Oak Services Co. - Nash Jennings Pumps

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When it is structurally impractical to install the vacuum heating pump for "gravity returns", an auxiliary accumulator tank must be used; except that in the case of subatomspheric steam systems, **no lift of any kind is permissible**. The installation of the auxiliary accumulator tank should be made in accord with the appropriate installation details.

Conventional lift fittings must not be substituted for an auxiliary accumulator tank. Such use of lift fittings results in improper pump control and greatly impairs the operation of the entire heating system.

The auxiliary accumulator tank is to be installed with all returns from the system at or above the tank inlet connection. Again it is important that **all** vacuum return lines from the system be properly sized and pitched to the inlet of the auxiliary accumulator tank.

It should be noted that the use of the auxiliary accumulator tank results in essentially a gravity return job. However, it should also be noted that in addition to its primary functions, the pump is called upon to lift condensate vertically before it can be pumped to the boiler plant.

Based on practical experience the lift should be limited to 5 feet. it should also be emphasized the lift must be deducted from the maximum vacuum that can be maintained in the main return line. The lift requires a pressure differential of about 1/2 lb. (or 1 inch of mercury vacuum) for each foot of vertical rise. Therefore the lift reduces the suction available for drawing the returns back from the system for proper steam circulation. This is why lifts should be avoided or at least kept to a minimum.

Operation of auxiliary accumulator tank

A vacuum heating pump is required to function under two general conditions of operation. First, when its primary duty is to handle large volumes of air. Second, when its primary duty is to handle large quantities of condensate. The lift action resulting from the use of the auxiliary accumulator tank differs considerably under the two general operating conditions, as explained below.

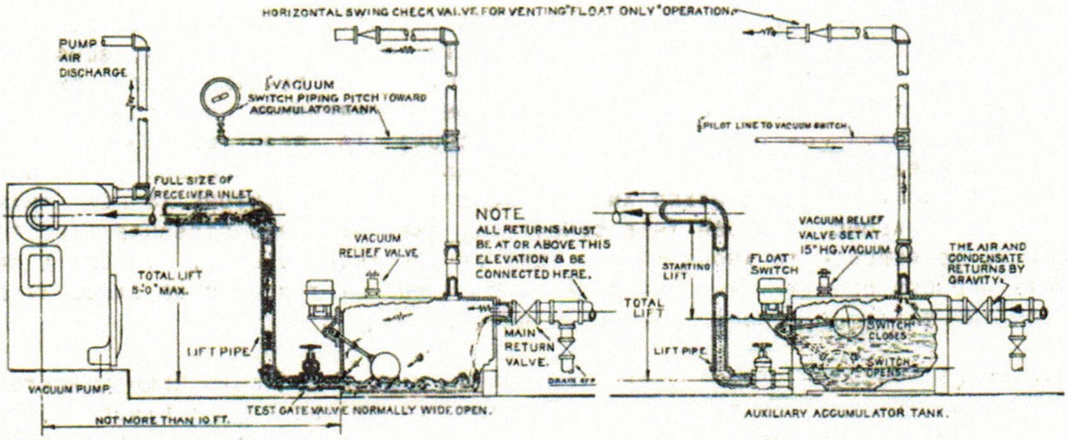

FIG. 1
PRIMARY PUMP OPERATION ON DEMAND OF VACUUM SWITCH.

FIG. 2
PRIMARY PUMP OPERATION ON DEMAND OF FLOAT SWITCH.

Figure (1) primary pump operation on demand of vacuum switch.
Figure (1) of the above drawing shows the first of the two general conditions of operation. On most systems this is the normal daytime operating condition. Under this condition the pump operates primarily on demand of the vacuum switch. When the air pump is running, air passes through the tank and condensate cannot accumulate. This is because waves form on the bottom of the tank. As each wave reaches the tank outlets it forms a water slug which is then carried up the lift pipe by the high velocity air stream. The reason why the lift pipe is made small is to create this required velocity. Having completed the lift, the velocity may be reduced by increasing the pipe size in the horizontal run. This is desirable to reduce friction.

With an accumulator tank the vacuum switch must not be connected to the main receiver of the pump since the lift causes a fluctuating vacuum at that point. The switch must be connected at a point where stable system conditions can be measured.

