

heat exchangers of the coil or tube types which transmit the heat from the steam to the water. This type of installation has the following advantages:

1. The boiler operates at low pressure.
2. The boiler is protected from scale and corrosion.
3. The scale is formed in the heat exchanger in which the parts to which the scale is attached can be cleaned or replaced. The accumulation of scale does not affect efficiency although it will affect the capacity of the heat exchanger.
4. Discoloration of water may be prevented if the water supply comes in contact with only non-ferrous metal.

Where a steam or a forced circulation hot water heating system is installed, the domestic hot water may be heated by an indirect heater attached to the boiler. For most satisfactory performance in the steam system, this heater is placed just below the water line of the boiler. In a forced circulation hot water system, it should be located as high as possible with respect to the boiler.

BOILER DESIGN CONSIDERATIONS

Furnace Design

Good efficiency and proper boiler performance are dependent on correct furnace design. There must be sufficient volume for burning the particular fuel which is used, and means to obtain a thorough mixing of air and gases at a high temperature and at a velocity low enough to permit complete combustion of all the volatiles. For hand fired boilers, the furnace volume should be large enough to hold sufficient fuel for reasonably long firing periods. (See Chapters 8 and 10.)

Heating Surface

Boiler heating surface is that portion of the surface of the heat transfer apparatus in contact with the fluid being heated on one side and the gas or refractory being cooled on the other side. Heating surface on which the fire shines is known as *direct* or radiant surface and that in contact with hot gases only, as *indirect* or convection surface. The amount of heating surface, its distribution and the temperatures on either side thereof influence the capacity of any boiler.

Direct heating surface is more valuable than indirect per square foot because it is subjected to a higher temperature and also, in the case of solid fuel, because it is in position to receive the full radiant energy of the fuel bed.

The effectiveness of the heating surface depends on its cleanliness, its location in the boiler, and the shape of the gas passages. The area of the gas passages must not be so small as to cause excessive resistance to the flow of gases where natural draft is employed. Inserting baffles so that the heating surface is arranged in series with respect to the gas flow increases boiler efficiency and reduces stack temperature, but increases the draft loss through the boiler.

Heat Transfer Rate

Practical heat transfer rates in heating boilers expressed in Btu absorbed per square foot of surface per hour will average about 3300 for hand fired boilers and 4000 for mechanically fired boilers when operating at *design load*. When mechanically fired boilers are operating at *maximum load* as defined in this chapter under heading *Selection of Boilers*, these values will run between 5000 and 6000. Boilers operating under favorable

conditions at these heat transfer rates will give exit gas temperatures that are considered consistent with good practice, although there are boilers which have high efficiencies and also operate at higher transmission rates.

TESTING AND RATING CODES

The Society has adopted four solid fuel testing codes, a solid fuel rating code and an oil fuel testing code.

A.S.H.V.E. Standard and Short Form Heat Balance Codes for Testing Low-Pressure Steam Heating Solid Fuel Boilers—Codes 1 and 2—(Revision of June, 1929)¹, are intended to provide a method for conducting and reporting tests to determine heat efficiency and performance characteristics.

A.S.H.V.E. Performance Test Code for Steam Heating Solid Fuel Boilers—Code No. 3—(Edition of 1929)¹ is intended for use with A.S.H.V.E. Code for Rating Steam Heating Solid Fuel Hand-Fired Boilers². The object of this test code is to specify the tests to be conducted and to provide a method for conducting and reporting tests to determine the efficiencies and performance of the boiler.

The A.S.H.V.E. Standard Code for Testing Steam Heating Boilers Burning Oil Fuel³, (Adopted June, 1932), is intended to provide a standard method for conducting and reporting tests to determine the heating efficiency and performance characteristics when oil fuel is used with steam heating boilers.

In 1938 the Society adopted a Standard Code for Testing Stoker-Fired Steam Heating Boilers⁴, (Adopted June, 1938), which is intended to provide a test method for determining the efficiency and performance characteristics of any stoker and boiler combination burning any type of solid fuel such as anthracite or bituminous coal.

The *Steel Heating Boiler Institute* has adopted a method for the rating of low pressure boilers based on their physical characteristics and expressed in square feet of steam or water radiation or in Btu per hour as given in Table 1. The detailed requirements of this code were outlined in Chapter 13 of THE GUIDE 1939.

The *Institute of Boiler and Radiator Manufacturers* has adopted a method of rating cast-iron heating boilers based upon performance obtained under tests. This code⁵ now applies to sectional boilers having a grate width of 41 in. or less. Eventually the Institute intends to include all sizes of cast-iron boilers in this program of testing and rating.

The *American Gas Association* has adopted a method of rating gas designed boilers based upon performance under tests. This is described in Approval Requirements for Central Heating Gas Appliances.

The *Heating, Piping and Air Conditioning Contractors National Association* has adopted a method of rating boilers based on their physical characteristics for those boilers that are not rated in accordance with the S.H.B.I. or I=B=R Codes. Ratings are expressed on a Net Load basis in square feet of steam radiation.

¹See A.S.H.V.E. TRANSACTIONS, Vol. 35, 1929, pp. 322 and 332.

²See A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 42.

³See A.S.H.V.E. TRANSACTIONS, Vol. 37, 1931, p. 23.

⁴See A.S.H.V.E. TRANSACTIONS, Vol. 44, 1938, p. 366.

⁵I=B=R Testing and Rating Code for Low Pressure Heating Boilers (*Institute of Boiler and Radiator Manufacturers*.)