

Fire tube boilers may be of the direct tube, return tube or a combination of direct and return tube type and have any desired ratio between grate and heating surface. Generally this type of boiler is very efficient in operation, moderate in first cost and may be operated to at least 150 per cent of normal rating without difficulty or decreased efficiency.

The Water Tube Boiler, which may be of the horizontal brick set pattern with either horizontal or cross drums, the vertical brick set pattern, the bent or inclined tube brick set pattern, or the self contained fire box pattern with any one of the above arrangements of tubes.

Water tube boilers are usually constructed with steel or iron tubes, steel drums and either steel, cast steel or cast iron headers. On account of the smaller diameter of drums and the fact that the tubes are the only parts to come into direct contact with the hot furnace gases it is generally felt that this type of boiler is safer to operate, especially on high pressure. They heat up and steam rapidly but also lose their heat and steam pressure quickly. The water and steam spaces are moderate and their performance on rapid and wide variations of load is accordingly fair.

The principal heating surface consisting of tubes with the water inside and the heated gases outside, is easy to clean from the inside with hydraulic or pneumatic tube cleaners and from the outside with steam or air jet soot blowers although with highly scaling waters the scale formation on the inside of a small tube may be comparatively rapid.

The water line is generally high and considerable space and head room is required. On account of being constructed with drums and banks of tubes they may be shipped knocked down and be assembled on the job, thus passing through small openings at any stage of the construction. The sectional construction facilitates repairs or increase and decrease in capacity. This type of boiler is efficient in operation, comparatively high in first cost, but may be operated to 200 per cent of the usual normal rating without undue loss in efficiency. It is especially adapted to the larger plants where higher pressures are required.

SIZE, RATING AND CAPACITY OF BOILER

These three words are sometimes used indiscriminately to designate any one of the three things for which they should be used. The size of a boiler should indicate its physical dimensions, *i.e.* the size of a sectional boiler may be the inches in width or a rectangular fire box or the inches in the diameter of a round fire pot, combined with the number of sections; the size of a return tubular boiler is usually the inches in the diameter by the feet in the length of it shell combined with the number and size of tubes. The sizes of fire box boilers are usually arbitrary figures based on heating surface and grate surface. The size of a water tube boiler is generally stated in horse power, or the number of tubes wide by the number of tubes high with the size and length of tubes.

All of these are intended to designate the physical size and dimensions of the particular boiler and not its rating or capacity as it will be seen that these are quite different things. While the size or number of a boiler may give only one or more of its physical dimensions it must be the key from which all of the necessary physical dimensions may be obtained by corresponding references in tables or drawings.

The rating of a boiler is the measure of what it will do under certain conditions. The manufacturers rating is the measure which the manufacturers place upon the performance of their own boilers; this may be given for one or more well defined sorts of conditions or for what the manufacturers may choose to consider average working conditions without definition.

The ratings of low pressure boilers are usually stated in terms of the number of square feet of standard cast iron direct radiation the boiler will supply with steam or hot water, referred to conditions when the plant is heated up and operated under stable conditions with the radiation in still air at 70 deg. fahr and all proper allowances made for the added load of piping and connections. These ratings are usually for an 8 hour or other stated firing period and for hard coal or other stated fuel with allowance factors for other lengths of firing periods and for other kinds of fuel. In connections with most rating the chimney or draft requirements corresponding to the ratings are given. Most manufacturers rating tables give the square feet of grate surface and some give the square feet of heating surface in the boilers.

Unfortunately there are wide differences in the ratings of boilers by the various manufacturers due largely to the fact that there has never been a full and complete cooperation in the establishment of a standard code on which to rate. It is hoped that the proposed code which is being developed jointly by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, the *Boiler and Radiator Manufacturers Association*, the *Heating and Piping Contractors National Association*, and others interested will supply this long felt want. In the meantime there are certain physical data about the rating of boilers which may be used to assist in the selection of proper ratings for various services.

The most important factors involved are:

1. Square feet of grate surface which determines the pounds of coal that can be burned per hour under any set of draft and firing conditions. On the basis of from 6 to 8-hour firing periods for low-pressure heating boilers using nut, egg or stove sizes of anthracite coal and with the usual draft of from $\frac{1}{8}$ to $\frac{3}{8}$ in. water (depending on the size of boiler and coal used) the usual rate of combustion is from 5 to 20 lb. of coal per square foot of grate per hour, depending upon the size and type of boiler and ranging from the lower rate for small boilers to the higher rate for large boilers. From 25 per cent to 35 per cent more soft coal may be burned under similar conditions.

Under average working conditions from 7500 for small boilers to 8500 B.t.u. for large boilers, per pound of coal burned will be transferred to the heating medium so that the square feet of grate by the rate of combustion by the B.t.u. transferred per pound of fuel will give the normal rated output of the boiler in B.t.u. per hour. This output divided by 240 for steam and 180 for water (which corresponds to the B.t.u. transmitted per hour per square foot of steam and hot water radiation respectively under standard conditions) will give the normal rating of the boilers in terms of the radiation which it will carry as based upon the grate surface only. For other conditions as to firing periods, fuels and draft the following may be used.

Where fires are constantly attended the maximum practical rates of combustion corresponding to a draft of 1 in. of water through the fuel bed may be taken as follows and the rates of combustion for other intensities of draft to vary as the square root of the draft.

Small anthracite coal.....	20 lb. per sq. ft. of grate
Large sizes anthracite coal.....	25 " " " " "
Run of mine soft coal.....	25 " " " " "
Large sizes of soft coal.....	30 " " " " "