before rising to the condenser. This minimizes the possibility that refrigerant, condensed in the line on off cycles, will drain back to the head of the compressor. Any oil traveling up the pipe wall also will not drain back to the head of the compressor.

The loop in the hot gas line, shown in Fig. 11, will serve as a reservoir and trap liquid resulting from condensation in the line during shutdown.

Hot gas lines discharging straight across to a condenser

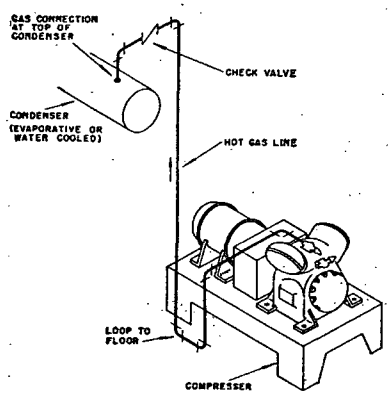


Fig. 11 .... Hot Gas Loop[2]

immediately adjacent to the compressor will not require this loop at the compressor.

Whenever the condenser and receiver are located where the ambient temperature can be higher than that of the compressor, a check valve is sometimes installed in the hot gas line near the condenser. This valve prevents refrigerant from boiling off in the condenser or receiver and condensing in the cooler hot gas line or on the compressor heads during off cycles.

A purge valve should be installed at the high point in hot gas lines to facilitate the releasing of non-condensable gases. Purging at this point should be conducted only after the system has been shut down for a short time to allow the non-condensables to gather there.

Hot Gas Mufflers

Mufflers may be installed in hot gas lines to dampen the discharge gas pulsations and thus reduce vibration and noise in the piping system.

The proper location of a muffler is in a horizontal or down comer portion of the hot gas line, immediately after leaving the compressor. It should never be installed in a riser.

Gas velocities through the muffler are substantially lower than in the hot gas line itself and the muffler may form an oil trap if installed in a riser or in a horizontal line in such a manner that it does not drain oil at the outlet.

CONDENSER TO RECEIVER PIPING

Liquid receivers are usually used in systems having evaporative or air-cooled condensers, and also with water-cooled condensers where additional liquid storage capacity is needed to pump the system down. In many water-cooled condenser systems, however, the condenser also serves as the receiver if the total refrigerant charge in the system does not exceed its storage capacity.

When receivers are used it is necessary that liquid piping from the condenser to the receiver be designed to allow free drainage of liquid from the condenser at all times. For this to happen, the pressure in the receiver, in relation to the pressure in the condenser, must not be allowed to rise to the point where a restriction in flow can occur.

Liquid flow from the condenser to receiver can be restricted by any of the following:

1. Gas binding of the receiver.
2. Excessive friction drop in the condensate line.
3. Incorrect condensate line design.
4. Condenser outlet to receiver inlet relationship.

Gas Binding at Receiver

Liquid piping between the condenser and receiver should be designed to prevent liquid hold-up in the condenser due to a gas-bound receiver.

Gas binding usually occurs when the receiver ambient temperature is above condensing temperature, and may happen as the result of any of several conditions:

1. On evaporative condensers:
   - *a.* Where low prevailing wet-bulb temperatures result in low condensing temperatures.
   - *b.* Where they are oversized for dry-coil operation.
   - *c.* Where no provision is made to control the supply air automatically at partial load operation.
2. On water-cooled condensers:
   - *a.* Where the low water supply temperature makes it economical to design for low condensing temperatures.
   - *b.* Where no provision is made to control the flow of water automatically, particularly at partial load operation.
3. On receivers where it is necessary to install them in abnormally warm locations.

In whichever way it occurs, the existence of a condensing temperature lower than receiver ambient temperature means that the liquid inside the receiver is colder than the outside of

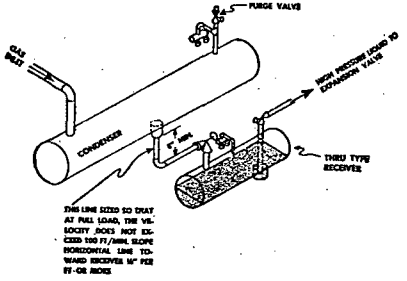
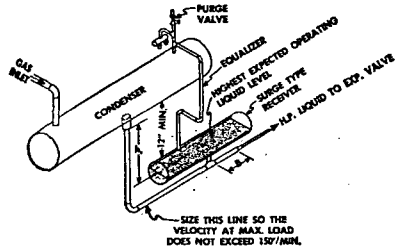


