

vacuum and high vacuum. Low-vacuum pumps are those rated for maintaining $5\frac{1}{2}$ in. Hg vacuum on the system, and high-vacuum pumps are those rated to maintain vacuums above $5\frac{1}{2}$ in. Hg.

The required air and condensate removal capacity of vacuum pumps depends upon the size and type of heating system to which they are applied.

The required condensate capacity is closely related to the amount of radiation installed together with the range of the heating requirement. For average design conditions, the theoretical condensing rate of a heating system is approximately 0.5 gpm per 1000 sq ft equivalent direct radiation (EDR) served. Vacuum-pump water-delivery rates generally should be the same as for condensate pumps, which range from 2 to 3 times the design condensing rate. This provides sufficient capacity for peak loads, and for intermittent automatic operation.

The wide varying operating range and characteristics of individual heating systems have a greater effect on the quantity of air to be removed than on the condensate to be handled. The air-handling requirement cannot be found by applying a common factor to the equivalent direct radiation design load although this would be possible in determining the condensate. For low-vacuum systems, where the returns are controlled at an average vacuum of 5.5-in. Hg vacuum and the temperature averages 160 F, the various manufacturers of vacuum pumps provide pump capacities from 0.3 to 1.0 cfm of air per 1000 sq ft equivalent direct radiation served. For high-vacuum systems, the vacuum-pump air capacity requirements are generally greater. A capacity of 2.0 cfm of air, at 20-in. Hg vacuum per 1000 sq ft equivalent direct radiation served, is a typical capacity furnished on high-vacuum systems. These higher air capacities on subatmospheric controlled systems are required basically because of the increase in vacuum which expands the volume of air and vapor that is to be removed to maintain circulation at the higher operating vacuum.

It is particularly important on high-vacuum installations to see that the entire system is tight in order to reduce the amount of inward air leakage and, furthermore, to assure that relatively higher temperature steam is prevented from entering the vacuum return lines through leaky traps, high-pressure drips, etc. The hotter the returns, the lower will be the possible vacuum for a given air leakage into the system. It is for this reason that the condensate from equipment using steam at high pressure should not be connected directly to a vacuum return line, but should drain to a flash tank or flash leg through a high-pressure trap. The receiver should have an equalizing connection to a low-pressure steam main and drain through a low-pressure trap to the vacuum return main, as indicated later in this chapter in section on Drips.

Vacuum-Pump Controls

In the ordinary vacuum system, the vacuum pump is controlled by a vacuum regulator which cuts in when the vacuum drops to the lowest point desired, and cuts out when it has been increased to the highest point, these points being varied to suit the particular system or operating conditions. In addition to this vacuum control, a float control is included which will start the pump whenever sufficient condensate accumulates in the receiver, regardless of the vacuum on the system. A selector switch is usually provided to allow operation at night as a condensate pump only, also to give manual or continuous operation when desired.

There are several variations in the control of the vacuum maintained on the system by the pump. In some subatmospheric systems where orifices are used, the vacuum-pump control maintains a pressure difference between the supply and the return piping, which is held within relatively close limits. There are other subatmospheric systems which utilize special temperature-pressure actuated controls for maintaining the desired conditions in the return lines. Where various zones are connected to the same return main, the return vacuum must be controlled to meet the requirements of the zone operating at the lowest steam supply pressure.

Piston-Displacement Vacuum Pumps

Piston-displacement return vacuum heating pumps may be either electric or steam driven. Their piston speed in feet per minute should not exceed 20 times the square root of the number of inches in their stroke. They are usually supplied with an air separating tank, open to the atmosphere, placed on the discharge side of the pump, and at an elevation sufficiently high to allow gravity flow of the condensate to the boiler. If the boiler pressure is too high for such gravity feed, then an additional steam pump for feeding the boiler is desirable. The extra pump is sometimes avoided by using a closed separating tank with a float-controlled vent. In both arrangements, the air taken from the system must be discharged against the full discharge pressure of the vacuum pump. In the case of high- or medium-pressure boilers, it is better to use the atmospheric separator and the second pump.

In figuring the required displacement for such pumps, a value of from 6 to 10 times the volumetric flow of condensate is used for average vacuums and systems.

STEAM TRAPS

Steam traps, as the name implies, are automatic devices used to trap or hold steam in an apparatus or piping system until it has given up its latent heat, and to allow condensate and air to pass as soon as it accumulates. In general, traps consist of a vessel in which to accumulate the condensate, an orifice through which the condensate is discharged, a valve to close the orifice port, mechanisms to operate the valve, and inlet and outlet openings for the entrance and discharge of the condensate from the trap vessel.

Steam traps are classified according to the type of operating device by which they function. The traps which are available on the market today may be classified as (1) float, (2) thermostatic, (3) float and thermostatic, (4) upright bucket, (5) inverted bucket, (6) flash, (7) impulse, (8) lifting, and (9) boiler return trap or alternating receiver.

