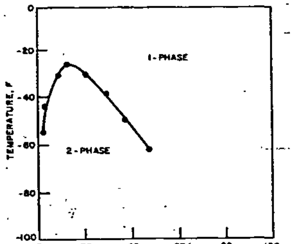


Fig. 31 .... Critical Solubility of Refrigerant 13B1 and Naphthenic Oil[8]

solubility of water in a refrigeration grade 150 SUV naphthene base oil has been estimated to fall between 50 and 70 parts per million by weight.[28] If it is desired to measure and control the amount of dissolved water below the solubility limit, a quantitative test such as the Karl Fischer method must be employed.[29] A moisture content of 20 parts per million is frequently specified as the maximum permissible in refrigeration oils, but according to Divers[30] economical considerations and practical refinery handling practice limit the minimum moisture content of refrigeration oils to about 30 parts per million at the present time.

The solubility of water in mineral oils increases with increasing temperature. Unfortunately, the published literature contains no reference to temperature-moisture solubility relationships as specifically applied to refrigeration oils. However, Clark's data[31] on the solubility of water in transformer oil (Fig. 41) may be used as a general guide. Spot checks on refrigeration oils have agreed reasonably well with points on Clark's curve.

In refrigerator manufacturing plants, oils can be dried below the solubility limit by several methods. *Blotter pressing* will remove a substantial portion of the dissolved moisture, provided the filter papers are carefully dried at an elevated

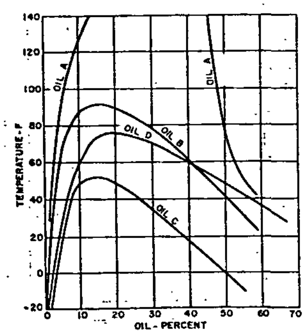
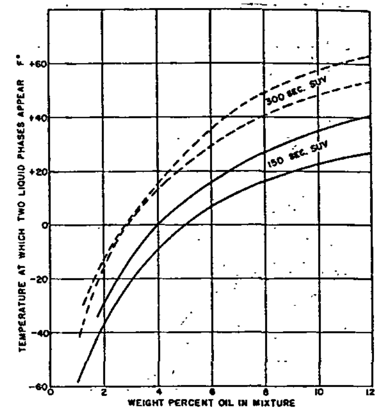


Fig. 32 .... Temperature-Composition Diagram Showing Miscibility of Refrigerant 22 with Four Oils[17]



Redrawn from Reference 19.

Fig. 33 .... Temperature-Miscibility Relations at Low Oil Concentrations in Refrigerant 22-Oil Mixtures

temperature just before use and are installed in the frame while still hot. For minimum moisture content a *vacuum drying* process may be used. Vacuum drying of the oil provides an added advantage since dissolved air is also removed (see Chapter 47).

When refrigeration repair work is done in the field it is not always possible to protect the oil from access of moisture, and redrying is impractical. However, when opening of the system is necessary, this usually exposes other parts of the system (e.g., motor windings) which also are vulnerable to moisture absorption. Hence it is common practice in repair work to install a desiccant-type dryer of a size adequate to redehydrate the whole system (see Chapter 49).

Solubility of Air in Oil

Refrigerating systems should not contain excessive amounts of air or other noncondensable gases. The oxygen present in air reacts quite readily with oil and this in itself is a valid reason for removing and excluding air. A more compelling reason, however, is that air, or at least the 79 percent nitrogen which it contains and which does not react with the oil, constitutes a noncondensable gas which, even in amounts so small as to cause no concern over possible oil oxidation, can interfere with the proper performance of refrigerating machines. (See Chapter 47). In some systems the tolerable volume of noncondensables is very low, and if the oil is added after the system is evacuated, it must not contain too much dissolved air or, for that matter, too much of any other, noncondensable gas. As mentioned in the preceding section, dissolved air is removed when a vacuum process is employed to dry the oil. However, if the deaerated oil is subsequently stored under dry air pressure, it will reabsorb air in proportion to the pressure. Fig. 42 shows the volume of air under standard conditions that can be absorbed (i.e., dissolved) in mineral oil over a range of pressures.[8] The data in Fig. 42 were determined at 68 F but are applicable also to other tempera-

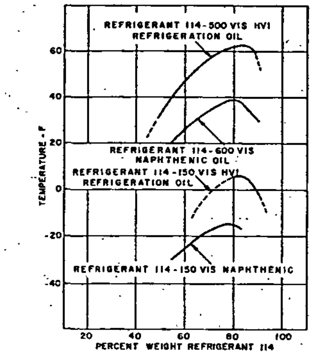


Fig. 34 .... Critical Solution Temperatures of Refrigerant 114-Oil Mixtures[1]

tures since there is only a minor variation in solubility between 20 F and 120 F.

Volatility—Flash and Fire Points

Some indication of volatility may be obtained by determining the *flash* and *fire* points of the oil which ordinarily are not particularly important in refrigerant systems. However, some refrigerants such as sulfur dioxide, ammonia and methyl chloride have a high ratio of specific heats c_p/c_v and consequently have a high adiabatic compression temperature. It has been reported that these refrigerants frequently produce carbonization of oils with low flash and fire points when operating in high ambient temperatures.[1]

Foaming and Antifoam Agents

Excessive foaming of the lubricant is undesirable in refrigeration systems. Brewer[27] has pointed out that an abnormal tendency to foam with refrigerant reduces the effectiveness of the oil in cooling the motor windings and removing heat from the compressor. Also, too much foaming may cause too much oil to pass through the pump and enter the low side. Foaming in a pressure oiling system may result in starved lubrication under some conditions.

However, it has also been claimed that moderate foaming is beneficial in refrigeration systems. There is no general agreement as to what constitutes excessive foaming, or how it should be prevented. Some manufacturers add small amounts of an antifoam agent, such as a silicone fluid, to refrigerator oils, but others believe that foaming difficulties are more easily corrected by equipment design than by the use of antifoam agents available at the present time.[28] The use of crankcase heaters to reduce oil foaming has been discussed by Neubauer[32] and others.[33]

Boundary Lubrication and Film Formation

An important function of the lubricant in many types of service is to prevent wear under conditions of *boundary friction*. The boundary condition is manifested by a sharp increase in friction coefficient as the relative speed of the moving

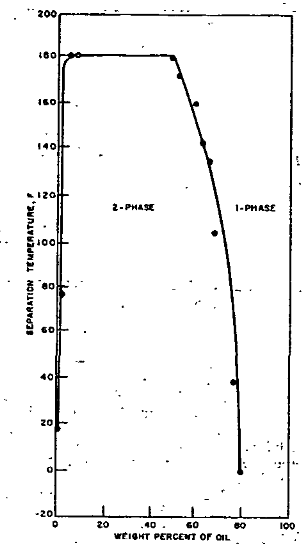


Fig. 35 .... Critical Solubility of Refrigerant 502 and Naphthenic Oil[8]

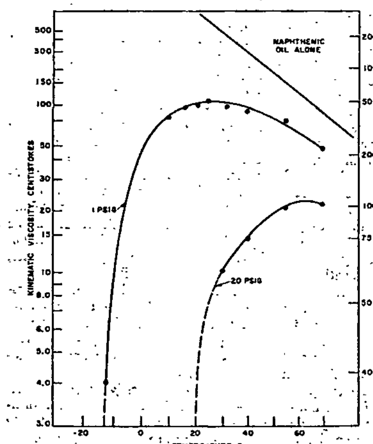


Fig. 36 .... Viscosity of Refrigerant 12-Oil Solutions at Low-Side Conditions[8]