.
6. Patent for utility model No. 102764 RF. Prison-extractor device / G.A. Zakharov, O.L. Lazovskaya, K.V. Tsygankova, A.A. Zhurmilov (RF). 1c: ill. Publ. 10.03.2011.

#### АНАЛІЗ ПРИПЛИВНО-ВИТЯЖНИХ УСТАНОВОК З РЕКУПЕРАЦІЄЮ ТЕПЛА

*Проблема енергозбереження стосується, зокрема, агропромислового комплексу, де значна частка енергоресурсів витрачається на силове живлення, підігрів теплоносіїв для різних технологічних потреб, освітлення майстерень, тому використання найбільш ефективних енергозберігаючих засобів і методів у цій галузі стає актуальним завданням. Однією з форм енергозбереження та створення оптимальних умов роботи обслуговуючого персоналу, а також ефективного зберігання техніки на підприємствах сервісу є підтримка комфортного температурно-вологісного мікроклімату. Для створення цих умов можуть бути використані припливно-витяжні установки з рекуператором тепла. Сучасні будівельні матеріали дають змогу зменшити тепловтрати будівлі і водночас роблять їх герметичними, порушуючи повітрообмін. Припливно-витяжні установки з рекуператором тепла відновлюють повітрообмін без зайвих витрат на підігрів свіжого повітря, своєю чергою, рекуператори дають змогу скоротити значну частку втрат на нагрівання повітря. У цій статті розглянуто пристрій промислових припливно-витяжних установок з рекуператором тепла для підігріву повітря в приміщеннях підприємств технічного сервісу.*

**Ключові слова:** вентилятор, підігрівач повітря, потік повітря, рекуператор пластинчастий, технічний сервіс, установка припливно-витяжна, утилізація тепла, фільтр, енергозбереження.

#### АНАЛІЗ ПРИТОЧНО-ВИТЯЖНИХ УСТАНОВОК С РЕКУПЕРАЦІЄЮ ТЕПЛА

*Проблема енергозбереження касається, в частности, агропромышленного комплекса, где значительная доля энергоресурсов расходуется на силовое питание, подогрев теплоносителей для различных технологических нужд, освещение мастерских, поэтому использование наиболее эффективных энергосберегающих средств и методов в данной области становится актуальной задачей. Одной из форм энергосбережения и создания оптимальных условий работы обслуживающего персонала, а также эффективного хранения техники на предприятиях сервиса является поддержание комфортного температурно-влажностного микроклимата. Для создания этих условий могут быть использованы приточно-вытяжные установки с рекуператором тепла. Современные строительные материалы позволяют уменьшить теплопотери здания и в тоже время делают их герметичными, нарушая воздухообмен. Приточно-вытяжные установки с рекуператором тепла восстанавливают воздухообмен без лишних затрат на подогрев свежего воздуха, в свою очередь, рекуператоры позволяют сократить значительную долю потерь на нагрев воздуха. В данной статье рассмотрено устройство промышленных приточно-вытяжных установок с рекуператором тепла для подогрева воздуха в помещениях предприятий технического сервиса.*

**Ключевые слова:** вентилятор, подогреватель воздуха, поток воздуха, рекуператор пластинчатый, технический сервис, установка приточно-вытяжная, утилизация тепла, фильтр, энергосбережение.