Opening

Monday, November 10, 2025 3:29 PM

This course is designed to walk operators through some of the basic math they will be completing at the WWTP.
We will be covering

- Area and Volume
- Force
- Flow Rate
- Work and Power
- Means
- Flow meter Calibration
- DMR Calculations
- Detention Time
- Chemical Feed Rates and Dosages

Resources
https://www.epa.gov/compliance/math-wastewater-operators
Larry gives insight on how to calculate your electric bill and more practical tips

Sacramento State Water Programs Manual
https://www.owp.csus.edu/operator-training/courses/correspondence-courses/wastewater-courses/#/

Minnesota Pollution Control Agency
https://www.pca.state.mn.us/sites/default/files/wq-wwtp8-02.pdf

Chlorine Dosage Rates
https://www.waterboards.ca.gov/drinking_water/programs/districts/docs/sonoma/naocl_examples.pdf
https://www.youtube.com/watch?v=Y-vMuwfIspU

There are lots more. Talk to your local board about resources which can prepare you for your local exam.

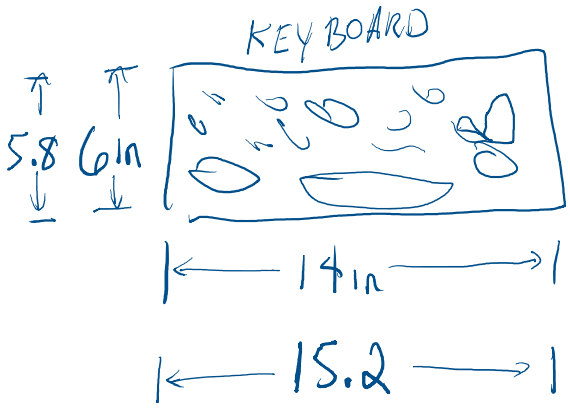
Rounding

Monday, November 17, 2025 2:38 PM

- 5 and up - round up
- 4 and down round down
- If we measured or calculated it, we keep it!

How big is my keyboard?

- Approximately?
- Exactly?
- What we need!



Approximately

$A = 14 \times 6 = 84 in^2 \Rightarrow 80 \approx 84$

$A = 15.2 \times 5.8 = 88.16 in^2$

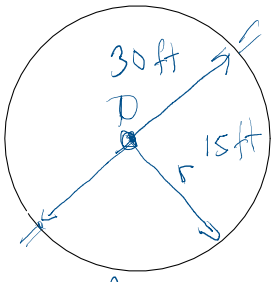
ROUND

$88.2 in^2$

EXACTLY

Area/Volume

Monday, November 3, 2025 10:26 AM

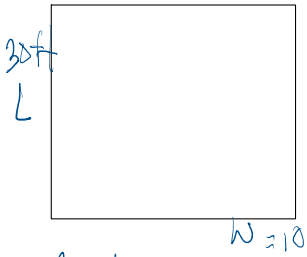


$A = \pi r^2$

$= \pi (15ft)^2$

$\pi (15ft)(15ft)$

$706ft^2$

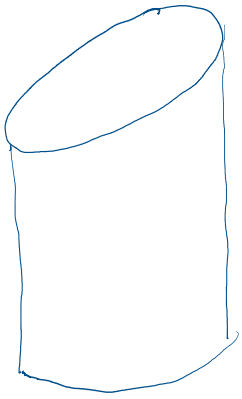


$A = L \times W$

$= 30ft \times 10ft$

$= 300ftft$

$= 300ft^2$

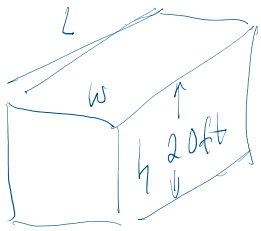


$V = A \cdot h$

$V = \pi r^2 h$

$= 706ft^2 \cdot 20ft$

$= 14,120ft^3$ cu.ft



$V = L \times W \times h$

$V = 300ft \cdot 20ft$

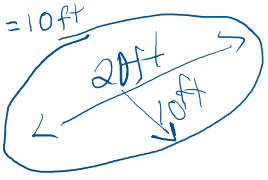
$V = 6,000ft^3$ cu.ft

Poll Question #1

Thursday, November 13, 2025 8:04 AM

What is the surface area and volume of a digester that is 20ft in diameter? And 12 feet deep?

Diameter = 20 ft
radius = 10 ft



$\pi\left(\frac{d}{2}\right)\left(\frac{d}{2}\right) = \frac{d^2}{4} \cdot 3.14 = 0.785 d^2$

NOTE - WE ESTIMATE π as 3.14

$A = \pi r^2$

3.14

$= \pi \cdot 10ft \cdot 10ft$

$A = 314 ft^2$

$V = A \times h$

$V = 314 ft^2 \cdot 12 ft = 3768 ft^3$

$V = 3,768 ft^3$

Pressure

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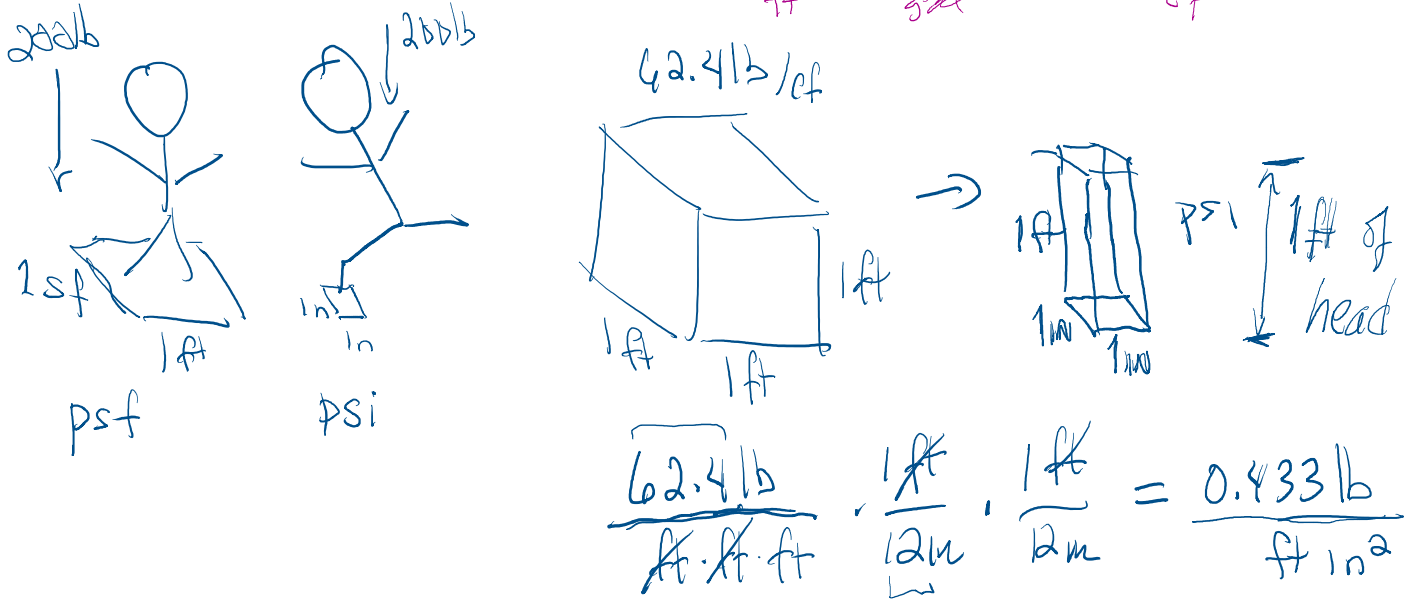
Pressure (p) is a type of force (F). Specifically a concentrated force. The general equation is p = F/A. Examples are

- lbs per square inch, psi
- Lbs per square foot, psf
- Atmospheres, atm

Imagine you stand inside a 1ft square tile. The force you are exerting is your weight per sf. I weigh 200lbs. My force would be 200psf. Does not matter how tall I am. It is the weight or F per area.

