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Republic Steel Corp.

MINING

MANUAL

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VENTILATION

Fundamental Formulae.

$s = lo$ $\quad p = \frac{Klov^2}{a} = 5.2i$

$q = av$ $\quad K = \frac{pa}{lov^2}$

$P = pa = R$ $\quad l = \frac{pa}{Kov^2}$

$u = pq$ $\quad o = \frac{pa}{Klv^2}$

$H.P. = \frac{u}{33,000}$ $\quad v^2 = \frac{pa}{Klo}$

q = quantity
a = area
v = velocity
i = water guage
p = unit press. (lbs per sq ft)
P = total press. in lbs. = R
R = total resistance lbs. = P
K = coefficient of friction
l = length of air travel in ft.
o = perimeter in ft.
s = rubbing surface
H.P. = Horse Power
u = units of work per minute.

Application

Total Ventilating press.

Airway 12' wide 4' high water guage 1.5 inches

Find Total ventilating pressure

$a = 12 \times 4 = 48$
$p = 5.2 \times 1.5 = 7.8$

$P = pa = 7.8 \times 48 = 374.4$ lbs.

Mine resistance

$i : i_2 :: \frac{o_1}{a_1^3} : \frac{o_2}{a_2^3} = \frac{i_1\left(\frac{o_2}{a_2^3}\right)}{\left(\frac{o_1}{a_1^3}\right)}$

Mine resistance varies as the perimeter divided by the cube of the area.

Unit ventilating press.

Airway 10' wide 4' high 6,000' long with a velocity of 500' per min.

Find Unit ventilating pressure.

$p = \frac{Klov^2}{a} =$

$\frac{.00000001 \times 6,000 \times 28 \times 500^2}{40} =$

$\frac{420}{40} = 10.5$ lbs. per sq ft

Coefficient of friction

Airway 10' wide 6' high 5,000' long with 30,000 cu. ft of air per minute passing thru. water gauge 1.5 inches.

Find coefficient of friction.

$a = 6 \times 10 = 60$
$p = 5.2 \times 1.5 = 7.8$
$v = \frac{q}{a} = \frac{30,000}{60} = 500$ fpm

$K = \frac{pa}{lov^2} = \frac{60 \times 7.8}{5,000 \times 32 \times 500^2} =$

$\frac{468}{40,000,000,000} = .0000000117$

Quantity of air

Airway 12' wide 5' high 4000' long. Water guage 2 inches

Find quantity of air per min.

$a = 12 \times 5 = 60$
$p = 5.2 \times 2 = 10.4$

$v^2 = \frac{pa}{Klo} = \frac{10.4 \times 60}{.00000001 \times 4000 \times 34}$

$\frac{624}{.00136} = 458,824$

$v = \sqrt{458,824} = 677$ ft per min.

$q = av = 60 \times 677 = 40,620$ cu. ft per min.

Quantity of air

Mine fan speed 125 r.p.m. and delivers 150,000 cu ft air. Find air delivered with a speed of 200 r.p.m.

125 : 200 :: 150,000 : x = 240,000 cu. ft.

Volume varies directly as the speed of the fan.

Water gauge

Airway 10' wide 5' high 4,000' long with a velocity of 300' per min.

Find water guage

$i = \frac{Klov^2}{5.2a} =$

$\frac{.00000001 \times 4000 \times 30 \times 300^2}{5.2 \times 50} =$

$\frac{108}{260} = .41$ inches

Water gauge

Airway 14' wide 6' high 6,000' long with 30,000 cu. ft. of air passing thru.

Find water gauge

$p = \frac{Klov^2}{a} =$

$\frac{.00000001 \times 6,000 \times 40 \times 357.1^2}{84}$

$= \frac{306}{84} = 3.64$ lbs. per sq. ft.

$i = \frac{p}{5.2} = \frac{3.64}{5.2} = 0.7$ inches

Water gauge

If 1 inch of water gauge required to ventilate an airway 10' wide 5' high

Find water gauge required to pass the same quantity of air through an entry 10' wide 4' high and the same length.

$i_2 = \frac{i_1\left[\frac{o_2}{a_2^3}\right]}{\left[\frac{o_1}{a_1^3}\right]} = \frac{1\left[\frac{28}{40^3}\right]}{\left[\frac{30}{50^3}\right]}$

$i_2 = \frac{1 \times .000437}{.00024} = 1.82$ inches

Water gauge

Water gauge of 2 inches produces velocity of 400' per min. Find water gauge required to produce velocity 800' per min.

