GENERAL ENGINEERING INFORMATION

BRITISH THERMAL UNIT B.T.U.

A BTU is the amount of heat required to raise one pound of water one °F.

ENTHALPY

Total heat content expressed in BTU's per Pound above, an arbitrary set of conditions chosen as the base or zero point. In relationship to steam/water it is the expression for the amount of energy contained in the water or vapor per pound and can be readily found from steam tables.

SPECIFIC HEAT (S.H.)

The amount of heat required to raise one pound of any material one °F. Water has a specific heat of 1.00 BTU/Lb - °F.

LATENT HEAT

The amount of heat required to change the state of a material without a change in temperature. Water at 212°F (0 P.S.I. Gage) in changing to steam at the same temperature requires the addition of 970 BTUs per pound (Heat of Vaporization). Ice at 32°F in changing to water at 32°F requires the addition of 143.4 BTUs per pound. (Heat of Fusion)

HEAT

Heat is a form of energy that causes physical changes in the substance heated. The transfer of heat is accomplished by:

- (1) Conduction - Heat flow between two bodies or portions of a body having different temperatures.
- (2) Convection - Transmission of heat conveyed by currents of air, water or other substances passing over a surface having a higher temperature than the currents flowing over it.
- (3) Radiation - Transfer of heat from one body to another *by heat* waves which radiate from the body with the higher temperature to the other.

MEASURING PRESSURES

The value of pressure, irrespective of the device used to measure it, is dependent on the reference point chosen. Two such reference points exist: zero absolute pressure and standard atmospheric pressure.

If standard atmospheric pressure (approximately 14.7 psi) is chosen as the reference, pressure are known as a gage pressure. Positive gage pressures are always pressure above atmospheric pressure. Vacuum (negative gage pressure) is the pressure below at atmospheric. Maximum vacuum, according to this convention, is -14.7 psig. The term 'gage' is somewhat misleading, since a mechanical gage may he used to indicate both gage and absolute pressure.

If zero absolute pressure is chosen as the reference, the pressures are known as absolute pressures.

PRESSURE DROP

Pressure Drop is the difference in pressure between two points, primarily caused by frictional resistance and condensation in the pipeline.

SATURATED STEAM

Saturated steam is steam in contact with the liquid water from which it was generated, at a temperature, which is the boiling point of the water and the condensing point of the steam. "Dry" saturated steam is steam free from mechanically mixed water particles. "Wet" saturated steam contains water particles in suspension. Saturated steam has a definite temperature at any pressure.

SUPERHEATED STEAM

Superheated steam is steam at any given pressure heated to a temperature higher than the temperature of saturated steam at that pressure. Water cannot exist in the presence of superheated steam.

BOILER HORSEPOWER:

Packaged Boiler Manufactures when developing nominal ratings for their units, consider a boiler horsepower as the evaporation of 34.5 pounds of water (4.14 Gallons) at 212°F. (Feedwater Temperature of 212°F into Steam at 212°F.)

A boiler horsepower is the output of 33,500 B.T.U. per hour.

The actual output of a boiler is reduced from the nominal "from and at 212°F" rating as the Feedwater Temperature is reduced from 212°F and as the steam pressure is increased above 0 PSI.

There are two major variable factors, which affect the generating capacity of a boiler. These are the feedwater temperature and the operating steam pressure. Operating conditions differ with various installations.

If the pounds/incur steam load, feedwater temperature and maximum required operating pressure for the installation are known the horsepower rating of the boiler to be specified can be readily determined from formula (a) below.

$$(a) \qquad hp = \frac{w\,(hg - hf)}{34.5\ hfg}$$

Where: hp = Boiler Horsepower
w = Quantity of dry saturated steam at desired pressure (lb/hr)
hf = Enthalpy of saturated water at feedwater temp (Btu/lb)
hg = Enthalpy of dry saturated steam at desired pressure (Btu/lb)
hfg = Enthalpy of evaporation at 212°F = 970.3 Btu/lb

To determine the actual pounds/hr output delivered from a known H.P. Boiler, use the following (a-l) Formula.

$$(a\text{-}1) \qquad w = \frac{34.5\ (hp)\ hfg}{hg - hf}$$

For most applications, 30 lbs of steam per BHP is a reasonable number to use considering lower feedwater temperatures and higher pressures.

Table 4 is a chart designed from the results of successive solutions of formula (a-1) for varying steam pressure and feedwater temperatures. This chart can be used to determine steam quality when operating conditions are known.

Example 1: (Solve on Table 4)
Find size of boiler required to generate 510 pounds of dry saturated steam per hour at 125 psig from feedwater 60°F.

1. Locate on chart the point of intersection of the 125psig line and 60°F curve.
2. From this point extend a horizontal line to intersect the left hand scale.
3. Read 28.8 pounds of steam per hour per BHP.
4. Divide 510 pounds of steam per hour by 28.8 to obtain the solution, 17.7.
5. 17.7 should be rounded up to the next larger standard rating, 20 H.P.

Example 2: (Solved on Table 4)
Find the pounds of dry saturated steam per hour that can be generated by a 20 H.P. boiler operating at 12 psig and supplied with 60° F feedwater.

1. Locate on chart the point of intersection of the 12 psig line and 60°F curve.
2. From this point, extend a horizontal line to intersect the left hand scale.
3. Read 29.6 pounds of steam per hour per BHP.
4. Multiply 29.6 by 20 hp to obtain the solution of 592 pounds of steam per hour.
5. Notice how this is 85% of the standard catalog rating.