Water weighs 62.4lb per cubic foot. What is its PSI

$$\frac{7.481\ gal}{ft^3} \cdot \frac{8.34lb}{gal} = 62.4\frac{lb}{cf}$$



$$\frac{62.4lb}{ft \cdot ft \cdot ft} \cdot \frac{1ft}{12in} \cdot \frac{1ft}{12in} = \frac{0.433lb}{ft\ in^2}$$

Head

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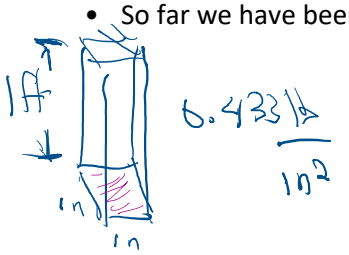
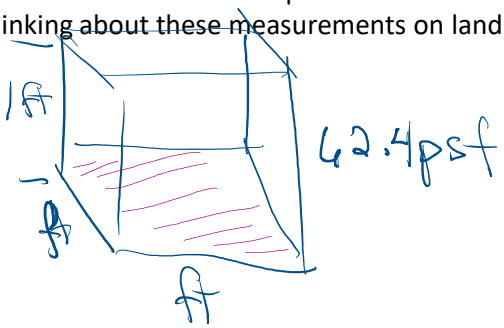
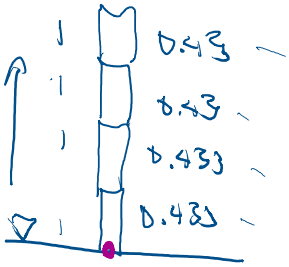
Head is the amount of fluid above your point of reference.
What does this mean?

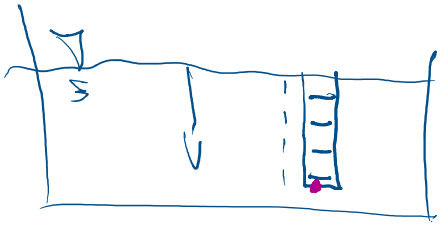
- We know that one cubic foot of water is 0.433 psi. That means for every 1ft of Head is also 0.433psi or 62.4psf
- So far we have been thinking about these measurements on land. What happens if we are underwater?







4ft 1.73 lb/in²



REMEMBER WE ADD THE WEIGHT UP AND APPLY IT AT THE BOTTOM OF THE COLUMN.

Force (cylinder)

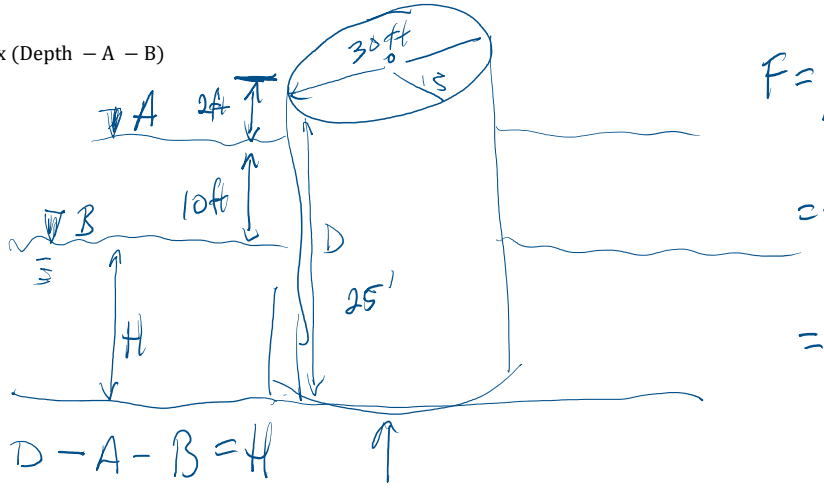
Monday, November 3, 2025 11:55 AM

Now let's combine things.

- If we rearrange our equation for pressure, p from p=F/A to F=p X A
- p = W_w x H
- $A = \pi r^2$
- W_w = 62.4lb/cf
- H = Depth - A - B

Final equation

F = W_w x πr^2 x (Depth $-$ A $-$ B)



$A \cdot P = \frac{F}{A} \cdot A \quad A \cdot p = F$

$F = A \times p$

$\pi r^2 \quad w_w \cdot h$

$= \pi 15^2 \cdot 62.4 \frac{lb}{cf} \cdot (25 - 10ft - 2ft)$

$=$

$D - A - B = H$

Force (rectangular)

Monday, November 3, 2025 12:50 PM

Now let's combine things.

- If we rearrange our equation for pressure, p from p=F/A to F=p X A
- p = W_w x H
- $A = L \text{ x } W \text{ x } H$
- W_w = 62.4lb/cf
- H = Depth - A - B

Final equation

F = W_w x L x W x H x $(\text{Depth} - \text{A} - \text{B})$

Velocity

Monday, November 3, 2025 12:56 PM

In physics, velocity is the speed and direction something is going. Typically in wastewater the direction is given. For example we pump from here to here. Wastewater is flowing from here to the effluent point. So we will focus more on the speed even though we will use the term Velocity.

Velocity is measured in Distance per time. This is mi/hr, ft/s, etc.

Let's say I want to drive from Atlanta to Miami. It is approximately 665 miles. It takes me 9 hours to get there. What is my velocity?

665 miles / 9 hours = 74 mi/hr - the direction is south

$$\frac{665 \text{ miles}}{9 \text{ hrs}} = \frac{74 \text{ mi}}{\text{hr}} \text{ south}$$

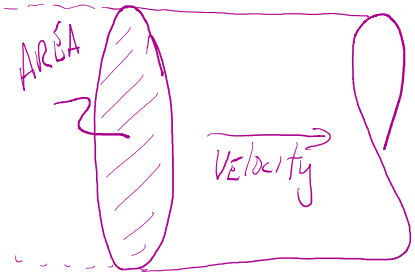
Flow Rate

Wednesday, November 12, 2025 9:19 AM

Now we have an understanding of Volume, Head, Pressure, Velocity, and now we come to Flow Rate.

Flow Rate is simply the amount of fluid that passes a certain point in a given amount of time. To calculate it we take the velocity component and multiply by the area component.

The symbol for Flow is Q and the equation for flow is Q = A x V.



Flow Rate

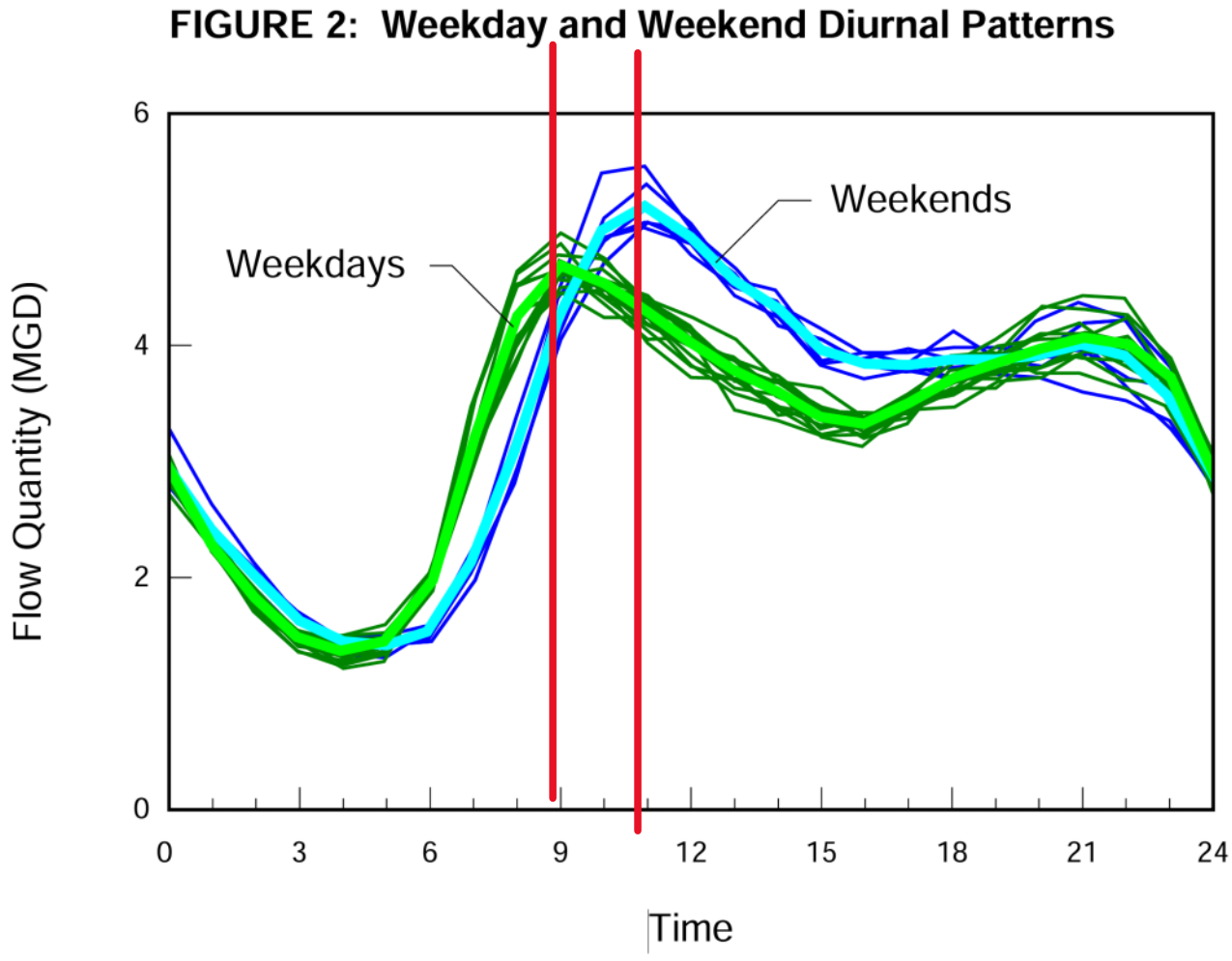
Wednesday, November 12, 2025 9:47 AM

We need to buy a pump for a pump station.

