

FIGURE 7.29 Proper draining of a single condenser to a bottom inlet receiver.

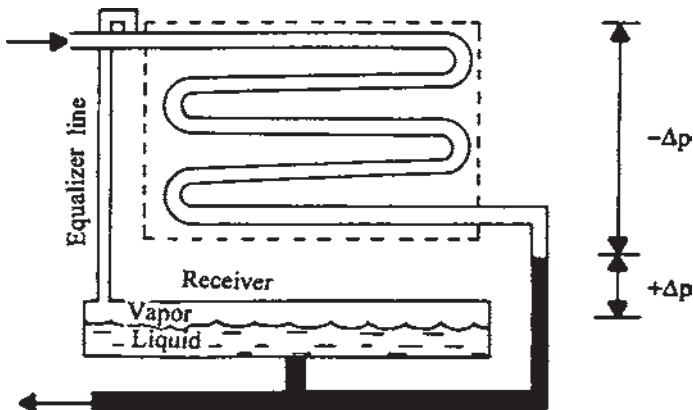
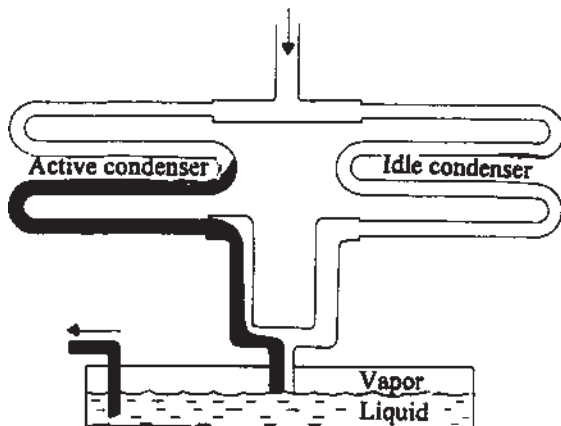


FIGURE 7.30 Pressure profiles when the receiver is equalized to the top of the condenser.

7.24 DRAINING CONDENSATE—PARALLEL CONDENSERS

A characteristic of industrial refrigeration plants is the use of parallel condensers and compressors. This fact is especially pertinent to ammonia systems, and not always true for halocarbon systems where the oil transfer between parallel units sometimes becomes a problem. Plants of even moderate size are usually designed for parallel condensers to offer flexibility in meeting a wide range of load variation. When condensers are piped in parallel, the following rules should be observed:

**FIGURE 7.31**

Backup of liquid into one of two parallel condensers.

- trap the liquid drain lines
- provide a generous length of vertical drain line
- install an equalizer line between the receiver and the entrance of the condensers

The purpose of trapping the liquid drain lines is to aid in drainage of liquid from all condensers. The potential drainage problem with multiple parallel condensers is illustrated in Fig. 7.31 where the condenser on the right has, at least at this moment, a low flow rate of refrigerant. Some reasons for the low flow rate include: a different design of condenser than the other or the fans are completely or partially shut down.

The pressure drop through both condensers must be the same because there are two common points in the piping—at the inlet and the outlet of the condensers. The only way the active condenser on the left can operate with the low pressure drop of the condenser on the right is if liquid backs up into the condenser tubes. Assume that the drain lines are large, so the liquid head in the tubes on the left condenser supplements the available pressure difference.

To avoid the problem of liquid backup into one of the condensers, liquid lines from both condensers should be trapped, using arrangements such as those shown in Fig. 7.32. Once again, the pressure drop through the two condensers from their common inlet to their common outlet is identical, but because the liquid lines are trapped, the drain line is full, and the difference in liquid level in the vertical drain line compensates for the difference in pressure drop. Thus, the liquid head in the left condenser builds up in the drain line and not in the condenser tubes where it would adversely affect the condenser performance. The bottom inlet receiver in Figure 7.33 inherently provides liquid traps for each condenser.

