Sample Boiler Calculations:

1.**Convert actual steam rating into From and At 100 C**

Steam capacity from and at 100 C (212 F) is equivalent steam capacity if operating conditions are reduced to atmospheric pressure.

Steam capacity = 8000 kg/hr at 10.5 kg/cm2 saturated
Feed water inlet = 30 C
Heat load = 8000 (664-30) Kcal/hr
= 5.072e06 Kcal/hr = 20.127e06 btu/hr = 5.8976 MW

where Sat steam enthalpy = 664 Kcal/kg
Inlet water enthalpy = 30 Kcal/kg
Steam enthalpy at 100C and 1 atm pressure = 540 Kcal/kg

Therefore, steam capacity F&A 100 C = 5.072e06/540
= 9392 Kg/hr

2**. Heat Duty Calculations** :

Let us calculate heat duty of a boiler generating 50,000 kg/hr at 65 bar and 485 C
Water inlet temperature = 105 C

Steam & water properties:

Superheated steam enthalpy at 65 bar & 485 C = 808 Kcal/kg
Saturated water enthalpy = 295 Kcal/kg

Heat Duty = 50000 x (808 - 105)
= 35.15e06 Kcal/hr (139.48e06 Btu/hr or 40.87 MW)

Usually 1 – 3% of the water flow is used for blowdown.

Considering 2% blow down , heat in blowdown water = 50000 x 0.02 x (295 – 105)
= 0.19e06 kcal/hr

Total heat duty = (35.15 + 0.19) e06 = 35.34e06 kcal/hr
= 140.24e06 Btu/hr = 41.09 MW

In case of Hot water generator or hot water boiler,

Heat duty = Water flow x Cp of water x Temp gain

For example, 200,000 kg/hr of water is heated from 70 to 90 degC,

Heat Load = 200,000 x 1 x (90-70)
= 4.0e06 Kcal/hr
= 15.873e06 Btu/hr or 4.651 MW

3. **Heat Transfer calculations:**

Over all heat transfer coefficient,

Uo = 1/(1/Ho+Rm+1/Hi*(TubeOD/TubeID)
+Ro+Ri*(TubeOD/TubeID))

Where Ho = Outside heat transfer coefficient
Hi = Inside heat transfer coefficient
Rm = tube metal resistance
Ro = Fouling resistance on outside tubes
Ri = Fouling resistance on inside tubes

Inside Heat Transfer coefficient can be calculated using the following correlation :

NuInside=0.023* (ReInside^0.8)*(PrInside^0.4)

Where NuInside = Hi x TubeID / Gas Cond

Outside heat transfer coefficient during boiling is very high and so resistance offered is negligibly small. There are many correlations available to predict Ho, but Ho can be safely assumed to be about 10000 Kcal/hr/m2/C.