Let's take a moment to learn about pumps
https://youtu.be/U8iWNaDuUek?si=51E4LzinaB7MhKNQ&t=252 (4:14 -> 5:55)
https://www.youtube.com/watch?v=m3i_5xP9PYU

So we know, we need to know the flow rate and the amount of head required before we can select a pump.

We measured our wet well, and it is 6 ft in diameter and 20 ft deep. This 20ft is our starting head! There are three pipes from the sewer system that feed it. What is the minimum flow rate the pump needs to have to prevent the pump from overflowing? (YES, WE ARE ASSUMING NO FRICTION AND PUMPING TO THE TOP OF THE WELL)
First we need to understand the diurnal pattern (https://www.adsenv.com/sewersociology/)



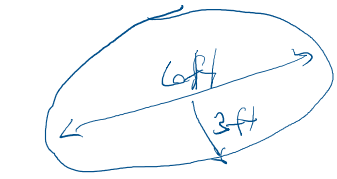
Why is this important to sizing our pump? We need to know what the maximum flow rate is so we don't overflow our tank!

Flow Rate Area

Wednesday, November 12, 2025 10:20 AM

We go to our wet well on the weekend around 9AM and bring a long stick and a stopwatch. Since Q = A x V let's start with calculating area.

Our wet well is 6 feet in diameter. So our area is:



$A = \pi r^2$

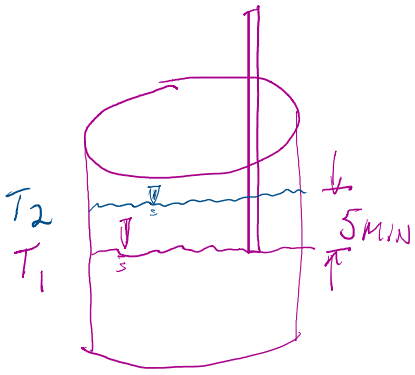
$= \pi (3ft)^2$

$A = 28ft^2$

Flow Rate Velocity

Wednesday, November 12, 2025 10:49 AM

Next lets tackle our Velocity. Remember velocity(V) is distance per time.
We stick our pole or stick into the wet well at the water's surface. Five minutes later we pull it out and see the water level rose 10 feet. NOTE: DRAW A DIAGRAM TO HELP VISUALIZE THE PROBLEM



Since Velocity = Distance / Time we have:

$$\frac{10\,ft}{5\,MIN} = 2\,\frac{ft}{MIN}$$

So our flow rate Q = A x V

$$Q = 28\,ft^2 \times \frac{2\,ft}{MIN} = \frac{56\,ft^2 \cdot ft}{MIN} = \frac{56\,cuft}{MIN}$$

There are 7.48gal per CF. So our Flow in Gal per minute is:

$$\frac{56\,cf}{MIN} \cdot \frac{7.48\,gal}{cf} = \boxed{420\,\frac{gal}{MIN}}$$

To get the right pump we need to grab our catalogue and order a pump with a flow rate of $\frac{420\,gal}{MIN}$ at 20ft of Head right? Not quite. Let's learn about Work and Power to see what we are missing.

Day 2 Reminders

Thursday, November 20, 2025 7:55 AM

For clarity - there are 7.481 gallons of water in 1 cu ft
Density is 8.34lb/gal or 62.4 lb/ cu ft - we are not accounting for solids

- For those who must know sludge is denser than freshwater, and its density will vary; It will be around 8.74lb/gal. It can be even heavier if it is old activated sludge.
- If you use the actual density of RAS in calculations, your answers will be marked wrong on almost any exam.

- Work and Power

Work & Power

Wednesday, November 12, 2025 12:32 PM

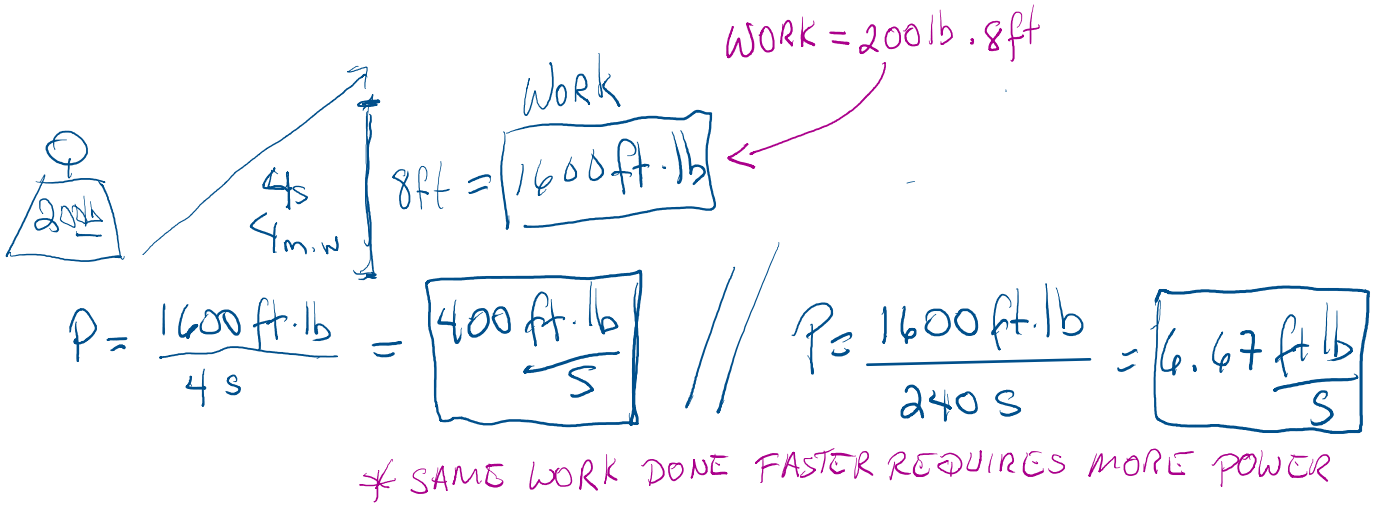
Flow rate is not the only thing we need to size our pump. Pumps do not turn themselves. They require motors. To know what size motor, we need to know how much work needs to be done by the pump.

Let's get an understanding of the concept of work. Work is simply the Force, F applied over a Distance, d
I weigh 200lbs. I go up a flight of steps 8ft. I have done 1,600 ft lbs of work.

Notice those units. Just like a torque wrench!

Work is Force applied over distance. Now Power is work applied over time.
20 years ago, I didn't weigh 200lbs, but let's say I did. 20 years ago I could go up the steps in 4 seconds, one day it may take me a solid 240 seconds or 4 minutes.

P = W / t. We established the work done is 1,600 ft lbs



Horse Power

Wednesday, November 12, 2025 2:17 PM

So we know how to calculate Work and Power, but where does horsepower come from? It comes from the need to relate electricity to work. In the 1700s when electricity was being marketed to the masses, we needed a way to describe the amount of work electricity does in terms everyone understood. In the 1700's most work was done by horses.