Float Traps. Float traps operate by the rise and fall of a float due to a change of condensate level in the trap. When the trap is empty, the float is in its lowest position and the discharge valve is closed. As condensate accumulates in the trap chamber, the float rises and gradually opens the valve, and the pressure of the steam pushes the condensate out of the valve. The discharge from a float trap is generally continuous, since the opening of the valve is proportioned to the flow of condensate through the trap. A gage glass may be used to indicate the height of condensate in the trap chamber.

Unless float traps are well made and proportioned, there is danger of considerable steam leakage through the discharge valve due to unequal expansion of the valve and seat, and the sticking of moving parts. Float traps are made in sizes from $\frac{1}{4}$ to 3 in., and for pressures varying from vacuum conditions to 200 psig. Float traps are used for draining condensate from steam separators, steam headers, blast coils, heating systems, steam-water heaters, laundry equipment, sterilizers, and other equipment. When used for draining low-pressure systems, float

Steam Heating Systems

traps should be equipped with a thermostatic air vent (see Float and Thermostatic Traps). Fig. 34 illustrates a single-port float trap.

Thermostatic Traps. Thermostatic traps function by means of elements which expand and contract under the influence of heat and cold. In early types of thermostatic traps, carbon posts and bimetallic elements were used for expansion. In general, the modern type of thermostatic trap consists of thin corrugated metal bellows or discs enclosing a hollow chamber. The chamber is either filled with a liquid, or a small amount of a volatile liquid, such as alcohol, is introduced. The liquid expands or becomes a gas when steam comes into contact with the expansive element. The pressure created in either case expands the element and closes the valve of the trap against the

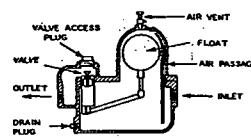


Fig. 34 Single Port Float Trap

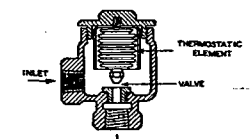


Fig. 35 Thermostatic Trap Bellows Type

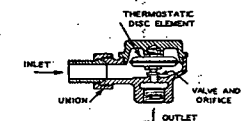


Fig. 36 Thermostatic Trap Disc Type

escape of steam. When condensate or air comes in contact with the element, it cools and contracts, opening the valve and allowing them to escape.

The discharge from this type of trap is intermittent. Thermostatic traps find their use generally for the draining of condensate from radiators, convectors, pipe coils, drips, unit heaters, water heaters, cooking kettles, and other equipment. Except for radiators and convectors, it is recommended that a strainer be installed on the inlet connection to the trap to prevent dirt, pipe scale, and other foreign substance from entering the trap. A cooling leg of a length of pipe should also be provided ahead of the trap on unit heaters and similar apparatus to cool the condensate in order to help in the trap

action. Thermostatic traps are made in sizes from $\frac{1}{4}$ to 2 in., and for pressures ranging from vacuum conditions to 200 psig. Figs. 35 and 36 illustrate types of thermostatic traps which are available at the present time.

Float and Thermostatic Traps. This type of trap is a combination of the float trap and the thermostatic trap, and finds its use in the draining of condensate from unit heaters, blast heaters, and coil heaters for water, oil, or other liquids where there is apt to be a large volume of condensate which would not permit successful operation of thermostatic traps alone. The function of the float element of this trap is to handle the condensate, and of the thermostatic element to permit the flow of air and to prevent the flow of steam around the float valve. Float and thermostatic traps are made in sizes from $\frac{1}{4}$ to 2 in. and usually operate under pressures varying from vacuum conditions to 40 psig, although some are made to operate at a maximum pressure of 200 psig. Fig. 37 illustrates a typical float and thermostatic trap.

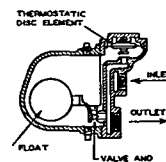


Fig. 37 Typical Float and Thermostatic Trap

Upright Bucket Traps. In this type of trap, the condensate enters the trap chamber and fills the space between the bucket and the walls of the trap. This causes the bucket to float, and forces the valve against its seat, the valve and its stem usually being fastened to the bucket. When the condensate in the chamber rises above the edges of the bucket, it overflows into it and causes the bucket to sink, thereby withdrawing the valve from its seat. This permits the steam pressure acting on the surface of condensate in the bucket to force the water to

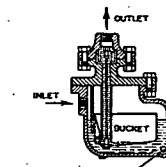


Fig. 38 Upright Bucket Trap

the discharge opening. When the bucket is emptied, it rises and closes the valve and another cycle begins. The discharge from this type of trap is intermittent, and it requires a definite differential pressure (usually 1 psi at least) between the inlet and outlet of the trap in order to lift the condensate out of the bucket to the return opening.

Upright bucket traps are used for draining condensate and air from blast coils, unit heaters, steam mains, laundry equipment, sterilizers, water and oil heaters and other equipment. This type of trap is particularly suited for use where there are pulsating pressures, such as occur in draining steam lines and separators at reciprocating pumps or engines. It is not influenced by pulsations or wide fluctuations of pressure. Upright bucket traps are obtainable in sizes varying from $\frac{1}{4}$ to 2½ in., and for pressures varying from vacuum to 1200 psig. Fig. 38 illustrates an upright bucket trap.