$i_1 : v_1^2 :: i_2 : v_2^2 =$

$\frac{2 \times 800^2}{400^2} = 8$ inches

The water gauge varies as the square of the velocity.

Water gauge

Mine fan speed 100 r.p.m. produces pressure of 1 inch water gauge. Find pressure produced with a speed of 150 r.p.m.

$100^2 : 150^2 :: 1 : x$

$x = \frac{1 \times 150^2}{100^2} = \frac{22500}{10000} = 2.25$ [illegible]

The water gauge varies as the square of the speed of the fan.

Units of work per minute

60,000 cu. ft. of air is passing through an airway with a water gauge of 2 inches. Find foot lbs. of work expended per minute.

$p = 5.2\,i = 10.4$
$u = pq = 10.4 \times 60000 = 624,000$ foot lbs.

Units of work per minute.

An airway 6 square feet 2000' long. Find how many units of work required to pass 24,000 cu. ft. of air.

$p = \frac{Klov^2}{a} =$

$\frac{.00000001 \times 2000 \times 24 \times 667^2}{36}$

$\frac{213.5}{36} = 5.93$ lbs. per sq. ft.

$Q = pq = 5.93 \times 24000 = 142,320$ ft. lbs.

Horse power

At 1.75 inches water gauge find horsepower required to circulate 50,000 cu. ft. of air per minute.

$p = 5.2\,i = 9.1$
$u = pq = 9.1 \times 50,000 = 455,000$ foot lbs.

$H.P. = \frac{u}{33,000} = \frac{455000}{33,000} = 13.79$ H.P.

Horsepower

2 entries each 12' wide 4' high and 3,000' long. Find horsepower required to circulate 40,000 cu. ft. per min.

$p = \frac{Klov^2}{a} =$

$\frac{.00000001 \times 3000 \times 64 \times 416.67^2}{36}$

$\frac{333.33}{96} = 3.47$ lbs per sq. ft.

$u = pq = 3.47 \times 40,000 = 138,800$ foot lbs.

$H.P. = \frac{u}{33,000} = \frac{138,800}{33,000} = 4.2$ H.P.

Horsepower

If 50 effective horse power is required to pass 120,000 cu. ft. of air per min. through a mine.

Find how many horse power required to pass 150,000 cu. ft. of air per min.

$50 : 120,000^3 :: x : 150,000^3$

$x = \frac{150000^3 \times 50}{120,000^3} = 97.65$ H.P.

The power varies as the cube of the quantity.

Equivalent Orifice

A mine is passing 150,000 cu. ft. of air at a 4 inch water gauge.

Find its equivalent orifice.

$a = .0004 \times \frac{q}{\sqrt{i}}$

$a = .0004 \times \frac{150,000}{\sqrt{4}} =$

30 Sq. ft.

Quantity of air through a regulator

area of regulator = 4 sq. ft. difference of pressure of two sides of reg. = 0.5 in. of water guage. The approximate formula:

$q = \frac{a\sqrt{i}}{.0004} = \frac{4 \times .727}{.0004}$ cu.

= 7070 ft. per min.

Pressure Potential

A mine is passing 60,000 cu. ft. of air through 2 splits: one is 6 x 8 ft. and 5,000' long, and the other is 5 x 8 ft and 10,000' long.

Find the volume of air passing in each split.

$x = a\sqrt{\frac{a}{l \times o}}$

$x_1 (6 \times 8)\sqrt{\frac{6 \times 8}{2(6+8) \times 5000}} = .8888$

$x_2 (5 \times 8)\sqrt{\frac{5 \times 8}{2(5+8) \times 10,000}} = .4961$

$\Sigma x_p = 1.3849$

$q_1 \frac{60000 \times .8888}{1.3849} = 38,560$ cu. ft.

$q_2 \frac{60,000 \times .4961}{1.3849} = 21,494$ cu. ft.

