2006

Common Boiler Formulas

Steam & Combustion

11/3/2006

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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 = (LB/HR*fe)/34.5

BHP = (LB/HR*fe)/34.5

BHP = 21500 * 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?

CYC = Bch/FCh

CYC = Bch/FCh

CYC = 186 / 38

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 = [SP * (hs – hw) / (BE * 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:

Fuel	**Heating Value in BTU/gal (VHI)**
Propane	90,500
Fuel No. 2 (Diesel)	130,000
Fuel No. 6 (Bunker)	145,070
Values are closely estimated	

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?

$\Delta S = P1 - P2$

$S = P1-P2$

$S = 105 - 80$

$S = 25$

Where,

ΔS differential setting delta

P1 cut-out pressure delta

P2 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?

$FE = SH + LH / 970.3$

$FE = SH + LH / 970.3$

$FE = ((338 - 225) + 881) / 970.3$

$FE = 1.02$

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 = P/A

F=PA

F=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 = (d * F) / (t * 33,000)

HP = (d * F) / (t * 33,000)

HP = (220 * 450) / (1 * 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 = P / 0.491

in. Hg = P / 0.491

in. Hg = 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 = (1 / CC) * 100

%BD = (1 / CC) * 100

%BD = (1 / 8.6) * 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 = (1 / CC) * BC

BR = (1 / CC) * BC

BR = (1 / 8.6) * 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:

GPM's = [(#/hr)/ 8.33] / 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 = (PP - RP) / PP

%BD = (PP - RP) / PP

%BD = (300 - 275) / 300

%BD = 8.33%

Where,

%BD percent of blowdown

PP popping pressure

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?

RC = H / (Vf * t)

RC = H / (Vf * t)

RC = (3825.2 * 1100) / (45.5 * 1)

(cu. 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% = (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?

SHP = Bpr * 2.31

SHP = Bpr * 2.31

SHP = 275 * 2.31

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 = HP * 34.5 * T

S = HP * 34.5 * t

S = 150 * 34.5 * 2.5

S = 12937.50

Where,

S	steam
HP	horsepower
34.5	constant (lb/hr)
t	Time (hr)

TEMPERATURE CONVERSIONS

°F to °C		Convert 92° to °C
°C =	(°F - 32) / 1.8	°C = (°F - 32) / 1.8 °C = (92-32) / 1.8 °C = 33.33
°C to °F		Convert 30°C to °F
°F =	(1.8 * °C) + 32	°F = (1.8 * °C) + 32 °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 = 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

WC = 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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