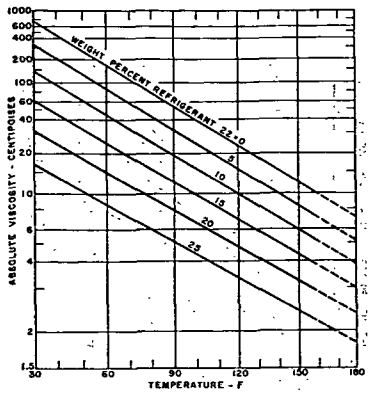
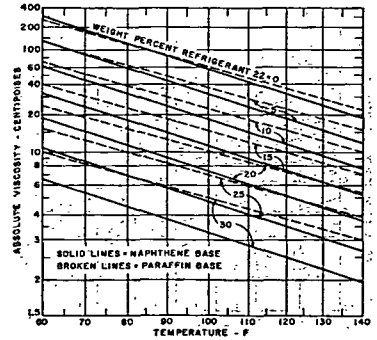


Fig. 25 .... Viscosity-Temperature Chart for Solutions of Refrigerant 22 in a 210 SUV German Naphthene Base Oil[9]

termine whether loss of fluidity, congealment, or wax deposition will occur at low-side temperatures.

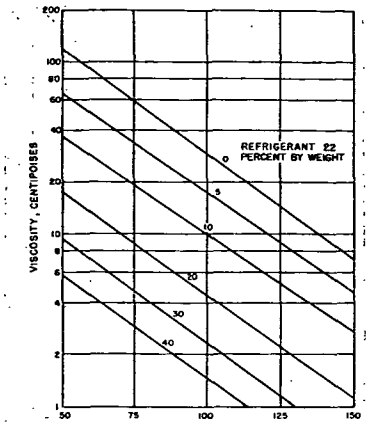
Wax Separation (Floc Tests)

In selecting an oil for use with completely miscible refrigerants such as Refrigerants 11 or 12, the wax-forming tendency of the oil is frequently judged by the *floc test*. In this test a solution of oil (e.g., 10 percent by volume) in refrigerant is sealed in a glass tube and is then cooled slowly until a flocculent, clumpy precipitate of wax appears. The maximum temperature at which this phenomenon just will occur is recorded as the *floc point*. The floc point test has not been standardized in the same sense as ASTM D-97 for pour points, but in general, the original procedure of Walker and Rinelli[24] is followed.



Converted from Reference 15.

Fig. 26 .... Viscosity-Temperature Chart for Solutions of Refrigerant 22 in 300 SUV Naphthene and Paraffin Base Oils



An unexplained but significant difference exists between these curves and those reported for paraffin base oils in Reference 15.

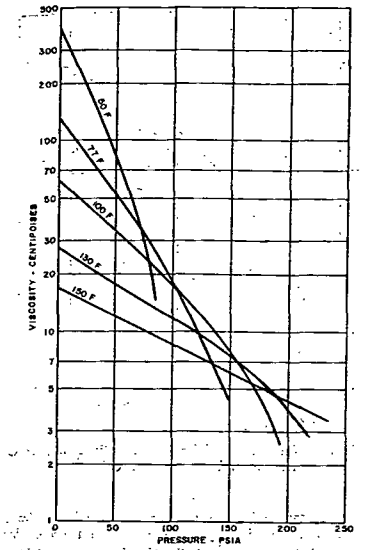
Fig. 27 .... Viscosity-Temperature Curves for Solutions of Refrigerant 22 in 150 SUV Paraffin Base Oil[13]

It is difficult to obtain a significant floc point with partially miscible refrigerants. Attempts to develop the test for use with Refrigerant 22 have not been very successful.[19,25] The solutions being cooled often separate into two liquid phases before the true wax precipitation temperature is reached. Two difficulties then appear. First, the wax may require several days to form, and second, as the temperature is lowered the immiscible range broadens so that additional liquid phase separation occurs.[19] The new liquid phase material appears as a cloud or suspension which may be mistaken for wax. Moreover, the separated liquid phases differ from one oil to another in their relative proportion of oil to refrigerant in solution so that a valid comparison of different oils is not easily obtained.

Floc point determinations may not be reliable when applied to used oils. Such determinations generally show a plateauing effect regardless of the value obtained on the new oil.[26]

Needless to say, oils should be selected which do not deposit wax in low sides, regardless of single-phase or two-phase refrigerant-oil solutions. Bosworth has described a number of troubles attributed to wax separation in systems of various types.[17] In a Refrigerant 12 system for example, the wax may be fluffy and practically fill the whole evaporator, or it may consist of very hard pieces. In either case the wax tends to float and also to stick to surfaces such as tube walls. As wax is a thermal insulator, it will lower heat transfer and also cause functional difficulties. With flooded-type evaporators, the float valves will probably not stick; but eliminators may become wax coated at low temperatures, so that refrigerant sludging occurs. Wax has also been known to clog impedance tubes and to cause expansion valves to stick.

Mechanical design also affects the susceptibility of a given equipment design to wax deposition. Experience has shown that wax is deposited from refrigerant solutions at points where sharp bends occur, and the suspended wax particles build up on the walls of the tubing by impingement. Careful design avoids bends and materially lessens the tendency to deposit wax.



An unexplained but significant difference exists between these curves and those reported for paraffin base oils in Reference 15.

Fig. 28 .... Viscosity of Mixtures of 300 SUV Paraffin Base Oil and Refrigerant 22[13]

Solubility of Water in Oils

Refrigerant systems must be dry internally if trouble-free operation is to be guaranteed. Hence it is customary to require that oil and other substances used in refrigerant systems should be dried to a low moisture content. When oils have once been dehydrated and meet the necessary requirements, they must be protected from humid atmospheres and handled in sealed containers (see Chapter 47).

A simple method for detecting free water is the dielectric strength test (ASTM D-877). This test is commonly used for controlling the free moisture content of electrical insulating oils (transformer oils). It has also been used to control the free moisture content of refrigeration oils.[27] A dielectric strength of 25,000 volts or more indicates that no free water is present; but the oil may still contain dissolved water up to the solubility limit at the testing temperature. At 80 F the

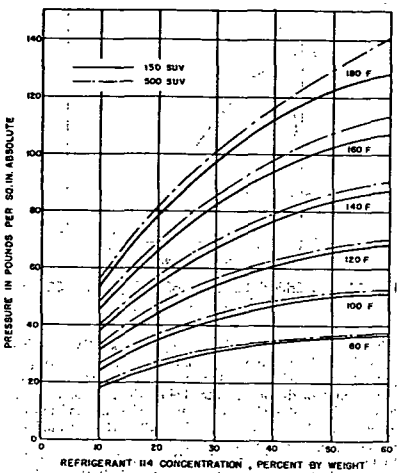


Fig. 29 .... Solubility of Refrigerant 114 in HVI Oils[16]

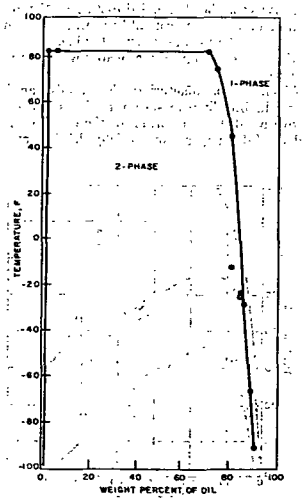


Fig. 30 .... Critical Solubility of Refrigerant 13 and Naphthenic Oil[8]