Gases

Table of gases

common chem. name	Symbol	Formula wts. Specific gravity air = 1	Wt. per cu ft lbs.
Hydrogen	H	1	0.0056
Carbon	C	12	0.0672
Nitrogen	N	14	0.0784
Oxygen	O	16	0.0896
Sulphur	S	32	0.1792

Table of gases (cont'd)

common name	Chem. name	Symbol	Formula	atomic wts.	Specific gravity air = 1	Wt. per cu. ft. lbs.
atmosphere	air is a mech. mixture	ON_4	$\frac{16+(4 \times 14)}{5}$	14.4	1.00	0.07[illegible]
marsh gas	methane	CH_4	$\frac{12+(4 \times 1)}{2}$	8	.55	0.0448
Black damp	carbon dioxide	CO_2	$\frac{12+(2 \times 16)}{2}$	22	1.527	0.1232
White damp	carbon monoxide	CO	$\frac{12+16}{2}$	14	.972	0.0784
Stink damp	hydrogen sulphide	H_2S	$\frac{(2 \times 1)+32}{2}$	17	1.1805	0.0952
after damp	variable mixture	[illegible]	$\frac{22+(7.5 \times 14)}{8.5}$	14.94	1.0375	0.0500

Name	meth.	carbon dioxide	carbon monoxide	hydrogen sulph.
chem. formula	CH_4	CO_2	CO	H_2S
Specific gravity	.555	1.529	.967	1.190
Combustible?	yes	no	yes	yes
support combustion	no	no	no	no
poisonous	no	no	yes	yes
explosive range	5-15	----	12.5-74	4.3-46
ignition temp.	1200	----	1200	700

Afterdamp is the gases left in a mine after an explosion. The mixture is variable depending on the available amount of air when the explosion takes place. Afterdamp contains some CO and moisture in the form of steam and sometimes has some unburned methane.

Firedamp is the mixture of methane and air.

Methane is a chemical combination of carbon and hydrogen.

To find weight of 1 cu. ft. of air.

$\frac{1.3273 \times B}{460 + T}$

To find weight of 1 cu. ft. of CH_4

$\frac{12+4}{2} = 8 \times 0.0056 =$

0.0448

Use similar formula to find weight of any of the mine gases.

To find atomic weight in any mechanical mixture divide molecular weight by 2. $CH_4 = \frac{12+(4 \times 1)}{2} = 8$

Then to find specific gravity divide the atomic wt. by 14.4 which is satisfactory for all practical purposes. $\frac{8}{14.4} = .555$

Gas problems

A mine liberates 1,000 cu. ft. of CH_4 per min.

Find cu. ft. of air and gas required per min. to keep CH_4 content to .5% on return.

$\frac{1000}{.005} = 200,000$ cu. ft.

On the return air course 50,000 cu. ft. of air and 0.8% of CH_4 is passing per min.

Find air to be added to reduce the CH_4 to 0.5%.

CH_4 per min. = 50,000 x 0.8% = 400 cu. ft.

Total volume with 0.5% of $CH_4 = \frac{400}{.005} = 80,000$ cu. ft.

80,000 - 50,000 = 30,000 cu. ft. of additional air required.

Gas problem

The air being exhausted from a mine contains 1.5% of CH_4. The volume of air entering the mine was 100,000 cu. ft. per min.

Find the volume at the return fan.

```
          101,522.8
.985 )100,000.000
       985
        1500
         985
         5150
         4925
          2250
          1970
           2800
           1970
            8300
            7880
```

Volume at the return fan = 101,522.8 cu. ft.

Drainage

The Syphon

It is desired to convey the water from D to E. The level of the water in E being always lower than in D. The syphon consists of ordinary cast iron pipe jointed and three valves, A, B, and C. The suction end of the pipe has a perforated pear-shaped end in order to keep out large particles which would prevent the syphon from working. In order to start the syphon it is necessary to remove the air in the pipe. This is done by closing the valves A and B and opening the valve C. Water is then poured

The Syphon - cont'd.

in the funnel F. The water drives the air out and takes its place in the pipe. When no more water can be poured in without overflowing at F the valve C is closed, the valves A and B are opened and the syphon is in operation. The distance S between the highest point of the center of the pipe and the lowest level of the water in D must not exceed 28 feet. It would be better not to have it exceed 21 feet. The greater the distance h between the two water levels, the better the syphon will work.

Centrifugal pump

By means of a revolving impeller or impellers on a centrifugal pump of which creates a vacuum which draws in water which is forced ahead by centrifugal force.

Reciprocating pump

The action of the piston or plunger on a reciprocating pump creates a vacuum which draws in water, the reverse action operates directly on the water forcing it through the discharge.