Figure (2) primary pump operation on demand of float switch.
Figure (2) shows the second of the two general conditions of operation. This condition occurs periodically during normal daytime operation when the air pump, under control of the vacuum switch, does not run frequently enough to keep the accumulator tank clear of condensate. This is always

the case with a tight vacuum heating system. The condition also occurs during non-heating periods, such as night or weekend shut– downs. This is the condition obtained by “float only” operation.

Under this general condition of operation condensate collects in the accumulator tank until the level rises high enough to close the float switch. Note that the water also rises to the same level in the lift pipe. Closing the float switch starts the air pump. No air can be removed from the system since it is sealed off by the water in the accumulator tank. Therefore the air pump draws air from a limited volume, the main receiver and the short run of piping at the top of the lift, and a vacuum is quickly established. When sufficient air has been removed there is enough pressure differential to raise the column of water in the lift pipe and it flows to the main receiver. The action continues until the float switch opens to stop the air pump.

One point to be particularly emphasized is that a high “induced vacuum” can occur in the return main when steam is shut off. In these circumstances the air pump must not only create the required differential to raise the water through the lift, but more importantly, it must also overcome the “induced vacuum”. For example, assume an induced vacuum of 15 inches in the return main and a total lift of 5 feet (equivalent to 5 inches vacuum) from the accumulator tank. The air pump must therefore create a vacuum of not less than 20 inches. A vacuum relief valve, usually set at 15 inches, is provided to limit the degree of induced vacuum so that condensate must be quickly removed through the lift and returned to the boiler without delay.

Lift fittings should not be used at top or bottom of the lift pipe because they add resistance to the flow of the water. Omission of an inverted lift fitting at the top actually reduces the total lift, and is unnecessary since the horizontal run to the receiver is so short that any danger of back flow is eliminated.

Finally under the figure (2) conditions, the horizontal distance between the pump receiver and the lift should be not more than 10 feet. A greater distance means a greater volume to be evacuated, and because of the pulsating conditions of the lift, surging is created in the accumulator tank. This will result in objectionable return line noises and possible water hammer. If the maximum dimension of 10 feet must be exceeded, there are special provisions that can be made to handle the problem satisfactorily.

In the above discussion it has been emphasized that the total lift should not exceed 5 feet. Notwithstanding this, there are occasionally very special situations where it is impossible to comply with this restriction. In such case it is possible to increase the total lift to as much as. 8 feet by using a "two—step" lift between the outlet of the accumulator tank and the top of the lift. The two—step lift should be constructed as shown on the lifts in vacuum return lines page. As far as system and pump operation is concerned, the two—step lift will be substantially equal to a one—step lift of 5 feet.

Sizing Auxiliary Accumulator Tanks

As a general rule, Auxiliary Accumulator Tanks are smaller than the main vacuum condensate receiver. This is because when the vacuum pump is operating, the Auxiliary Accumulator Tank functions as a lift fitting. Condensate flows right through it and no condensate is stored in this tank. This is illustrated in Figure 1, above.

It is only when the vacuum pump is not operating, either because the system vacuum is satisfied, or the unit is placed in FLOAT ONLY operation, that condensate is held in the Auxiliary Accumulator Tank. See figure 2, above. FLOAT ONLY operation is usually used when steam flow is low, and returning condensate is diminished.

If the sizing of the Auxiliary Accumulator Tank was similar to that of the vacuum condensate receiver, the sudden flow from a full auxiliary accumulator tank would cause a flooded condition in the main vacuum condensate receiver. This flooded condition could overcome the removal capacity of the condensate pump(s), and would cause the vacuum pump to discharge condensate out of it's air discharge, which would then go down the drain. A vacuum pump overload trip-out could also occur.

These days many modern boilers are of compact design and are supplied feedwater from a separate boiler feed pump and receiver unit. Condensate that is held in the system is not available to feed the boiler. By limiting the size of the Auxiliary Accumulator Tank, more condensate is available in the boiler feed pump's receiver to meet the demands of the boilers. By making as much condensate available as possible, the addition of make-up city water is diminished.

It is important to understand that the purpose of the condensate pumping function of the Vacuum Heating Pump is to **MOVE** condensate, **NOT TO STORE condensate**. When in doubt, it is always better to err on the small side when sizing an Auxiliary Accumulator Tank.

Considering past experience and the above considerations, we recommend the Auxiliary Accumulator Tank volume should be 2/3 to ¾ of the main vacuum condensate pump's receiver.