By definition 33,000ft lbs in 1 min = 1HP period

* 1HP = 0.7457 KW
KILOWATTS

Let's convert my race to the top of the steps into HP.

$$400\ \frac{ft\ lb}{s}\left(\frac{60s}{1min}\right) = 24{,}000\ \frac{ft\cdot lb}{min} \qquad \frac{1hp}{33{,}000\ \frac{ft\cdot lb}{min}} = 0.73hp$$

Now let's find out how much HP I neet to get the water out of the wet well.
HP = Q (gal/min) x H (ft) x 8.34lb/gal x 1HP/33,000 ft-lb/min

$$3960 \approx \frac{33{,}000}{8.34}$$

OUR Hp EQUATION CAN BE REDUCED TO

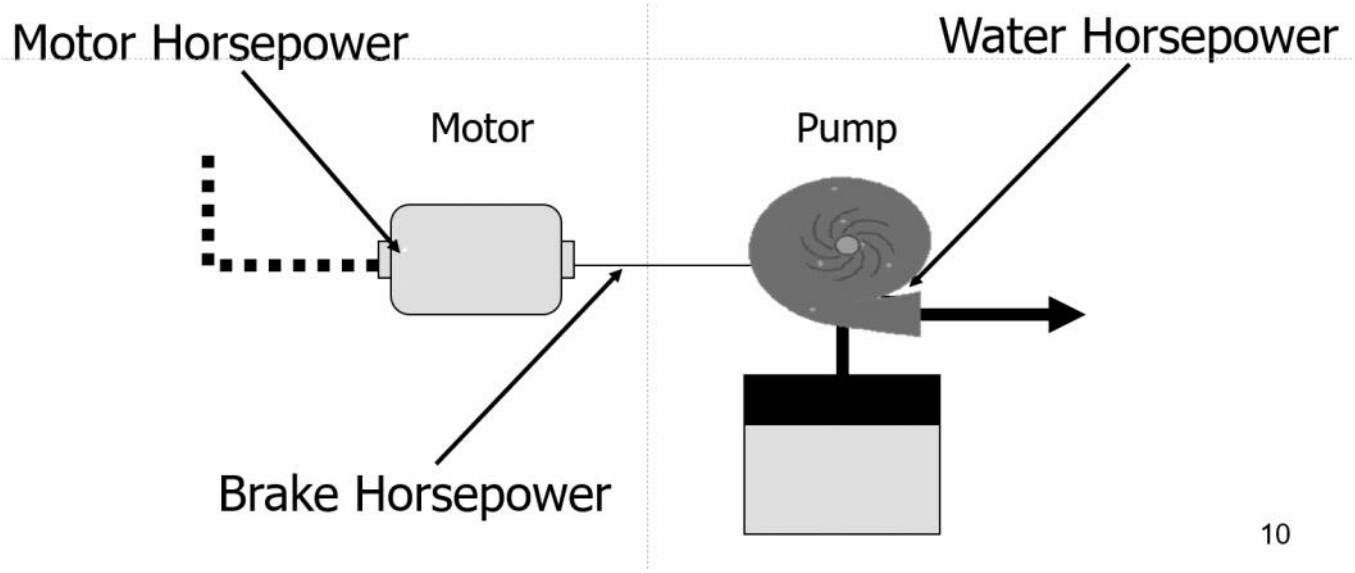
$$\frac{Q\,(gal/min)\cdot H\,(ft)}{3960}$$

If you would like to see how friction loss due to valves, elbows, etc impact HP check these video out
https://www.youtube.com/watch?v=kEVew9C3mv4&t=3s
https://youtu.be/U8iWNaDuUek?si=qxT3s6BosabJjalu&t=411 (6:51 -> 13:04)

Efficiency

Wednesday, November 12, 2025 2:53 PM

In an ideal world that HP would be all we need to maintain the level in our wet well. However in this world there are things which suck energy away from our systems. Sound, vibrations, and heat being primary among them.



Slides 7-17

Water, HP = (Q, GPM) (H,ft)(8.34 lb/gal)(HP/33,000ft lb/min)

We have to supply more HP to overcome these things….well how much?

Pump Horsepower

$$Hp = \frac{\text{Flow rate (gpm)} \times \text{Head (ft)}}{3960}$$

A pump is needed to deliver 2,000 gpm against a head of 20 ft. What hp is required for the pump?

2000 gpm x 20 ft/3960 = 10.1 hp

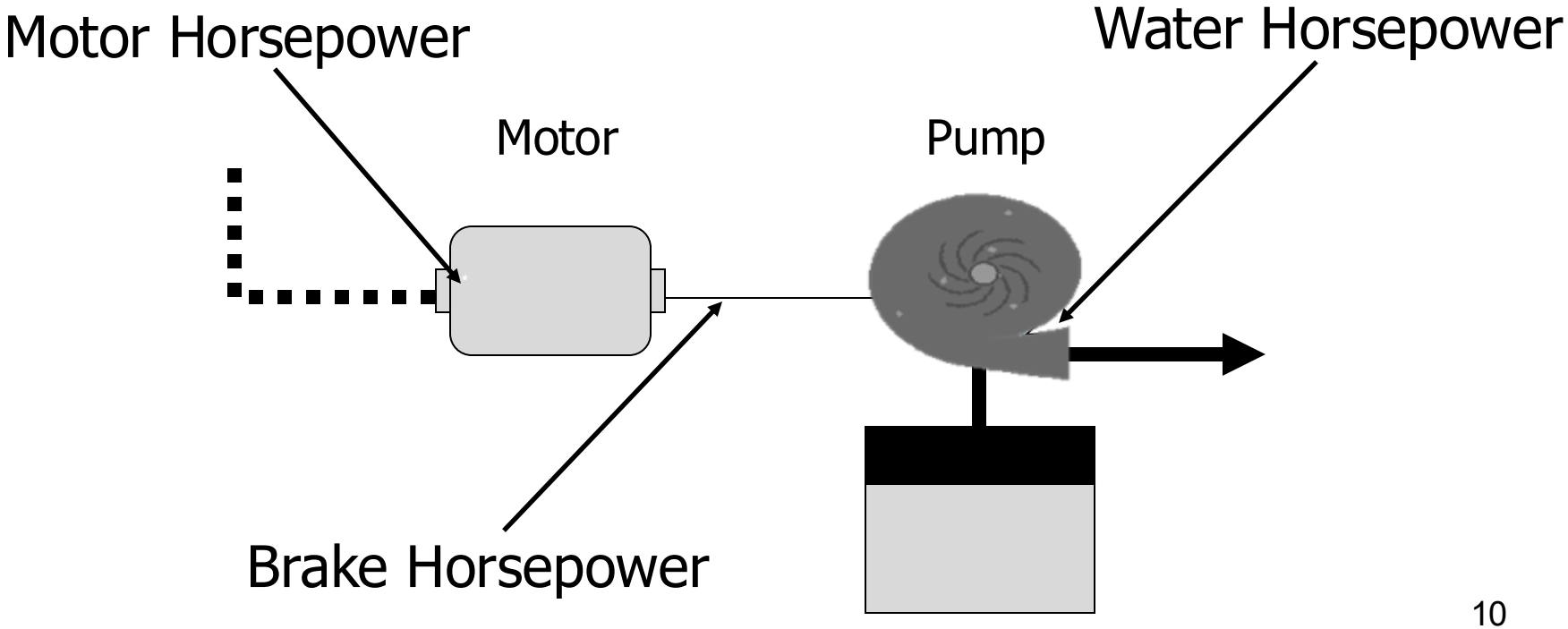
Pump Efficiency

- The ratio of total energy output to total energy input, expressed as %
- If a pump is needed to deliver 500 gpm against a total head of 100 ft and the pump has an efficiency of 80%, what hp must be supplied to the pump?

$$Hp = \frac{500 \text{ gpm} \times 100 \text{ ft}}{3960 \times 0.80} = 15.8 \text{ hp vs } 12.6$$

Horsepower and Efficiency

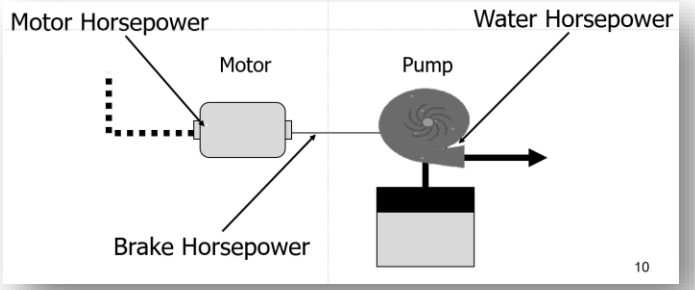
Horsepower can be expressed as Motor HP (or Input HP), Brake HP (or Shaft HP) and Water HP.



