CEA
Combustion Engineering Association

Boiler calculations for MCPD
Determination of the thermal input rating of a steam or hot water boiler

As a rule of thumb, the chart below may be used to check the rated thermal input of a boiler - the default position where very accurate calculations are needed will be to ask the boiler manufacturer:

This table will be sufficient for almost all boiler plant in the range 1 – 50MW as most boiler ratings will fall between the MCPD 'break points' of 1, 5, 20 and 50MW.

Approximate **steam boiler output** for the nett heat input based on kg/h F&A 100ºC @ 85% efficiency		
Nett boiler output	kg/h steam	lb/h steam
1MW	1,350	3,000
5MW	6,780	15,000
20MW	27,125	60,000
50MW	67,800	150,000

Approximate **hot water boiler output** for the nett heat input based on 85% nett efficiency	
Nett boiler output	MW hot water
1MW	0.85 (850kW)
5MW	4.25 (4,250kW)
20MW	17 (17,000kW)
kW50MW	42.5 (42,500kW)

Where it becomes necessary to calculate boiler thermal input ratings more accurately, the following notes may be helpful.

Steam Boilers are rated "from and at 100 ºC" (abbreviated to F&A100 ºC). This is a measure of energy, not steam output. For example, a boiler rated at 5000kg/hr F&A100 ºC can produce enough energy to change the state of 5000kg of water already at 100ºC to 5000kg of steam in one hour. However, boilers usually take water at a lower temperature, typically 85 ºC, therefore requiring more energy input to reach the rated output. The rating method describes the capability of the boiler assuming the water in it was already boiling.

Consequently the boiler rated at 5000kg/hr F&A 100 ºC in operation at 10 barg will actually produce around 4600 kg/hr. This is important when calculating the size of boiler required to supply the demand of any process plant. Some manufacturers will give a boiler rating in kW. This is not an evaporation rate, and is subject to the same 'from and at' factor.

Boilers originally supplied with economisers that have now been removed, thereby slightly increasing the fuel input to replace the heat that was recovered from the economiser, will need special consideration.

The efficiency part of the calculation is reasonably consistent since most plant will operate around 85% efficiency, although the final figure may depend on a number of details such as inherent losses and different construction types. If in doubt, consult the boiler manufacturer for more details.

Nett v Gross

Calorific Value (CV) is the amount of heat energy produced (gross or nett) per volume of fuel and is measured in MJ/m^3. The Imperial equivalent is British Thermal Units per cubic foot (Btu/ft^3).

The energy content can be expressed as an upper (or gross) value and a lower (or nett) value. The difference between the two values is due to the release of energy from the condensation of water in the products of combustion.

Gross CV is the theoretical total available amount of heat energy in the fuel.
Nett CV is the practical amount of heat energy available from the fuel.

When gases burn, the exothermic reaction gives off heat. Fuels with a high CV (such as LPG) give off much more heat per unit than those with a lower CV (Natural gas, less than half the CV of LPG).

As an example, the approximate difference between Gross CV and Nett CV for Natural Gas, which is predominantly (90%) methane, is 10%. The nett calorific value of natural gas is the gross calorific value x 0.9.

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