Formula for reciprocating pump.

Dia² in inches x length of stroke in feet x strokes per min. x .0408 x Eff. = Gallons per min.

Static head is the unit pressure exerted by the height of a column of water.

Friction head is the resistance offered by the friction of pipe against the flow of water expressed in the number of feet of static head equivalent to that resistance.

A pump is discharging 500 G.P.M. from a sump 610' vertically below the surface - Assuming the friction head = 10% of the static head - find total pumping head? =

610 X 110% = 671 feet

Pressure exerted per sq. inch by 300' of head of water.

0.434 X 300 = 130.2 lbs.

Sump

A sump 10' X 30' X 4' is full of water. If 50 G.P.M. are flowing in find how long it will take to empty sump with a pump having a capacity of 150 G.P.M.

10' X 30' X 4' X 7.5 =

9,000 Gals of water in sump

150 - 50 = 100 G.P.M. gain on sump

$\frac{9,000}{100} = 90$ minutes

Foot pounds

Foot pounds required to elevate 100 G.P.M. to a height of 200'

100 X 8.35 X 200 =

167,000 foot lbs.

Total pressure exerted by 100' head of water on a dam 10' wide and 5' high.

62.5 X 10 X 5 X 100 = 312,500 lbs. = 156.25 tons

Pressure exerted on a dam 8' wide and 5' high. The dam is filled within 1' of the top of the dam with water. Since the dam has the form of a rectangle the center of gravity will be located midway between the water level and the bottom of the dam or 2½ feet below the water level.

8' x 5' = 40'

2½' X 40' X 62.5 =

6250 lbs pressure exerted

Horsepower

Horsepower required to pump 400 G.P.M. to an elev. of 300' assuming the friction loss in the pipes amounted to 15% of the static head

$\frac{400 \times 345 \times 8.35}{33,000} =$

= 39.92 horsepower

Horsepower

How long would it take 40 horsepower to pump 88,000 gallons to a total head of 360 feet?

$\frac{33,000 \times 40}{360 \times 8.35} =$

439 G.P.M.

88000 ÷ 439 = 200 min.

Equation of pipes of different diameters

Showing relative capacity under same pressures.

Dia. inches	3"	4"	6"	8"
3"	1.0			
4"	2.1	1.0		
6"	5.7	2.8	1.0	
8"	11.7	5.7	2.1	1.0

1 Cu. ft. water = 62.5 lbs.
1 Cu. ft. = 7.5 gallons
1 gallon water = 8.35 lbs.
Pressure by a column of water 1 ft. high on 1 sq. in. of surface = .434 lbs.
Theoretical height water can be lifted in a vacuum by atmospheric pressure at sea level = 34 feet.
Practical height water can be lifted in a syphon at sea level = 28 ft.

Track

Table of rails and accessories

Wt. per yd lbs.	Width of base and head	length of splice bar inches	size of bolts inches	size of spikes inches	For one joint: wt. one splice bar lbs.	wt. of bolts	complete total wt.
85	5 3/16	34"	7/8 x 4	5/8 x 5 1/2	68.13	5.20	73.33
60	4 1/4	24"	3/4 x 3 1/2	5/8 x 5	32.40	3.12	35.52
40	3 1/2	20"	5/8 x 3	5 x 1/2	16.10	2.90	19.00
30	3 1/8	16 1/8	5/8 x 2 1/2	4 x 1/2	10.45	1.74	12.19

For 1 mile single track

Wt. per yd lbs.	Number pair of splice bars	Number bolts and nuts	Number Spikes	Weight in gross tons: Splice bars	bolts and nuts	Spikes	total accessories	rail	total complete
85	326	1956	10640	9.92	.76	2.80	13.48	133.57	147.05
60	326	1304	10640	4.71	.46	2.80	7.97	94.28	102.25
40	364	1456	10640	2.62	.47	1.94	5.03	62.86	67.89
30	364	1456	10640	1.70	.30	1.59	3.59	47.14	50.73

Weight of rails in long tons of 2,240 lbs. required to lay 1000' of single track.

weight of rail per yd.	ton for 1,000' of track
85	25.298
60	17.857
40	11.905
30	8.929

Number of ties per 1,000' and per mile of track

Distance	18"	24"	28"	30"
	Distance center to center in.			
1000'	667	500	429	400
1 mile	3,520	2,640	2,267	2,112

74 75 76
73
72