Horsepower and Efficiency

Efficiency is defined as output divided by input:

Motor Eff. (%) = $\frac{Brake\ HP}{Motor\ HP} * 100$



Pump Eff. (%) = $\frac{Water\ HP}{Brake\ HP} * 100$

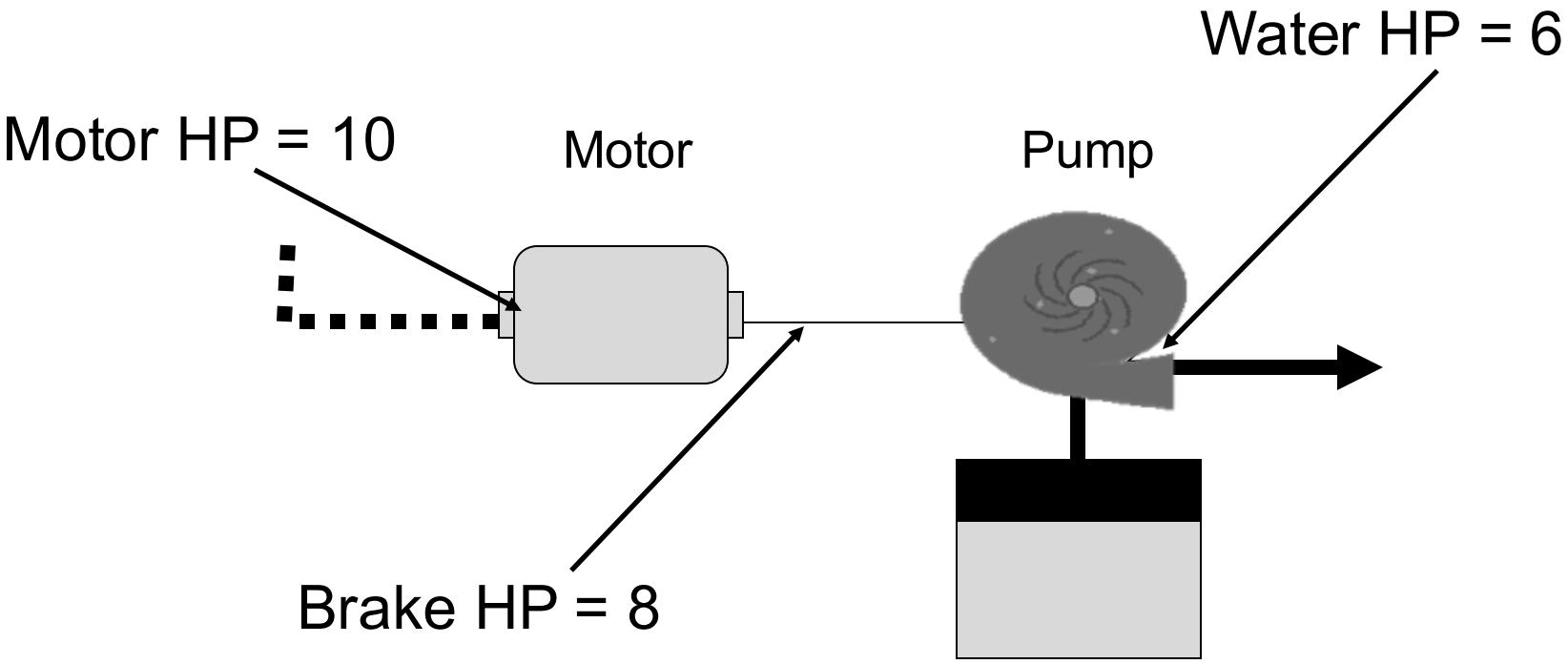
Wire-to-Water Eff. (%) = $\frac{Water\ HP}{Motor\ HP} * 100$

