STEAM HEATING SUPPLY SYSTEM EQUIPMENT.

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Abstract. This article analyzes the main equipment used in steam heating supply systems and their functions. Steam heating systems are an effective means of transferring heat energy in industrial and residential buildings. Various devices are used in these systems to control, manage and protect pressure, temperature, steam consumption and water level. In particular, manometers, thermometers, pressure regulators, condensate drains (condensate pipes), air vent valves and other control and measuring devices are widely used. The article covers the principle of operation, structure, arrangement and importance of these devices in steam systems. Special attention is also paid to high-efficiency devices selected based on modern energy saving requirements.

In addition to the devices used in the central heating system, special equipment is also used in the steam heating system: a water separator, a reducing valve, condensate discharge pipes, a condensate tank and pump, a separator-vessel, a safety valve. The water separator is designed to separate the condensate collected in the external steam pipe from the steam entering the heating system and dry the steam. The water separator is a round-shaped container, the dimensions of which are selected depending on the diameter of the steam pipe to which it is connected, its diameter should be 3-4 times the diameter of the steam pipe, and its height should be 4-8 times larger than the diameter of the steam pipe. The condensate spreads on the wall of the water separator and flows into the hole in the bottom. The diameter of the condensate hole is made 4-5 times smaller than the diameter of the steam pipe (but not less than 20 mm). The dried steam enters the reducing valve. The reducing valve is made spring-loaded or loaded. It is installed on the horizontal part of the steam pipe . A schematic diagram of the main part of a more complex spring -loaded pressure reducing valve is shown in Figure 4.9.

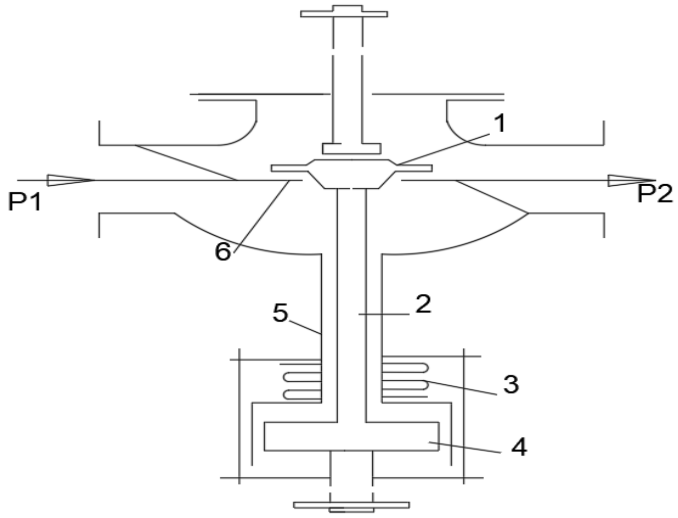


***Figure* 1. Scheme of a pressure reducing valve:**

1-cylinder ; 2- rod ; 3-spring ; 4-piston ; 5-pipe ; 6-base .

The plunger located in the steam path is firmly connected to the piston by a rod. The steam pressure P is transmitted through the pipe to the space above the piston. The initial states of compression of the piston, plunger and spring are controlled by turning the flywheel under the piston. In order to reduce the pressure of the steam passing through the plunger to the support from P_1 to P_2, the required size of the plunger hole is selected. The surface of the plunger and the piston are the same, and a change in the steam pressure P_1 does not affect the degree of opening of the plunger hole. An increase in pressure downstream of the valve (greater than P_2) causes the plunger to move down with the piston, and the spring 3 is additionally compressed, as a result of which the required pressure P_2 is restored. When the pressure decreases, the spring straightens, the piston rises with the plunger, as a result of which the pressure P_2 is restored again. The reducing valve can also perform the function of a closing device. At the top of the valve there is a second flywheel, with the help of which the spring can be compressed, lowering the plunger to the base, blocking the flow of steam. Reducing valves differ from each other in the diameters of the connected pipes (D=25-150 mm) and the inner surfaces of their holes (varying from 2 to 52.2 cm). The inner surface of the required hole of the reducing valve is selected by a and is determined by the following formula, cm^2:

$$A=G_b/0.6\,d, \qquad (1)$$

Here G_b - steam flow rate through the valve, kg/h ; d - steam flow rate passing through 1 cm^2 of the valve opening, kg/(h.cm^2), determined by the difference in steam pressures P_1