Implied in the correct piping of Figures 7.32 and 7.33 is an adequate length of the vertical leg. An estimate of the needed length of liquid column can be derived from the knowledge that the maximum pressure drop in an operating ammonia condenser is usually about 3.4 kPa (1/2 psi), which is the maximum pressure difference to be compensated for between an idle and an operating condenser. A liquid column of 0.6 m (2 ft) would compensate for this pressure difference, but most designers attempt to place the condenser high enough to permit a 1.2-m (4-ft) column of ammonia. Liquid R-22 has twice the density of liquid ammonia which would suggest that only half the length of liquid column would be needed for R-22, but the pressure drop in an R-22 condenser is about four times that of an ammonia condenser. The reason for the higher pressure drop with R-22 is because of its low latent heat, requiring perhaps six times the flow of R-22 compared to ammonia for a given heat-rejection capacity of the condenser. The recommended length of liquid column in an R-22 installation is 2.4 m (8 ft).

An equalizer line is required since the vapor from the top of the receiver cannot vent back to the condensers through the drain line because of the liquid traps as it could in the single condenser in Figure 7.28. Also the pressure at the outlet of the condenser tubes may be different, so the equalizer line must be connected to the top of the condensers where the pressure is the same for both condensers.

7.25 DRAINING CONDENSATE—THERMOSYPHON OIL COOLING

When the oil for screw compressors is cooled by refrigerant circulating by means of a thermosyphon, some of the same principles of condenser draining apply, but there are some additional considerations. A vessel, called the thermosyphon receiver, is needed to separate the liquid from the liquid/vapor mixture that rises from the oil cooler. The vapor thus separated passes to the discharge gas header, as shown in Figure 7.33. The return of liquid/vapor from the oil cooler should flow to the thermosyphon receiver and not to the discharge header of the condenser. Were the liquid from the oil cooler to enter the condenser, it would overload it with liquid and reduce its heat-transfer capacity.

A significant fact is that there is appreciable flow of vapor through the vapor line from the thermosyphon receiver, so there is a pressure drop in this line. Thus the pressure in the thermosyphon receiver is higher than that of the condenser inlet and certainly higher than the condenser outlet. To overcome this pressure difference a liquid column must develop somewhere. Figure 7.33 shows bottom inlet to the thermosyphon receiver with individual liquid columns for each condenser. Entrance of the condensate to the top of the thermosyphon receiver would work satisfactorily if the drains were equipped with the P-traps of Figure 7.32a. Even if the installation consists of only one condenser, there is