All efficiencies will be less than 100%

Horsepower and Efficiency

Motor Efficiency (%) = Brake HP/Motor HP x 100

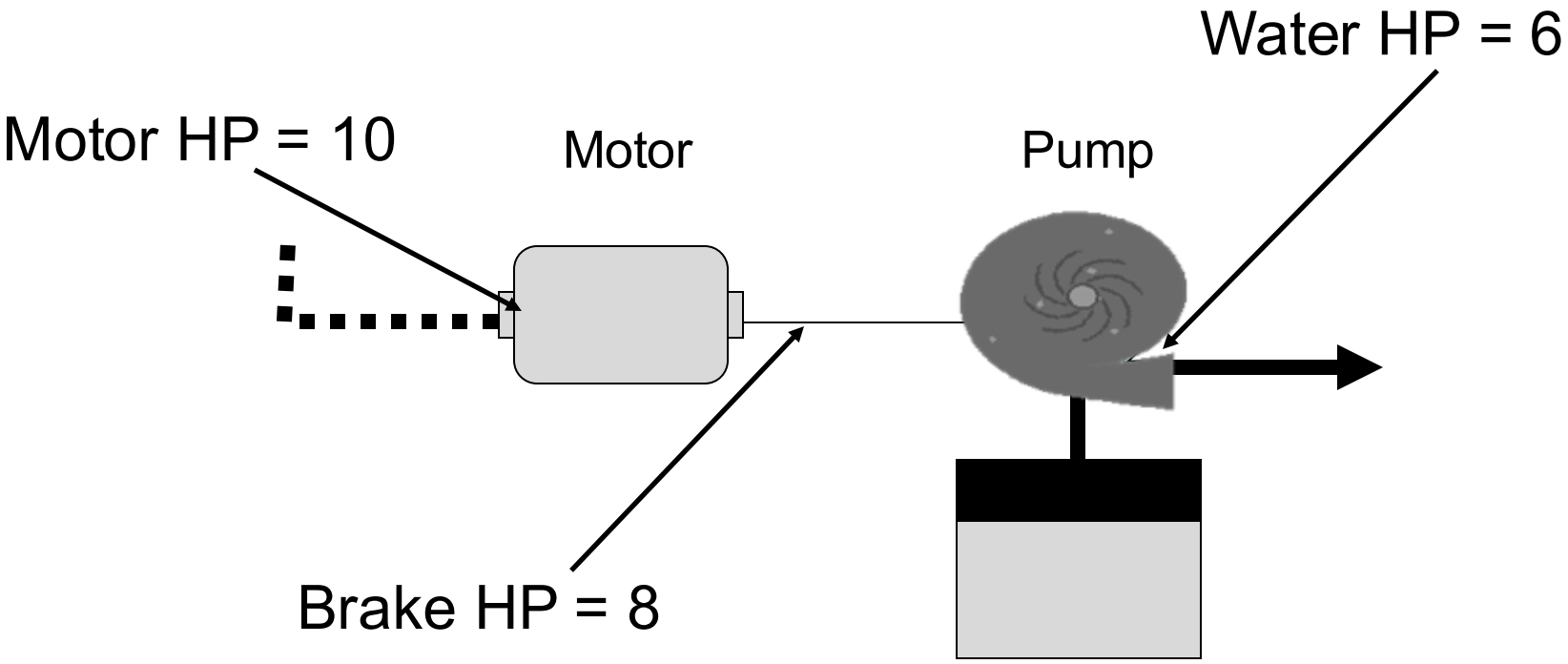
= 8 HP/10 HP x 100 = 80% = 0.8



Horsepower and Efficiency

Pump Efficiency (%) = Water HP/Brake HP x 100 =

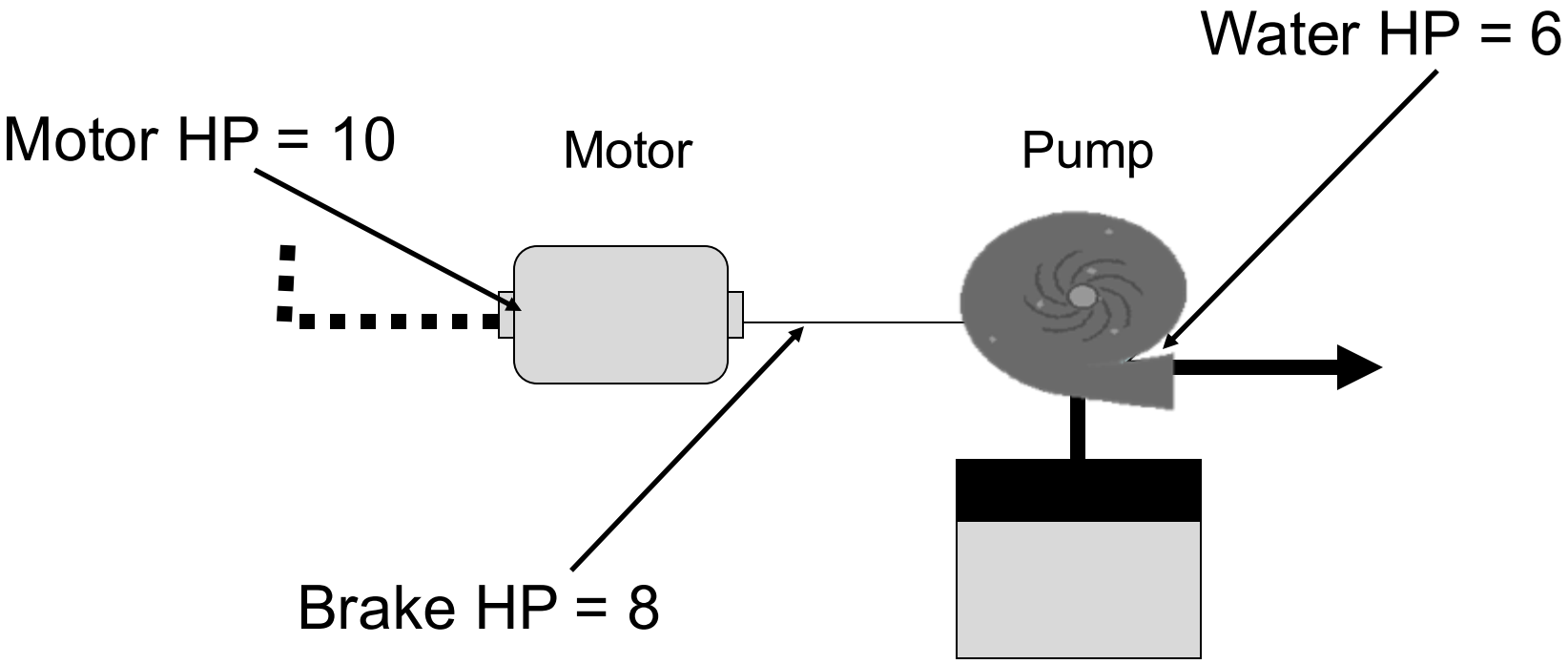
6 HP/8 HP x 100 = 75% = 0.75

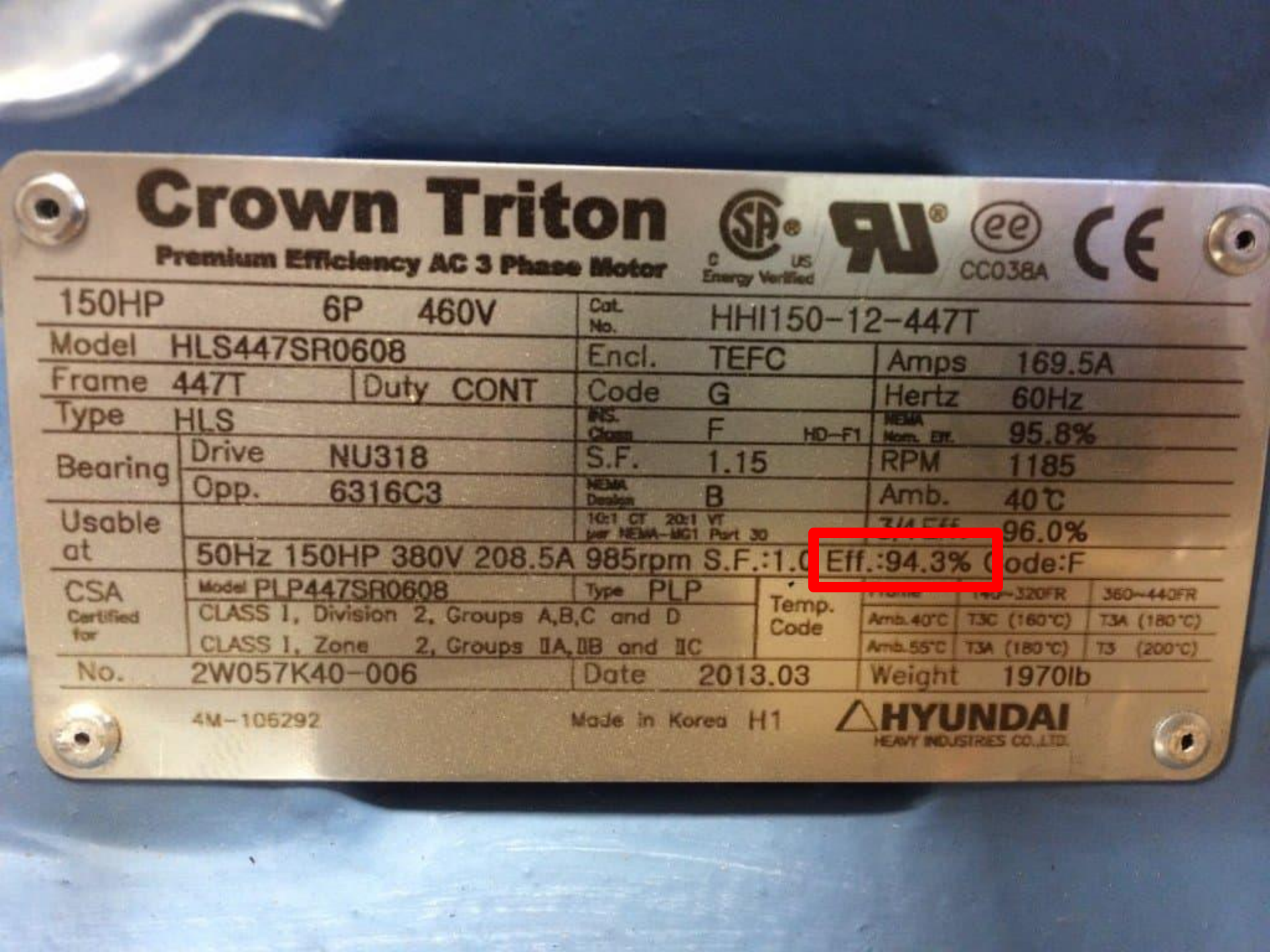


Horsepower and Efficiency

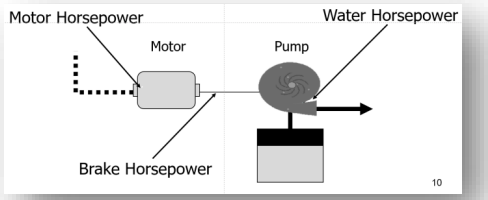
Wire-Water Efficiency (%) = Water HP/Motor HP x 100 = 6

HP/10 HP x 100 = 60% = 0.6




Crown Triton
Premium Efficiency AC 3 Phase Motor
C US Energy Verified
CC038A
150HP 6P 460V
Cat. No. HHI150-12-447T
Model HLS447SR0608
Encl. TEFC
Amps 169.5A
Frame 447T
Duty CONT
Code G
Hertz 60Hz
Type HLS
INS. Class F HD-F1
NEMA Nom. Eff. 95.8%
Bearing
Drive NU318
S.F. 1.15
RPM 1185
Opp. 6316C3
NEMA Design B
Amb. 40℃
Usable at
10:1 CT 20:1 VT per NEMA-MG1 Part 30
96.0%
50Hz 150HP 380V 208.5A 985rpm S.F.:1.0 Eff.:94.3% Code:F
CSA Certified for
Model PLP447SR0608
Type PLP
CLASS I, Division 2, Groups A,B,C and D
CLASS I, Zone 2, Groups IIA,IIB and IIC
Temp. Code
140~320FR
360~440FR
Amb.40℃ T3C (160℃) T3A (180℃)
Amb.55℃ T3A (180℃) T3 (200℃)
No. 2W057K40-006
Date 2013.03
Weight 1970lb
4M-106292
Made in Korea H1
HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

Calculating Horsepower from Flow, Head, and Efficiency



$$\text{Water hp} = \frac{\text{Flow (gpm)} \times \text{Head (ft)}}{3{,}960}$$

$$\text{Brake hp} = \frac{\text{Flow (gpm)} \times \text{Head (ft)}}{3{,}960 \times \text{Pump Efficiency}}$$

$$\text{Motor hp} = \frac{\text{Flow (gpm)} \times \text{Head (ft)}}{3{,}960 \times \text{Pump Efficiency} \times \text{Motor Efficiency}}$$

Example HP Problem

Find the motor horsepower for a pump station with the following parameters:

Motor efficiency = 94.3%

Pump efficiency = 74%

Total head = 20 ft

Flow = 426 gpm

$$\text{Motor hp} = \frac{426 \text{ gpm} \times 20 \text{ ft}}{3{,}960 \times 0.74 \times 0.94}$$

Motor hp = 3.09 mhp vs Brake HP = 2.91bhp vs Initial Water hp = 2.15whp

Arithmetic Mean

Wednesday, November 12, 2025 3:23 PM

We all know what an arithmetic mean is. This is typically what we learn in school. Simply the sum of all the numbers divided by the number of numbers.

$$\text{AVERAGE} = \frac{1}{n}\sum_{i=1}^{n} a_i = \frac{(a_1 + a_2 + a_3 \ldots a_n)}{n}$$