Fig. 12 .... Shell-and-Tube Condenser to Receiver Piping (Through-Type Receiver)[2]



Max. Velocity of Drain Line, fpm	Type Valve Between Condenser and Receiver	h, Required In.
150	None	14
150	Angle	16
150	Globe	28
100	None, Angle or Globe	14

B = Drain line sized for maximum velocity of 150 fpm may be reduced to smaller size line (or shut-off valve may be located a minimum distance of 12 in. downstream of the takeoff to the receiver).

Fig.13 .... Shell-and-Tube Condenser to Receiver Piping (Surge-Type Receiver)[2]

the receiver shell, thus causing heat leakage into the receiver. This, in turn, causes a portion of the liquid in the receiver to evaporate. If no provision is made to vent this gas back into the condenser, the receiver becomes gas-bound.

The following piping recommendations are made to overcome these difficulties.

SHELL-AND-TUBE CONDENSER TO RECEIVER PIPING

Single Condenser

Fig. 12 shows piping at a shell-and-tube condenser with a free draining liquid line to a top inlet high pressure receiver. With a free draining liquid line, having a liquid velocity at full load not exceeding 100 fpm, an external equalizer is not necessary. Any gas generated in the receiver can return back up the large condensate line to the condenser without restricting the flow of condensate leaving the condenser. Any horizontal run in this line should be pitched in the direction of the receiver at a slope of at least ¼ in. per ft. A shut-off valve located between the condenser and receiver should be located at least 8 in. below the condenser outlet so that any static liquid build-up to overcome the pressure drop through the valve will not build up in the condenser. When a shut off valve is located in a horizontal line, it should be positioned with the valve stem in a horizontal position so it will not form a liquid trap. Where an external equalizer (vent) line is desired it should be run from the top of the receiver to the top of the condenser, similar to Fig. 13.

Fig. 13 shows piping at a shell-and-tube condenser and a bottom inlet (surge type) receiver. An equalising line is required in this arrangement to prevent a build-up of receiver pressure, beyond condensing pressure, by relieving any flash gas back to the top of the condenser. Table 1 lists equalizer line sizes for various tonnage ranges.

The liquid drain line from the condenser to a bottom inlet type receiver, or a top inlet receiver that is equalised back to the condenser, should never be sized so that the velocity of the liquid through it at *full load exceeds 150 fpm*. There should always be an elevation difference of at least 12 in. between the bottom of the condenser and the top of the receiver to allow height for enough static head of liquid to offset the friction pressure drop in the liquid line between the two shells. When a valve is located in this line the height may have to be increased as indicated in the table in Fig. 13 unless the line is sized for a liquid velocity below 100 fpm.

Multiple Condensers

When two or more shell-and-tube type condensers are mounted in parallel in a single system they can be arranged as shown in either Fig. 14 or 15, depending upon the height available.

The liquid drain lines between the condenser outlets and receiver inlet should be sized for a liquid flow velocity not greater than 150 fpm, preferably 100 fpm. The elevation difference between the outlet of the condenser and inlet of the receiver in Fig. 14 or top of liquid level in Fig. 15 must be at least 12 in., and preferably greater (see table in Fig. 13).

An equalizer line is shown from the top of the receiver to the top of the condensers, in each case, to prevent liquid hold-up in one of the condensers.

A purge valve should always be located in the top of each condenser for removing noncondensables from the system.

EVAPORATIVE CONDENSER TO RECEIVER PIPING

Liquid receivers are used on all evaporative condenser systems to accommodate fluctuations in refrigerant charge at this point. Proper attention must be given to the condensate piping so that the receiver is always equalized back to some part of the condenser for the relieving of any gas pressure tending to develop in the receiver. Otherwise liquid hang-up can occur in the condenser due to restriction of free drainage, caused by this gas pressure building up in the receiver.

The receiver can be vented directly back through the con-

Table 1 .... Equalizer Line Sizes[2]

Equalizer Line Size (Nominal Pipe Size) In.	½	¾	1	1¼	1½	2
Max Tons—Refrigerant 12	35	70	120	200	280	460
Max Tons—Refrigerant 22	50	90	150	260	360	590