

Fig. 6 Typical Boiler-Burner Unit

contact with cold surfaces, or the flame will be quenched or chilled. Quenching or chilling of the flame results in the release of carbon which settles on the cold surfaces. It is the usual practice to supply a combustion chamber liner which will become hot enough to support the combustion, and which avoids the possibility of flames contacting cold surfaces until the combustion process has been completed.

Combustion Adjustments and Measurements

The modern oil burner, with mechanical oil and air supply, is capable of maintaining efficient combustion when properly installed and adjusted. Good practices of installation and adjustment have also been published by the Oil-Heat Institute of America (now the National Oil Fuel Institute).⁴

Before final combustion adjustments are made, details of the installation should be checked. The boiler or burner setting should be checked to make sure there is no air leakage. Even though a fan is used to supply the air for combustion in most oil burners, the importance of a proper chimney should not be overlooked. It should have sufficient height and size to insure a uniform draft within the limits needed. Detailed considerations of chimneys and flues are covered in Chapter 53.

The correct oil-firing rate should be established by selection of nozzle and pressure in the case of pressure atomizing burners, or by valve adjustment in the case of vaporizing or

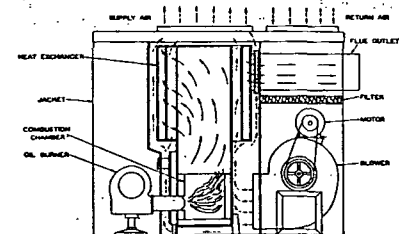


Fig. 7 Typical Oil-Fired Furnace Unit

vertical rotary wall-flame burners. Poor operating economy can result from overfiring.

Because of the importance of determining the level of smoke in the combustion products, smoke measurements should be taken by the simple and convenient method accepted by the oil-heating industry. The method is defined in Reference 6 and consists of sampling a known volume of flue gases through a filter paper and evaluating the discoloration of the paper by using an established shade scale. The use and interpretation of simple combustion instruments is described in Reference 7. Other basic combustion testing instruments include draft gage and flue gas analyzer.

A CO₂ content in the flue gas of 11 to 14 percent indicates excellent operation, if the flame is clean as indicated by a smoke reading of less than No. 2 on the standardized shade scale. Installation standards have been established by the former Oil Heat Institute (now National Oil Fuel Institute).⁵

Controls

The control of oil-fired equipment is discussed in the section Controls for Automatic Fuel-Burning Equipment.

COMMERCIAL AND INDUSTRIAL OIL BURNERS

Commercial-industrial burners are fired with all grades of fuel depending upon application. The following table of firing rate versus grade of fuel lists the generally accepted practice:

Firing Rate, gph	Grade of Fuel
Up to 5	No. 2
5 to 20	No. 2 and No. 4
20 to 35	No. 2, No. 4, and No. 5 (light)
35 to 50	No. 2, No. 4, and No. 5 (light and heavy)
50 to 100	No. 5 (heavy) and No. 6
Over 100	No. 6

In specific applications, manufacturers offer equipment for firing at rates other than those shown above.

Horizontal Rotary-Cup Burner

In this type of burner, oil is delivered into a horizontal cup that is rotated at high speed. As the thin film of oil is spun from the rim of the cup, it enters a cone of high velocity primary air, where atomization occurs. In some applications, secondary air for combustion is supplied by natural draft through checkered openings in the floor of the combustion chamber. In some applications, however, the secondary air is admitted through openings surrounding the burner nozzle, and may be supplied by forced draft.

The rotary-cup burner has been the most popular type in the capacity range from approximately 25 to 500 boiler horsepower. Its principal advantages are that it is a self-contained integral unit; it is adaptable to manual, semi-automatic, or fully-automatic control; and the firing rate may be modulated through a wide range. These burners are frequently used for firing packaged units.

Mechanical Pressure-Atomizing Burner

In this burner, oil is atomized by passing it through a specially designed nozzle, under pressures up to 1000 psig. The air for combustion may be supplied by either natural or forced draft, and is usually admitted through an air register

Automatic Fuel-Burning Equipment

surrounding the burner nozzle. These burners are also adaptable to automatic operation and modulation through a wide range.

Air-and-Steam-Atomizing Burner

This type of burner utilizes air or steam under pressure, to provide the energy necessary for atomizing oil. The oil is delivered to the fuel nozzle at whatever pressure is necessary to provide the discharge rate, but at a pressure which is not high enough to provide atomization. Air or steam is supplied at a pressure determined by the needs of the equipment and the design of the atomizer. This may vary from 1 psi and up, depending upon design.

This type of burner is particularly well suited to the handling of high viscosity fuels. Burners of this type are currently available in manual operation, semi-automatic operation, and completely automatic operation, as well as in combination dual fuel burners.

STORING AND HANDLING HEAVY FUEL OILS

Preheating of Heavy Fuel Oils

Unlike the lighter grades of fuel oils that can be pumped, atomized, and burned efficiently without prior preheating, the heavier grades of residual fuel oils require conditioning by the application of heat before use. Preheating is employed to reduce the viscosity of the oil so that it can be pumped and atomized properly by the burner. The function of the burner is to atomize the oil and mix it thoroughly with the proper amount of air for prompt ignition and efficient combustion. The optimum viscosity will vary from 80 to 450 seconds Saybolt Universal viscosity, depending on the type of burner, and is reached at different temperatures for different grades of oil. The range of recommended atomizing viscosities is roughly as follows for normal grades of oil:

Type of Burner	Range of Atomizing Viscosities
Mechanical-Atomizing	35 to 150 SSU
Steam and High-Pressure Air-Atomizing	150 to 250 SSU
Rotary-Cup-Atomizing	150 to 300 SSU
Low-Pressure Air-Atomizing	80 to 90 SSU

From Fig. 8 it is possible to determine temperatures needed to bring various oil viscosities to the proper atomizing levels. These can be varied for individual operations.

The correct degree of preheat must be used for each grade of oil. Underheating provides high terminal viscosity and interferes with the atomizing process.

No. 4 fuels oils, with a maximum viscosity of 125 seconds Saybolt Universal at 100 F, as a rule do not require any preheating before atomization. They are sufficiently fluid at normal ambient temperatures for good burner operation in typical commercial and industrial installations.

No. 5 fuel oils are of two types: a light grade, having a viscosity ranging between 150 and 300 seconds Saybolt Universal, that normally does not require preheating; and a heavier grade, having a viscosity ranging between 350 and 750 seconds Saybolt Universal, that requires preheating. Where the lighter No. 5 grade is burned in smaller size mechanical or low-pressure air-atomizing burners, some preheat may be necessary to obtain satisfactory operation.

No. 6 fuel oils (also known as Bunker C) always require preheating, as their viscosities range from 900 to 10,000

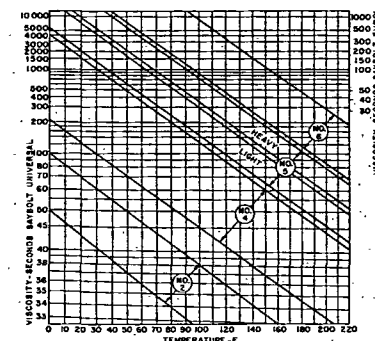


Fig. 8 Approximate Viscosity of Fuel Oil

seconds Saybolt Universal at 100 F (50 seconds to 300 seconds Saybolt Furol at 122 F).

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. 4, No. 5, No. 6).

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, and condensate is drained from the outer tube. A bell-shaped heater 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 are 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