Geometric Mean

Wednesday, November 12, 2025 3:38 PM

The Geometric mean is used for calculating the average of e.Coli or Fecal Coliform results. We use the geometric mean because microorganisms multiply. Anytime you want an average of anything that multiplies a geometric mean must be used.

$$\frac{N_1 + N_2 + N_3}{3} = \text{Arithmetic Mean}$$

NOTE: BOD IS ARITHMETIC BECAUSE OF THE LOG NATURE OF PH IT CANNOT BE AVERAGED

$$\sqrt[3]{N_1 \times N_2 \times N_3} = (N_1 \times N_2 \times N_3)^{\frac{1}{3}}$$

$$\sqrt[20]{N_1 \times N_2 \cdots N_{20}} = (N_1 \times N_2 \times N_3 \times N_4 \cdots N_{20})^{\frac{1}{20}}$$

Mean Examples

Thursday, November 13, 2025 8:44 AM

Permit Limits

Effluent Characteristic	Effluent Limitation		
	30-Day Average a/	7-Day Average a/	Daily Maximum a/
Flow, mgd	4.0	N/A	N/A
BOD_5, mg/L (Kg/day) b/	30 (454)	45 (681)	N/A
Total Suspended Solids, mg/L (Kg/day) b/	30 (454)	45 (681)	N/A
E. Coli, No./100 mL	126	252	N/A
Dissolved Oxygen, mg/L, Minimum c/	N/A	N/A	5.0 c/
Ammonia, Total (as N), mg/L	See Table 1	See Table 1	See Table 1

NOTE: WHEN REPORTING VALUES, REPORT THE ACTUAL VALUES MEASURED EVEN IF THEY ARE LARGER THAN YOUR PERMIT LIMIT!

Permit Monitoring Requirements

Effluent Characteristic	Frequency	Sample Type a/	Practical Quantitation Limits, ug/L g/
Total Flow, mgd b/	Continuously	Recorder	
Total BOD_5, mg/L c/	2/Week	Composite	
Total Suspended Solids, mg/L c/	2/Week	Composite	
E. coli, no./100 mL	2/Week	Grab	
pH, units	Daily	Grab	
Oil and Grease, visual d/	Daily	Visual d/	
Ammonia Nitrogen, Total, mg/L	2/Week	Composite	

Permit Limits

Effluent Characteristic	Effluent Limitation		
	30-Day Average a/	7-Day Average a/	Daily Maximum a/
Flow, mgd	4.0	N/A	N/A
BOD_5, mg/L (Kg/day) b/	30 (454)	45 (681)	N/A
Total Suspended Solids, mg/L (Kg/day) b/	30 (454)	45 (681)	N/A
E. Coli, No./100 mL	126	252	N/A
Dissolved Oxygen, mg/L, Minimum c/	N/A	N/A	5.0 c/
Ammonia, Total (as N), mg/L	See Table 1	See Table 1	See Table 1

MONTHLY AVERAGE BOD CALCULATION

1st Week		
Sun	1-Jan	
Mon	2-Jan	40.6
Tue	3-Jan	
Wed	4-Jan	
Thu	5-Jan	57.1
Fri	6-Jan	
Sat	7-Jan	
Weekly Ave.		48.85
	Round	48.8

2nd Week		
Sun	8-Jan	
Mon	9-Jan	46.2
Tue	10-Jan	
Wed	11-Jan	
Thu	12-Jan	50.5
Fri	13-Jan	
Sat	14-Jan	
Weekly Ave.		48.35
	Round	48.4

3rd Week		
Sun	15-Jan	
Mon	16-Jan	10.2
Tue	17-Jan	
Wed	18-Jan	
Thu	19-Jan	12
Fri	20-Jan	
Sat	21-Jan	
Weekly Ave.		11.1

4th Week		
Sun	22-Jan	
Mon	23-Jan	7.1
Tue	24-Jan	
Wed	25-Jan	
Thu	26-Jan	10.1
Fri	27-Jan	
Sat	28-Jan	
Weekly Ave.		8.6

5th Week		
Sun	29-Jan	
Mon	30-Jan	45.6
Tue	31-Jan	
Wed	1-Feb	
Thu	2-Feb	2
Fri	3-Feb	
Sat	4-Feb	
Weekly Ave.		23.8

Above monthly Average BOD limit of 30 mg/L

Monthly Average	31.044
Round	31.0

Thursday Feb 2 value not used in January monthly average because it was collected in February

WEEKLY AVERAGE BOD CALCULATION

1st Week		
Sun	1-Jan	
Mon	2-Jan	40.6
Tue	3-Jan	
Wed	4-Jan	
Thu	5-Jan	57.1
Fri	6-Jan	
Sat	7-Jan	
Weekly Ave.		48.85
	Round	48.8

2nd Week		
Sun	8-Jan	
Mon	9-Jan	46.2
Tue	10-Jan	
Wed	11-Jan	
Thu	12-Jan	50.5
Fri	13-Jan	
Sat	14-Jan	
Weekly Ave.		48.35
	Round	48.4

3rd Week		
Sun	15-Jan	
Mon	16-Jan	10.2
Tue	17-Jan	
Wed	18-Jan	
Thu	19-Jan	12
Fri	20-Jan	
Sat	21-Jan	
Weekly Ave.		11.1

4th Week		
Sun	22-Jan	
Mon	23-Jan	7.1
Tue	24-Jan	
Wed	25-Jan	
Thu	26-Jan	10.1
Fri	27-Jan	
Sat	28-Jan	
Weekly Ave.		8.6

5th Week		
Sun	29-Jan	
Mon	30-Jan	45.6
Tue	31-Jan	
Wed	1-Feb	
Thu	2-Feb	2
Fri	3-Feb	
Sat	4-Feb	
Weekly Ave.		23.8

5th weekly average reported in February because last day of weekly average was in February

DAILY MAX BOD

1st Week		
Sun	1-Jan	
Mon	2-Jan	40.6
Tue	3-Jan	
Wed	4-Jan	
Thu	5-Jan	57.1
Fri	6-Jan	
Sat	7-Jan	
Weekly Ave.		48.85
	Round	48.8

2nd Week		
Sun	8-Jan	
Mon	9-Jan	46.2
Tue	10-Jan	
Wed	11-Jan	
Thu	12-Jan	50.5
Fri	13-Jan	
Sat	14-Jan	
Weekly Ave.		48.35
	Round	48.4

3rd Week		
Sun	15-Jan	
Mon	16-Jan	10.2
Tue	17-Jan	
Wed	18-Jan	
Thu	19-Jan	12
Fri	20-Jan	
Sat	21-Jan	
Weekly Ave.		11.1

4th Week		
Sun	22-Jan	
Mon	23-Jan	7.1
Tue	24-Jan	
Wed	25-Jan	
Thu	26-Jan	10.1
Fri	27-Jan	
Sat	28-Jan	
Weekly Ave.		8.6

5th Week		
Sun	29-Jan	
Mon	30-Jan	45.6
Tue	31-Jan	
Wed	1-Feb	
Thu	2-Feb	2
Fri	3-Feb	
Sat	4-Feb	
Weekly Ave.		23.8

Poll Question #2

Thursday, November 13, 2025 9:17 AM

GEOMETRIC

What is the ~~Arithmetic~~ Mean of the following numbers 25, 200, 45, 300, 62, 2, 150, 1

$$\sqrt[8]{25 \times 200 \times 45 \times 300 \times 62 \times 2 \times 150 \times 1}$$

$$(25 \times 200 \times 45 \times 300 \times 62 \times 2 \times 1 \times 150 \times 1)^{1/8}$$

$$= 32.5$$

THE GEOMETRIC MEAN IS ALWAYS SMALLER THAN THE ARITHMETIC MEAN.

Flow Meter Calibration

Thursday, November 13, 2025 10:18 AM

When the EPA comes out sometimes we will check the calibration of your automatic flow meter. We do this by comparing your physical flow meter measurement to your digital flow meter measurement.

