Fig. 46 incorporates an air bypass arrangement for controlling head pressure. A modulating motor acting in response to a modulating pressure control positions dampers so that the mixture of recirculated and cold inlet air is such as to maintain the desired pressure. In extremely cold weather most of the air would be recirculated and thereby prevent the spray water from freezing on the coils.

Air-Cooled Condensers

With air-cooled condensers, various methods employed for condensing pressure control are: cycling fan motor, air throttling or bypassing, and coil flooding.

The first two methods are described in the section *Evaporative Condensers*. The third method serves to hold the condensing temperature up by reducing condenser capacity. This is achieved by backing liquid refrigerant up in the coil to cut down on effective condensing surface.

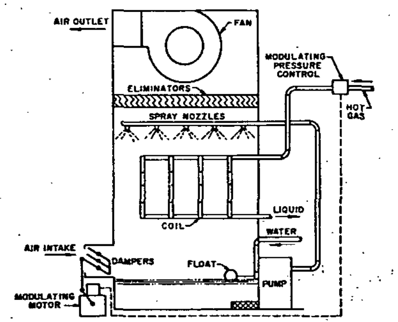

Fig. 45 .... Head Pressure Control for Evaporative Condenser (Air Intake Modulation)[1]

The control operates as follows: When the head pressure drops below the setting of the control valve, it opens, allowing discharge gas to enter the liquid drain line. This restricts the drainage of liquid refrigerant and causes enough of the condenser to flood so as to maintain the condenser and receiver pressure at the control valve setting. The control valve is modulating, and the amount of coil flooding is automatically adjusted to maintain the required head pressure at all times.

This control opens and passes gas to maintain a minimum downstream pressure. There must be a pressure difference available across the valve, however, to open it. Although the condenser would impose sufficient pressure drop at full load, this may practically disappear at low partial loading. Therefore, a positive restriction must be placed in parallel with the control valve. In some cases, it is handled by a loop in the liquid line which insures a lower pressure at the control valve outlet than that at the inlet. Other arrangements which do not require this loop, are also used.

Extra refrigerant charge is required in a system using this type of control.

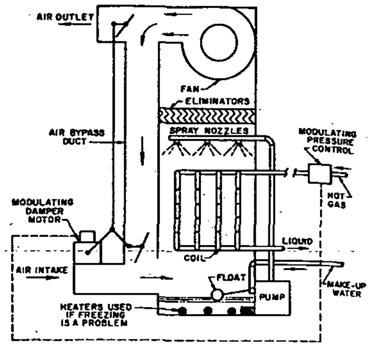

Fig. 46 .... Head Pressure for Evaporative Condenser (Air Bypass Modulation)[1]

LIQUID ENTERING COMPRESSOR BY DISTILLATION AND ABSORPTION

Refrigerant, in liquid form, can enter the compressor in many ways:

1. By actual gravity drainage from the system, during off periods.
2. By improper operation or sizing of the system liquid feed devices, causing periodic or continuous overfeed.
3. By the distillation process on off cycles wherein liquid refrigerant in a warm location can slowly boil off and condense in the compressor if it is in a cooler location.
4. By the absorption of refrigerant directly into the oil until equilibrium takes place.

Effect on Compressor

Liquid refrigerant entering the compressor has four adverse effects:

1. It dilutes the oil resulting in a poor lubricating mixture.
2. It accelerates oil loss from the compressor during start-up time.
3. It causes the machine to operate at sub-normal temperature which shortens compressor life and lessens its efficiency.
4. It may cause direct compressor damage such as broken valves and valve plates, distorted or broken connecting rods and shafts.

Effect on System

In addition to the deteriorating effect on the compressor caused by loss of lubrication or direct compressor damage, liquid entering the compressor is highly destructive of system efficiency. It takes up a substantial portion of the compressor displacement as it evaporates in the crankcase or manifold. This portion can then do no useful work with respect to the evaporator load.

Accordingly, it is necessary to carefully select and apply evaporator liquid feed devices to limit the quantity of refrigerant which can enter the compressor during operating time.

