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**BOILER HORSE POWER**

What is the boiler horsepower of a boiler generating 21,500 lbs of steam per hour at 155 psi? The factor of evaporation is 1.08.

\[
BHP = \frac{\text{LB/HR*fe}}{34.5}
\]

\[
BHP = \frac{21500 \times 1.08}{34.5}
\]

\[
BHP = 673
\]

Where,

- **BHP** boiler horsepower
- **Lb/Hr** pounds per hour
- **Fe** factor of evaporation (can be assumed to be equal to 1)

**CYCLE OF CONCENTRATION OF BOILER WATER**

What is the cycle of concentration if the chloride content of boiler water is 186 ppm and the feedwater chloride content is 38 ppm?

\[
\text{CYC} = \frac{\text{Bch}}{\text{FCh}}
\]

\[
\text{CYC} = 186 / 38
\]

\[
\text{CYC} = 4.89
\]

Where,

- **CYC** cycles of concentration
- **Bch** boiler water chlorides (ppm)
- **FCh** feedwater chlorides (ppm)
NOTE – If chlorides level are not known the same formula can be applied using the boiler’s and feedwater conductivity levels

**BOILER FUEL CONSUMPTION**
What is the fuel consumption of a 10,000#/hr steam boiler using diesel as fuel (VHI = 130,000 BTU/gal) with a feedwater temperature of 154 °F?

\[
FC = \frac{SP \times (hs - hw)}{BE \times VHI}
\]

FC = [SP * (hs – hw) / (BE * VHI)]

FC = [ 10000 * (1190 – 122) / ( 0.8 * 130000) ]

FC = 102.7 gal

Where,

FC = Fuel consumption
SP = steam produced
hs = enthalpy of steam @ 100 PSIG
hw = enthalpy of feedwater @ saturation temperature
BE = Boiler efficiency
VHI = Fuel heating value

**NOTES** - The following will help in the use of this formula

- hs = 1190 BTU/# constant @ 100 PSIG
- hw = enthalpy of saturated water at saturation temperature (steam tables)
- Boiler efficiency is assumed to be 80%
- Common fuel heating values:

<table>
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<tr>
<th>Fuel</th>
<th>Heating Value in BTU/gal (VHI)</th>
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<tr>
<td>Propane</td>
<td>90,500</td>
</tr>
<tr>
<td>Fuel No. 2 (Diesel)</td>
<td>130,000</td>
</tr>
<tr>
<td>Fuel No. 6 (Bunker)</td>
<td>145,070</td>
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Values are closely estimated
Common Boiler Formulas

DIFFERENTIAL SETTING
What is the differential setting of an automatic pressure control that turns the burner ON at 80 psi and OFF at 105 psi?

\[ \Delta S = P_1 - P_2 \]

\[ S = P_1 - P_2 \]
\[ S = 105 - 80 \]
\[ S = 25 \]

Where,

\( \Delta S \) differential setting delta
\( P_1 \) cut-out pressure delta
\( P_2 \) cut-in pressure delta

FACTOR OF EVAPORATION
Water enters the boiler at 225°F. The boiler pressure is 100 psi and the boiler water temperature is 338°F. The latent heat is 881 Btu. What is the factor of evaporation?

\[ FE = \frac{SH + LH}{970.3} \]

\[ FE = \frac{SH + LH}{970.3} \]
\[ FE = \frac{(338 - 225) + 881}{970.3} \]
\[ FE = 1.02 \]

Where,

\( FE \) factor of evaporation
\( SH \) sensible heat
\( LH \) latent heat

970.3 latent heat of evaporation of water at 212°F. (constant)
FORCE
What is the force of 260 lbs of pressure exerted on 8 sq. in.?

\[ F = \frac{P}{A} \]

\[ F = \frac{260}{8} \]

\[ F = 32.5 \]

Where,

- \( F \): force (psi)
- \( P \): pressure
- \( A \): area

HORSEPOWER (PUMP)
What is the horsepower of a pump that moves 450 lbs of water against a discharge head of 220 ft. in 1 minutes? Disregard friction and other losses.

\[ HP = \frac{d \times F}{t \times 33,000} \]

\[ HP = \frac{220 \times 450}{1 \times 33,000} \]

\[ HP = 3 \]

Where,

- \( HP \): horsepower
- \( d \): distance
- \( F \): force (lb)
- \( t \): time (minutes)
- 33,000: constant
INCHES OF MERCURY
How many inches of mercury are there at an atmospheric pressure of 14.5 psig?

\[
in. HG = \frac{P}{0.491} \]

\[
in. Hg = \frac{14.5}{0.491} \]

\[
in. Hg = 29.53 \]

Where,

- \( Hg \): inches in mercury
- \( P \): pressure (psi)
- 0.491: constant (psi @ 1 in. of Hg)