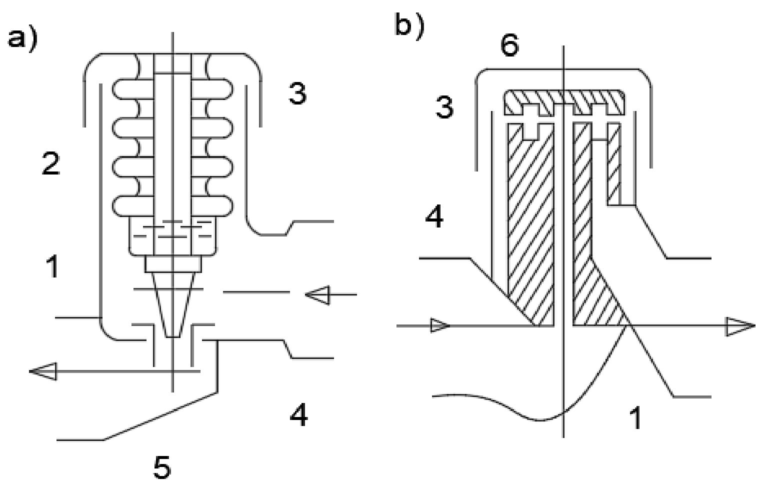
and $P_{2.}$ If the difference in pressures P_1 and P_2 is very large, and it is required to reduce the pressure by more than five times, two valves are selected and installed in series.

Condensate removal devices. The simplest devices used for condensate removal and steam arrestment are hydraulic valves.

- A ring made of U-shaped pipe (see Figure 1). In such traps, the hydrostatic pressure of the condensate column prevents the passage of steam into the condensate pipe. The height of the hydraulic lock is $h_{3,}$ m :

$$h3 = {}_{100\Delta p} + 0.2, \qquad (2)$$

Here Δp is the difference in pressure before and after the valve, MPa. In systems with extremely high and high pressure, instead of hydraulic valves, special devices are used - condensate drains. Condensate drains are divided into floating and thermal groups. Thermal devices are lighter and more reliable than floating ones. Condensate drains with a floating body have a diameter of 15 to 50 mm and are installed on pipelines with a pressure of less than 0.1 MPa. The condensate drain works as follows: the floating body rises, if not only condensate but also steam gets under it, then a ball valve attached to the body blocks the outlet. During the accumulation of condensate, the steam partially condenses and exits through a small hole (diameter 2 mm) in the cover.



2. Schemes of thermostatic (a) and thermodynamic (b) condensate removal devices :

1-body ; 2-bellows ; 3-cover ; 4-base ; 5-socket ; 6-disk .

The float filled with condensate sinks down and the outlet opens. After part of the condensate has been removed, the entire cycle is repeated. To trap uncondensed steam after heating appliances (and other steam consumers, for example, radiators), a thermostatic type condensate drain (also called a bellows) is used (Fig. 2, a). The body consists of a cover and a bellows (thermostat) with a gold insert welded to it.

The bellows is partially filled with a liquid that boils at 90-95 ^{o} C. When the condensate and steam come together, the liquid in the bellows boils. As a result of the increase in internal pressure, it expands and closes the hole in the support of the bellows.

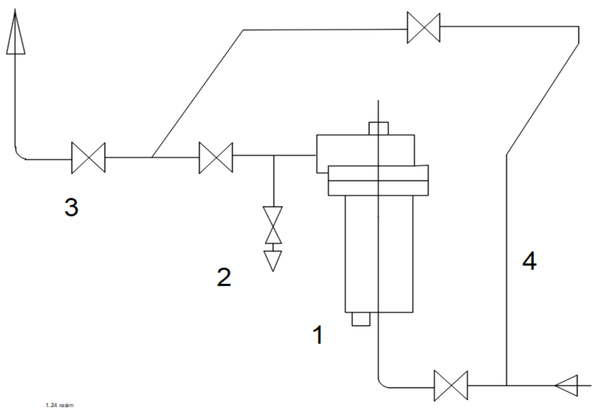


Figure 3. Installation diagram of a floating condensate removal device on a main :

1- condensate removal device; 2- air valve; 3- check valve; 4- bypass.