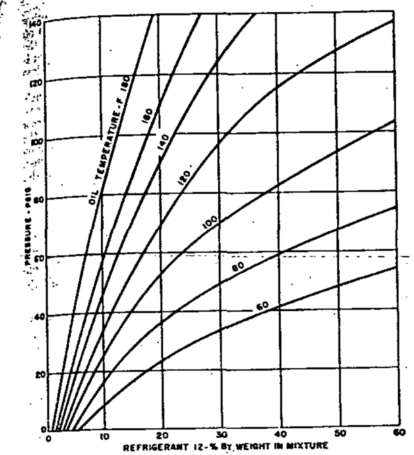

Fig. 47 .... Temperature-Pressure Relationship for Mixtures of Refrigerant 12 and Oil

Refrigerant-Oil Miscibility

Refrigerant 12 and lubricating oils are miscible in any proportion. Refrigerant 22 is somewhat less so but its miscibility is sufficient so that the same precautions are required as for the Refrigerant 12 system. Refrigerant 500 also needs similar treatment.

Fig. 47 shows the temperature-pressure relationship of Refrigerant 12 and oil mixtures. The bottom scale indicates percent by weight of Refrigerant 12 in the mixture and the scale at the left represents gage pressure in psi. The curve lines show mixture equilibrium conditions at various temperatures.

Note that even at 40 psi and 60 F, oil can absorb up to 38 percent weight of liquid refrigerant. If system pressure is allowed to equalize at 70 F ambient temperature, resulting in about 70 psig pressure in the system, it can be seen that the oil-refrigerant mixture in the crankcase will end up about 70 percent refrigerant before equilibrium is reached.

At low crankcase pressures, it can also be seen that the percent of refrigerant which can be absorbed in the mixture is quite low at practically any temperature. Also, the higher the oil temperature, the less the refrigerant absorbed in the mixture, for any given pressure.

The miscibility characteristic, and its effect, in a refrigeration system can be illustrated by reference to Fig. 48. If Refrigerant 12 is initially placed in one vessel and lubricating oil in the other, and the vessels are placed in a common ambient temperature, all of the refrigerant will migrate to the oil containing vessel by reason of the absorption head of the oil. Elevating the oil temperature will limit this migration, depending on the temperature elevation.

For instance, if the oil were in an ambient temperature 20 F higher than the refrigerant, or if the oil were heated by an immersion type heater to 20 F higher than the refrigerant temperature only 67 percent of the oil weight of refrigerant would become dissolved in the oil.

If large quantities of liquid are to be kept out of the lubricating oil in the crankcase of a refrigeration compressor during idle time, one of the following methods must be employed:

1. The oil and refrigerant must be separated by physical means, that is, by the closing of either automatic or manual shut-off valves.
2. The oil temperature must be higher than the saturated refrigerant temperature to reduce its absorption head.
3. The crankcase pressure must be maintained low enough to prevent excessive absorption.

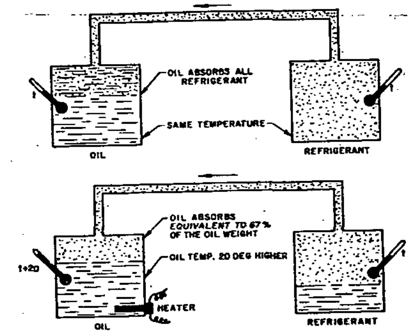

Fig. 48 .... Miscibility of Refrigerant 12 and Oil[1]

CONTROL OF COMPRESSOR TO KEEP LIQUID FROM CRANKCASE DURING OFF CYCLES

The control of reciprocating compressors must be such that excessive accumulation of liquid refrigerant in the crankcase during off cycles is positively prevented. The use of any one of the following methods of control is expected to accomplish this purpose.

Automatic Pump-Down Control (DX Systems)

The most effective, and the most common, means of keeping liquid out of the crankcase during system shut-down periods is to operate the compressor on automatic pump-down control. The recommended arrangement of this control involves the following devices and provisions:

1. A liquid line solenoid valve in the main liquid line or in the branch to each evaporator.
2. Compressor operation through a low pressure cut-out providing for pump-down whenever this device closes, regardless of whether balance of system is in operation or not.
3. Electrical interlock of the liquid solenoid valve with the evaporator fan or water cooler pump, whichever is used, so that the refrigerant flow will be stopped when either the fan or pump are out of operation.
4. Electrical interlock of the refrigerant solenoid valve with the safety devices (such as the high pressure cut-out, oil safety