PERCENT OF BLOWDOWN (BOILER BLOWDOWN)
What is the percent of blowdown for a 10,000#/hr boiler working at 8.6 cycles of boiler water concentration?

\[
%BD = \left(\frac{1}{CC}\right) \times 100 \]

\[
%BD = \left(\frac{1}{8.6}\right) \times 100 \]

\[
%BD = 11.6\% \]

Where,

- \( %BD \): percent of blowdown
- \( CC \): Concentration cycles

BOILER BLOWDOWN RATE
What is the boiler blowdown rate for a 10,000#/hr boiler working at 8.6 cycles of boiler water concentration?

\[
BR = \left(\frac{1}{CC}\right) \times BC \]
\[ BR = \frac{1}{CC} \times BC \]

\[ BR = \frac{1}{8.6} \times 10,000 \]

\[ BR = 1,163\#/hr \]

Where,

- \( BR \) Blowdown rate
- \( BC \) Boiler capacity in \#/hr

**NOTE –** To convert the previous example from \#/lb to GPM’s follow the following conversion:

\[ \text{GPM’s} = \left[ \frac{\text{#/hr}}{8.33} \right] / 60 \]

**PERCENT OF BLOWDOWN (SAFETY VALVE)**

What is the percent of blowdown for a safety valve set to pop at 300psi and reseat at 275 psi?

\[ \%BD = \frac{\text{PP} - \text{RP}}{\text{PP}} \]

\[ \%BD = \frac{300 - 275}{300} \]

\[ \%BD = 8.33\% \]

Where,

- \( \%BD \) percent of blowdown
- \( \text{PP} \) popping pressure
- \( \text{RP} \) reseat pressure

**RATE OF COMBUSTION FOR GASEOUS OR LIQUID FUELS**

A scotch marine boiler has a furnace volume of 45.5 cu. ft. if 3825.2 cu. ft. of natural gas is burned per hour and each contains 1100 Btu, what is the rate of combustion?
Common Boiler Formulas

$$RC = H / (Vf \times t)$$

$$RC = H / (Vf \times t)$$

$$RC = (3825.2 \times 1100) / (45.5 \times 1)$$

$$(cu. \text{ ft.}) \, RC = 92477.36$$

Where,

- $RC$ rate of combustion (Btu/hr)
- $H$ heat released (Btu)
- $Vf$ volume of furnace (cu. ft.)
- $t$ time (hr)

**RETURN CONDENSATE PERCENTAGE IN FEEDWATER**

What is the return condensate percentage in feedwater if the makeup conductivity is 834 µ ohms, the feedwater conductivity is 185 µ ohms, and the condensate conductivity is 65 µ ohms?

$$RC\% = (MC-FC) / (MC-CC)$$

$$RC\% = (834 - 185) / (834 - 65)$$

$$RC\% = 84.40\%$$

0.84

Where,

- $RC\%$ return condensate %
- $MC$ makeup conductivity (µ ohms)
- $FC$ feedwater conductivity (µ ohms)
- $CC$ condensate conductivity (µ ohms)
**STATIC HEAD PRESSURE**

What is the static head pressure of a boiler operating at 275 psi?

\[ \text{SHP} = \text{Bpr} \times 2.31 \]

\[ \text{SHP} = 275 \times 2.31 \]

\[ \text{SHP} = 635.25 \]

Where,

- **SHP** static head pressure
- **Bpr** boiler pressure (psi)
- **2.31** multiplier

**STEAM PRODUCED**

How much steam will a 150HP boiler make in 2.5 hours?

\[ S = \text{HP} \times 34.5 \times T \]

\[ S = 150 \times 34.5 \times 2.5 \]

\[ S = 12937.50 \]

Where,

- **S** steam
- **HP** horsepower
- **34.5** constant (lb/hr)
- **t** Time (hr)
Common Boiler Formulas

TEMPERATURE CONVERSIONS

°F to °C  
°F = (°F - 32) / 1.8  
Convert 92° to °C  
°C = (92 - 32) / 1.8  
°C = 33.33

°C to °F  
°F = (1.8 * °C) + 32  
Convert 30°C to °F  
°F = (1.8 * 30) + 32  
°F = 86

TOTAL FORCE
What is the total force of 120 psi acting on 4 sq. in?

TF = P*A

TF = 120 * 4

TF = 480

Where,

TF  total force (lb)
P  pressure (psi)
A  area of valve disc exposed
to steam (sq. in.)

WATER COLUMN
How high is a column of water that exerts 42.43 psi at the bottom of the column?

WC = P / 0.433

WC = P / 0.433
Common Boiler Formulas

\[ WC = \frac{42.43}{0.433} \]
\[ WC = 97.99 \]
\[ WC = 97.99 \]

Where,

- WC: water column
- P: pressure
- 0.433: constant (force per 1 ft of water depth)

For more information contact us:

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