After the body is filled with condensate and its temperature drops to 8-20 ^{0} C, the liquid vapor in the bellows condenses, the bellows contracts and the outlet opens. Thermostatic condensate drains can operate with a diameter of 15 and 20 mm and an initial pressure of up to 0.6 MPa. Thermodynamic (also called labyrinth) condensate drains, like floating ones, are installed on pipelines when the pressure is above 0.1 MPa. The thermodynamic condensate drain (Fig. 4.10, b) is simpler in design than others: a support with inlet and outlet holes is placed in the body, and a disk rests freely on the support under the cover. When condensate comes from below, the disk rises and the condensate flows into the outlet. If steam passes along with the condensate, then the steam fills the chamber between the cover and the disk. Since the surface of the disk is much larger than the surface of the outlet, the force acting on the disk from above overcomes the force acting from below and presses the disk to the support, as a result of which the steam path is closed. If the pressure on the disk decreases, the disk has the opportunity to rise due to the condensation of steam. The diameter of the pipes connected to the thermodynamic condensate removal devices ranges from 15 mm to 50 mm. The largest condensate removal device D_u 50 has a length of 200 mm and a height of 103 mm. The cover of the devices is installed on top. When selecting a condensate removal device according to the manufacturer's specifications, the coefficient of transfer characteristic k_v, tons / hour, is determined by the following formula:

$$k_v = \frac{20Gk}{(\Delta P \times \rho_k)0{,}5}, \qquad (3)$$

Here G_k - maximum condensate consumption, tons/hour; ρ_k - condensate density at the temperature in front of the device, kg/m ^{3}; $\Delta p = p_1 - p_2$ - pressure difference before and after the device, MPa; if installed after the heating device $p_1 = 0.95\ p_{asb}$, pressure $p_2 \leq 0.7 p_1$ (if the condensate drains freely $p_2 = 0$). The coefficient of performance indicates the maximum consumption of cold water at a pressure drop of 0.1 MPa in the condensate removal device. The condensate tank for removing condensate from the system is made of steel with a straight groove (Fig. 4.12).

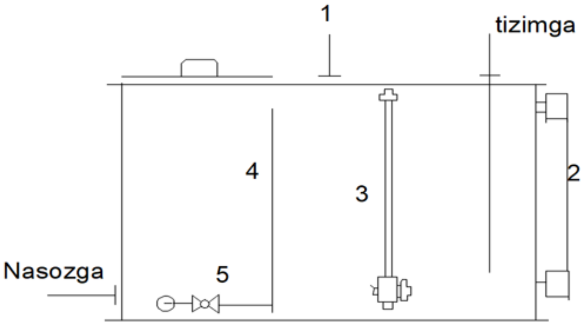


Figure 4. Condensate tank.

1-air pipe; 2-float relay; 3-water level indicator with tap; 4-5-pouring and draining sending pipes .

water level indicator k in the tank is equipped with a filling and draining pipe. When periodically removing condensate from the tank, the pump operation is automatically controlled: the pump is switched on and off using a relay mounted on the tank and moving up and down. The useful volume of the condensate tank is determined by the following formula, V_{ki}, m_3:

$$V_{ki} = \frac{z}{q \cdot k \cdot r} \cdot Qc, \qquad (4)$$

Here z- condensate collection time, hours; Q_c - heat capacity of the heating system, kJ/hour; r- steam generation heat, kJ/kg. The container should be filled with condensate by no more than 80%. The container-separator is used to separate the steam (secondary boiling steam) formed as a result of the boiling of condensate in high-pressure steam heating systems. Secondary boiling is used to heat water in low-pressure heating systems or hot water supply systems. In the container-separator, an excess pressure of 0.02-0.05 MPa is maintained using a hydraulic lock or safety valve, the speed of steam in it should not exceed 2 m/s, and that of condensate should not exceed 0.25 m/s. The container should be filled with condensate by no more than 20 percent. The container-separator and the hydraulic lock connected to it are made of steel (Fig. 4.12). Assuming the steam load for the vessel to be from 200 to 400 m^3/h, the approximate volume of the vessel-separator is determined. The more accurate volume of the vessel-separator V_{is}, m^3, is calculated from the following formula :

$$V_{is} = 0.5 \cdot x \cdot G_k / p_b, \qquad (5)$$

Here x is the steam fraction in the condenser (dryness of wet steam), G_k - condensate flow, m/h; p_b - steam density at pressure in the vessel, kg/m^3. It is advisable to place the vessel-separator closer to the condensate collection vessel, and for easy separation of the secondary steam formed, it should be installed above the condensate removal devices. Throttling devices are part of the system in parallel parts excessive pressure Used for reduction. Device thickness

It consists of a metal disk with a hole in the middle, 2-5 mm in diameter. The diameter of the hole depends on the amount of heat carrier and the temperature to be reduced. It is determined by calculations based on the pressure (it must be at least 4 mm to avoid overflow).

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