# BOILER ENGINEERING "CHEAT SHEET"

**VOLUME**
1 ltr = 0.2642 gal  $m^3$ x 35.31 = $ft^3$

**TEMPERATURE**
F° x 1.8 + 32 = C°  C° = (32 + (9/5)°F)

**PRESSURE**
PSI = 14.5 x bars  PSI = 0.001422 x $kg/m^2$  PSI = 14.22 x $kg/cm^2$  PSI = 14.7 x atm

**HEAT**
BTU x 0.252 = Kcal  Kcal x 3.968 = BTU  1 therm = 100,000 BTU  1 gigajoule = 948mBTU

**BOILER ROOM**
1BHP (steam from and @ 212°F) = 34.5 lb/hr = 15.65 kg/hr = 33,475 btu/hr = 8435.7 Kcal/hr = 9.803 kw = 0.335 therm = 35.3 GJ
BTU input required (Biomass) @: ~79% efficiency (8% Moisture Content Fuel) = 41,844 BTU or 10,545 Kcal x BHP
~69% efficiency (50% Moisture Content Fuel) = 47,821 BTU or 12,051 Kcal x BHP

| **FUEL** | **QUANTITY INPUT / 1 BHP** |
|---|---|
| natural gas @ 1000 btu/ft3 | 42 ft3 / 1.18 m3 |
| #1 & #2 oil @ 140,000 BTU/gal | 0.29 gal / 1.09 ltr |
| #6 oil @ 150,000 BTU/gal | 0.27 gal / 1.02 ltr |
| butane @ 102,600 BTU/gal | 0.40 gal / 1.51 ltr |
| propane @ 91,500 BTU/gal | 0.45 gal / 1.70 ltr |
| coal @ 12,500 BTU/lb | 3.5 lbs / 1.58 kg |
| 10% MC Pine @ 7,650 BTU/lb | 6 lbs / 2.72 kg |
| 35% MC Pine @ 5,525 BTU/lb | 9 lbs / 4.08 kg |
| 50% MC Pine @ 4,250 BTU/lb | 12 lbs / 5.44 kg |

Estimates @ industrial average efficiencies

burner(60 Hz) BTU output/0.833=BTU output @ 50 Hz
4% output reduction for each 1,000 FT over 2,000 FT altitude
120 $mg/nM^3$ @ 8% $O^2$ = 0.052 gr/dscf @ 12% $O^2$

**HEAT EXCHANGERS & HOT WATER BOILERS**
1 BTU to raise 1 lb of $H_2O$ 1° F  example: 78° F $H_2O$ (in) - 194° F $H_2O$ (out) = 116° F $\Delta$T, 1 gal of water weighs 8.337 lbs 116° F $\Delta$T x 8.337 = 967.1 BTU input required /gal of water

**HEAT RECOVERY BOILER**
$Q = Mcp\Delta T$  where Q = quantity of BTU's available, M = mass flow gases (lbs), cp = constant specific heat, assume (0.3 BTU/#) /$F^o$, $\Delta$T = temperature differential

**BUILDING HEATING**
100 bhp/70,000 $FT^2$, Assuming 25' ceilings, 10 F° $\Delta$T outside temperature (50 BTU/$FT^2$)  Glycol = +15% heating surface

**LUMBER / WOOD WASTE / DRYING** (ESTIMATES)
424 bf = 1 $M^3$
**Conventional Kilns** (3 day/72 hour schedule)(3.6 BHP/1000 BF):
1st kiln - 125 BTU/BF, 2nd kiln +50%, >2 kilns - 87.5 BTU/BF per kiln
**Hi Temp Kilns** (1 day / 24 hour schedule): 1st kiln - 225 BTU/BF, 2nd kiln - +50%, >2 kilns - 157 BTU/BF per kiln
**Hardwood/Poplar Kilns** (1 month/30 day schedule)(1 BHP/1,000 BF (hardwood)):
15 PS steam≤2 kilns, 150 PSI steam≥3 or more kilns (expense offset by lower kiln costs)
1st kiln-35 BTU/BF (40 BTU/BF–oak, 50 BTU/BF–poplar, 60 BTU/BF–white maple), 2nd kiln-25 BTU/BF (35 BTU/BF-poplar), ≥ 3 kilns-20 BTU/BF (29 BTU/BF-poplar) per kiln

**BIOMASS FUEL STRORAGE CAPACITY**
BHP x 48,000 BTU/BHP (or required) ÷ BTU of fuel = lbs/hr ÷ $lbs/Ft^3$ x time (hrs) = storage volume req.
2.5 x diameter = total silo height (max. recommended for wood waste)
One (1) HBC reciprocating floor "tree" stores ~1,000 $FT^3$ (truck shipped domestically in 3-tree units, container shipped in 2-tree units)

**ELECTRIC MOTORS**
Motor horsepower x 0.746 = KW power consumption

**COGEN**
From 270 PSI  Turbine Exhaust @ 0 PSI - PPH steam ÷ 36 PPH/kW = kW/hr
Turbine Exhaust @15 PSI - PPH steam ÷ 44.4 PPH/kW = kW/hr

**REFRACTORY**
Typical 600 BHP unit requires 58,000 lbs. of HBC 3,000°F Mud. Ignition arch (for >35% M.C., wet basis fuels) requires 140 bags (50 lbs ea.) of 2,800°F castable.

**DISCLAIMER: These calculations are for estimating only. Always use best engineering practices.**

Provided by Gene Zebley, Energy System Sales
Hurst Boiler and Welding Co., Inc.
100 Boilermaker Lane
Coolidge, GA, 31768
Phone: (229) 346-3972
Fax: (229) 346-3874
Email: boilrmkr@surfsouth.com / gzebley@hurstboiler.com
Web Site: www.hurstboiler.com