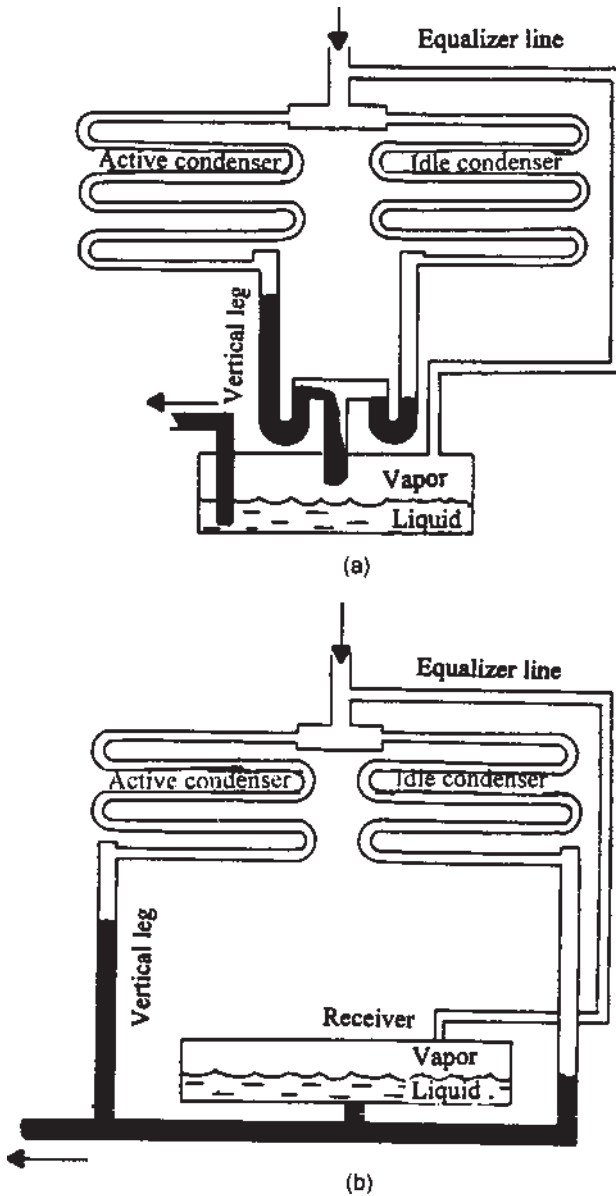


FIGURE 7.32

Trapping the liquid lines and using the liquid head in the vertical drain line to compensate for differences in pressure drop in the condensers in (a) a top inlet receiver and (b) a bottom inlet receiver.

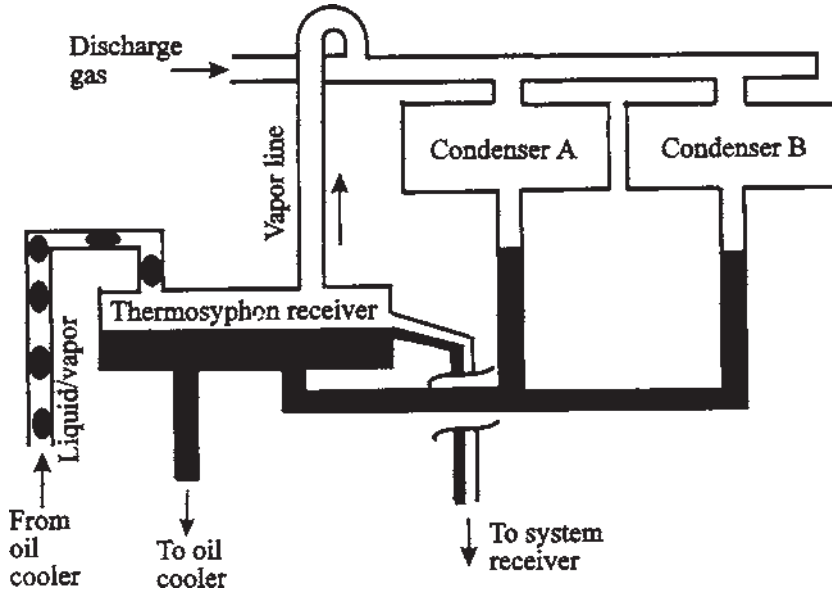


FIGURE 7.33

Trapping the liquid drain lines from multiple condensers that serve a thermosyphon receiver.

still the need to build up pressure from the outlet of the condenser to the thermosyphon receiver. A convenient means of providing a liquid seal to form a liquid trap is to immerse the drain line from the condenser below the liquid level maintained by the overflow to the system receiver.

7.26 SIZE OF EQUALIZER LINES AND THERMOSYPHON VAPOR LINES

Under normal circumstances equalizer lines between the receiver and the inlet or outlet of the condenser can be small, because it is not expected that they need carry high flow rates. They only need to convey a volume flow rate of vapor equal to the rate of change of liquid volume. There is one situation where the equalizer line should be generously sized and that is during a shutdown of a plant located in a cold ambient temperature but with the receiver located in a warm machine room. There will be a constant vaporization of the liquid in the receiver causing vapor to flow through the equalizer line to the discharge gas header where it will condense in the condenser. The pressure drop resulting from the vapor flow in the equalizer line must be compensated by a liquid column that will develop and back liquid into the condenser. For high pressure drops of, for example, 25 kPa (3.7 psi), an ammonia liquid column of 4.6 m (15 ft) may