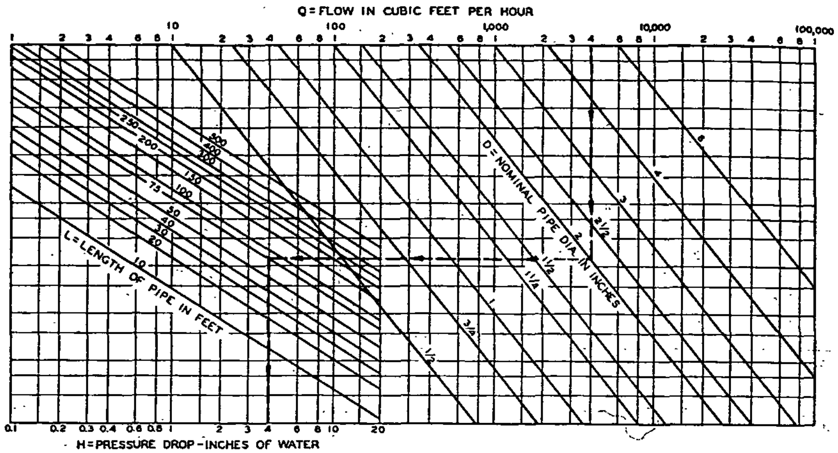

*Based on Spitzglass Friction Factor and 0.60 Specific Gravity. To convert for other specific gravity see Table 3

Fig. 11 .... Flow vs Pressure Drop for Low-Pressure Natural Gas

different specific gravity may be obtained by multiplying Fig. 11 capacities by a multiplier obtained from Table 3.

Example 1: A 2-in. pipe must carry 3640 cfh of a certain gas with a specific gravity of 0.50. Find the pressure drop if the pipe length is 75 ft.

Solution: From Table 3 multiply the flow by 1.10 to correct for the variation in specific gravity from a value of 0.60. Enter Fig. 11 at 4000 cfh and move vertically down this line until it intersects the 2-in. diameter line. From this intersection move horizontally across until it intersects the 75-ft line. From this second intersection move vertically down and read the pressure drop as 4 in. of water per 75 ft of pipe length for the particular gas.

Combustion Process and Adjustments

Most domestic gas burners are of the atmospheric injection (Bunsen) type in which primary air is introduced and mixed with the gas in the throat of the mixing tube. For normal operation of most atmospheric type burners, 40 to 60 percent of the theoretical air as primary air will give best operation. Slotted-port and ribbon burners may require from 50 to 80 percent primary air for proper operation. The amount of excess air required in practice depends upon several factors, notably: uniformity of air distribution and mixing, direction of gas travel from burner, and the height and temperature of combustion chamber. With power type burners utilizing motor driven blowers to provide both primary and secondary air, the excess air can be closely controlled while proper combustion is secured.

Secondary air is drawn into gas appliances by natural draft. As with other fuels, excess secondary air constitutes a loss, and should be reduced to a proper minimum, which usually cannot be less than 25 to 35 percent, if the appliance is to meet ASA approval requirements. Yellow flame burners depend only upon secondary air for combustion.

The flame produced by atmospheric injection burners is non-luminous. Air shutter adjustments for manufactured gas should be made by first closing the air shutter until yellow flame tips appear, and then opening the air shutter to a final position at which the yellow tips just disappear. This type of flame obtains ready ignition from port to port, and also favors quiet flame extinction. For natural gas, the air adjustment is generally made to secure as blue a flame as is obtainable without lifting of flames from burner ports. Manufacturers' instructions for burner adjustment should be followed.

Gas-designed equipment does not usually incorporate any means for varying the secondary air supply (and hence the CO_2). The amount of effective opening and baffling is determined by A.G.A. tests and cannot be varied. Gas conversion burners, however, do incorporate means for controlling

Table 3 .... Multipliers for Various Specific Gravities

(For Use With Table 2 and Fig. 11)

Specific Gravity	Multiplier	Specific Gravity	Multiplier
0.35	1.31	1.00	0.775
0.40	1.23	1.10	0.740
0.45	1.16	1.20	0.707
0.50	1.10	1.30	0.680
0.55	1.04	1.40	0.655
0.60	1.00	1.50	0.633
0.65	0.962	1.60	0.612
0.70	0.926	1.70	0.594
0.75	0.895	1.80	0.577
0.80	0.867	1.90	0.565
0.85	0.841	2.00	0.547
0.90	0.817	2.10	0.535

