their viscosities range from 900 to 10,000 seconds Saybolt Universal (50 seconds to 300 seconds Saybolt Furol).

A number of factors affect the selection of a fuel oil preheating method. The three basic factors are:

1. Type of installation (commercial heating, industrial process, power generating, etc.).
2. Type of operation (automatic, semi-automatic, manual, intermittent, continuous).
3. Type of fuel (No. 5, No. 6, Bunker C).

TABLE 1. PREHEATING TEMPERATURES TO OBTAIN SUITABLE VISCOSITIES FOR ATOMIZING

VISCOSITY OF OIL[a]		OIL TEMPERATURE (FAHRENHEIT) REQUIRED				
		Desired SSU Viscosity				
IN SSF AT 122 F	IN SSU AT 100 F	100	150	200	300	450
..	100	100	80	70	61	50
..	150	120	100	90	77	66
..	200	135	110	100	87	75
21	300	150	128	115	100	88
26	400	160	138	128	108	96
30	500	170	145	133	115	102
39	750	185	160	147	126	114
50	1000	190	168	155	133	120
60	1200	200	175	160	138	125
75	1500	205	180	168	145	132
100	2000	215	190	175	150	137
115	2500	220	195	182	156	143
135	3000	225	200	187	160	146
145	3500	229	205	190	162	150
160	4000	235	208	194	165	152
170	4500	237	212	197	167	155
190	5000	240	215	200	168	157
200	5500	245	218	204	172	160
220	6000	248	220	208	175	162
260	7000	250	225	210	177	165
285	8000	254	227	214	180	167
320	9000	258	230	216	183	169
342	10,000	260	235	218	186	171

[a] SSF = seconds Saybolt Furol viscosimeter. SSU = seconds Saybolt Universal viscosimeter.

From *Fuel Oil Manual*, by Paul F. Schmidt (*The Industrial Press*) 1951, p. 105. Columns for 300 and 450 viscosity from Davis Engineering Corp.

The pour point of an oil is another characteristic that could influence the preheating requirements, especially in areas subject to severe winter temperatures. An oil with a sufficiently high pour point may require preheating and continuous circulation at temperatures above its pour point at all stages between storage tank and burner to insure its easy pumpability. Oil specifications should be checked for this characteristic and limitations imposed, if feasible. Otherwise the oil piping system must be designed with this high pour specification in mind.

Four mediums for preheating fuel oil are in common use: steam, hot water, gas, and electricity.

With steam as the heating medium the heater may be of shell-and-tube (either straight or U-tube) type or the heaters may be of a bayonet type

inserted in the oil tank. In a bayonet-type heater an open-end tube is enclosed in a larger tube which has a closed outer end. Steam enters through the inner tube while condensate is drained from the outer tube. A heater of bell-shaped type may also be connected into the oil suction line at the tank for the purpose of raising the temperature of the oil drawn from the tank.

The steam preheating method has several limitations. Mainly, it is dependent upon continuity of burner operation to keep steam available to prevent viscosities beyond pumpability. Therefore, its practicability and economy is limited to installations having continuous operation. Another limitation is that the relatively high temperature of steam may cause changes in the chemical structure of lighter grades of residual fuel oils. To prevent excessively high viscosities in the fuel oil piping, constant oil circulation is maintained or the oil piping is enclosed with steam lines in the same thermal insulation. The economy of the steam preheating method is also dependent on the availability of steam at the pressure and quantity required, and on the distance from boiler to storage tank.

The hot water preheating method utilizes equipment similar to that used for steam. Because of the possibility that oil may penetrate into the boiler through faulty heat exchangers, some devices have been developed to prevent this condition. Double-transfer heaters and fuel-oil detectors are those most frequently used. Similarly, as with steam, continuity of burner operation, or cycling burner operation, is needed to maintain the temperature of the heating medium. Since oil heating is limited by the water temperature in the boiler less transmission and transfer losses, such losses must be taken into account, particularly on installations having a considerable length of oil piping.

The indirect gas-fired preheating method is a package arrangement that uses gas as the primary energy source. It generates its own supply of low pressure steam in a closed vapor-condensate cycle. The oil is pumped through the steam oil heater as required to compensate for radiation losses in the oil-circuit lines, whenever pumping action stops. During the layover period, the main boilers and oil burners are entirely inactive. If separate oil transfer pumps are not available, a small circulating oil pump is added to the package to provide circulation in the oil lines during the gas-firing periods.

The electrical preheating method involves use of immersion heaters plus one of two special arrangements for heating the fuel oil piping. One special arrangement is a heating cable (soil cable or plastic covered wire) wrapped around the supply line or all oil piping together with a vertical-element immersion heater in the suction pipe in the oil tank. The closeness and evenness of the spiral winding of the cable determine the heat input. The on-off periods are thermostatically controlled. For protection of the heating cable, the temperature of the oil piping has to be limited and usually must not exceed 170 F. Where pipe and oil temperatures permit wrapping of all oil piping, constant oil circulation is not required. The efficiency of this preheating method is lower than for element immersion or electric impedence heating because of transfer losses between the heating element and the pipe.

The other special arrangement for electrical preheating is a packaged system of electric impedence heating for all oil piping together with immersion element heating sufficient to heat the oil used. Low-voltage high-amperage alternating current of the 60-cycle frequency is passed through the oil piping itself, generating an even amount of heat in the pipe walls.