CHAPTER 52

HEATING BOILERS, FURNACES, SPACE HEATERS

BOILERS: Construction, Types, Design Considerations, Rating and Testing Standards, Efficiency, Rating, Selection, Space Limitations, Connections and Fittings, Erection, Operation and Maintenance. FURNACES: Types, Components, Ratings, Testing and Rating Standards. SPACE HEATERS: Types Solid Fuel, Oil, Gas; Materials and Construction; Testing and Rating; Design Considerations; Installation

IN presenting the subject of Boilers, Furnaces, and Space Heaters this chapter is divided into three parts; the first deals with boilers, the second with warm air furnaces, and the third with space heaters.

PART I: HEATING BOILERS

Steam and hot water boilers for low-pressure heating are built of steel or cast iron in a wide variety of types and sizes, many of which are illustrated in the Catalog Data Section.

The nationally recognized code governing the construction of low-pressure steel and cast-iron heating boilers is the *ASME Boiler Construction Code for Low Pressure Heating Boilers*. Some states and municipalities have their own codes which apply locally, but these are usually patterned after the ASME Code.

The maximum allowable working pressures are limited by the *ASME Code for Low Pressure Heating Boilers* to 15 psi for steam and 160 psi for hot water heating boilers, with a maximum temperature limitation of 250 F. Hot water boilers are generally designed for a working pressure of 30 psi, and may be equipped for higher working pressures for either heating purposes or for hot water supply only when designed, tested, and stamped for the higher pressure.

TYPES OF HEATING BOILERS

Heating boilers are classified in a number of different ways, such as:

1. According to materials of construction. Most heating boilers are constructed of cast iron or steel, but nonferrous metals are used for some.
2. According to the fuels for which the boilers are designed. These are coal, hand-fired or stoker-fired; oil, or gas. Some boilers are designed specifically for one fuel, but many boilers are designed for more than one fuel.
3. According to the specific purpose or application for which the boiler is used, such as space heating or domestic hot water supply.
4. According to the design or construction of the boiler, such as sectional, round, fire-tube, water-tube, magazine-feed, Scotch.
5. According to combustion air handling system, such as natural draft, induced draft, or forced draft.

The general responsibility for this chapter is assigned to TC 3.1, Hot Water and Steam Heating; and TC 3.2, Warm Air Heating-Fuel Burning.

Cast-Iron Boilers

Cast-iron boilers are generally classified as:

1. Square or rectangular boilers with vertical sections.
2. Round, square, or rectangular boilers with horizontal pancake sections.

Cast iron boilers are usually shipped in sections, and assembled at the place of installation. However, some boilers are shipped factory assembled and as boiler-burner units or packaged boilers having all components in an assembled unit. In the majority of boilers the sections are assembled with push nipples and tie rods, but external headers and screw nipples are also used satisfactorily. Many sectional boilers are provided with large push nipples at top to permit the circulation of water between adjacent sections at both the water line and bottom of the boiler. This is necessary to permit the use of an indirect water heater with the boiler for summer-winter hot water supply. Round and sectional boilers may be enlarged by the addition of sections and corresponding plate work.

Sectional type boilers are available with *wet-base* or water backed construction, wherein the ashpit or firebox is completely surrounded by water-carrying channels, and thus no separate base is required. This type of construction permits the boiler to be set directly on a wood or composition floor without danger of fire. It also allows the incorporation of a permanent gas-tight seal, permitting forced-draft firing of the sectional type cast iron boiler.

Capacities of cast iron boilers generally range from capacities required for the small residences up to about 15,000 sq ft of steam radiation, but boilers are made with capacities up to approximately 32,000 sq ft of steam radiation.

Steel Boilers

Steel boilers may be of the fire-tube type, in which the gases of combustion pass through the tubes and the boiler water circulates around them, or of the water-tube type, in which the gases circulate around the tubes and the water passes through them. Either the fire-tube or water-tube type may be designed with integral water-jacketed furnaces, or arranged for refractory lined brick or refractory lined jacketed furnaces. Those with integral water-jacketed furnaces are