The first step is to make sure your flume, weir or other device is installed correctly and appropriate for the volume of flow we are measuring. Ie a 40' rectangular weir would not be appropriate for measuring 10s of gallons of flow. The flow over the weir would be too small to accurately measure.

$$\frac{\text{OURS} - \text{YOURS}}{\text{OURS}} = \frac{\text{Actual} - \text{digital}}{\text{Actual}} \times 100 = \%\ \text{ERROR}$$ ± 10%

NOTE: ELECTRONIC MEASUREMENT SHOULD BE CHECKED AND ADJUSTED BY A THIRD PARTY AT LEAST ONCE A YEAR.

$$\frac{\text{PHYSICAL MEASUREMENT} - \text{DIGITAL MEASUREMENT}}{\text{PHYSICAL MEASUREMENT}} \times 100$$

DMR Calculations

Thursday, November 13, 2025 11:49 AM

Reference: https://floridadep.gov/sites/default/files/helpful-tips-completing-dmrs-%20July%202020.pdf
https://www.reddit.com/r/Wastewater/comments/1fa5zce/how_does_the_lbs_formula_make_sense/

We understand how to calculate Flow and we know when to do a Geometric Vs. Arithmetic Mean. Both of these elements are critical to completing our DMR accurately.

Our lab results are measured and given to us. These are the values which go onto your DMRs under the concentration section. Typically values are reported in grams and kilograms per Liter. If you need to conduct or have questions about any laboratory test please reach out to your state lab and/or reference the latest edition of Standard Methods.

Since flow is general measured in units of MG the equation for Daily Load is

Q(MGD) x Concentration(mg/L) x 8.34lb/gal = lb/d
Q(MGD) x Concentration(mg/L) x 3.785kg/gal = kg/d

You say Cornell, these units don't work out! Let me show you.

$$2.0\ \frac{MG}{D} \cdot 45\ \frac{mg}{L} \cdot 8.34\ \frac{lb}{gal} \cdot \left[\frac{1{,}000{,}000\ gal}{1\ MG} \cdot \frac{1K}{1{,}000{,}000\ mg}\right] = DMR$$

THE EQUATION HAS BEEN SIMPLIFIED FOR CONVENIENCE. MAKE SURE YOU ENTER THE UNITS AS REQUIRED BY THE EQUATION.

DMR Calculation

Thursday, November 20, 2025 7:25 AM

Your lab analyzes for BOD three days a week. Results come back as follows. What is the average weekly loading of BOD to the receiving stream?

	Flow MGD	BOD mg/L
Mon	1.9	197
Wed	2.1	210
Fri	1.5	180
Average	1.8	196

Q · CONC · 8.34

1.8 × 196 · 8.34 = 2,942 lb/day

LOADING = Q(MGD) × CONCENTRATION $\left(\frac{mg}{L}\right)$ × 8.34 $\frac{lb}{gal}$

Q = 1.8 MGD

Concentration = 196 $\frac{mg}{L}$

Hydraulic Retention Time (HRT)

Thursday, November 13, 2025 11:42 AM

= Volume / Flow

SAME AS MCRT
MEAN CELL RETENTION TIME

NOTE: SLUDGE RETENTION TIME (SRT) IS DIFFERENT, HRT IS THE LENGTH OF TIME WATER IS IN THE SYSTEM.

Aeration Basin Detention time

$Q = 1.8\ MGD$

$VOLUME = 6{,}000\ ft^3$

CONVERT TO GALLONS

CONVERT TO HOURS

$$\frac{V}{Q} = \frac{6{,}000\ ft^3}{1.8\ MG}\left(\frac{7.48\ gal}{1\ ft^3}\right)\left(\frac{24h}{1D}\right)\left(\frac{1\ MG}{1{,}000{,}000\ gal}\right) = 0.598\ hours$$

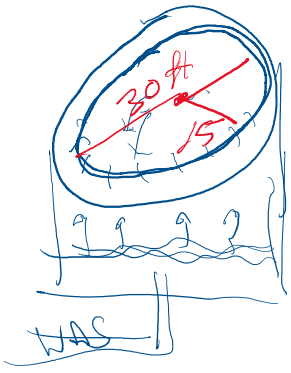
Activated sludge is being treated for 0.598 hours before going to the clarifier.

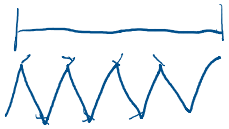
IN REALITY, ACTIVATED SLUDGE SHOULD BE IN THE BASIN FROM 4-8 HOURS FOR COMPLETE TREATMENT.

Clarifier - Weir Overflow Rate

Thursday, November 13, 2025 12:31 PM

Flow / Length of weir. Target is 10-20k GPD/FT





$2\pi r$ = circumference

$2\pi 15\text{ft} = 30\text{ft} \cdot \pi = 94.2$

$\approx$ 94ft

Diam = 30ft

Radius = 15ft

$$\frac{Q}{L} = \frac{100{,}000\ \frac{GAL}{D}}{94} = 1{,}063\ \frac{GPD}{ft}$$

Concentration

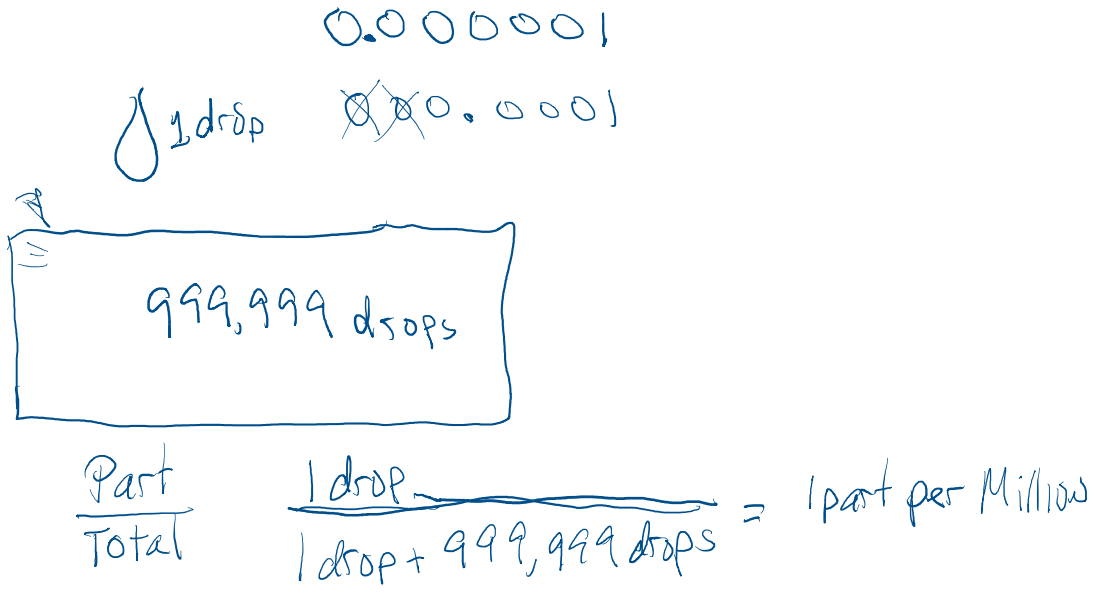
Monday, November 17, 2025 5:56 PM

The amount of something in a given space. We have all been affected by shrink -flation.
We understand we have less product per container - or the concentration went down!
Think chicken nuggets in the bag. Their used to be a whole lb of pasta in the box, now it is slightly less.

What is a PPM?

1mg/L = 1ppm
In fraction form, 1 ppm = 1/1,000,000
In decimal form, 1 ppm = 0.000001
In percent form, 1 ppm = 0.0001 %

Many of you are having liquid or powder chemicals delivered. On the delivery sheet it is going to tell you what the concentration is.



Concentration

Monday, November 17, 2025 6:11 PM

Ultimately

$$\frac{weight\ (or\ volume)\ of\ solute}{weight\ (or\ volume)\ of\ solution} \times 100$$

If 25 lb of chemical **is added** to 400 lb of water, what is the % strength of the solution by WEIGHT? (%W/W)

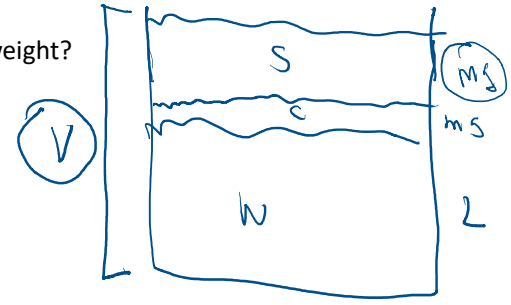
$$\frac{25lb}{(25lb+400lb)}$$

If 25L of chemical **is added** to 400 L of water, what is the % strength of the solution by VOLUME? (%V/V)

$$\frac{25L}{25L+400L}$$

If 25mg of chemical **is in** 400L of water, what is the % strength of the solution by weight? (%W/V)

$$\frac{25mg}{400L}$$



Feed Rate

Monday, November 17, 2025 6:15 PM

Most of us are getting a liquid or gaseous chemical which we are feeding into our plant. We need to know how many mL/min to feed. To find this out we use the equation

Feed Rate (mL/min) = [Q (GPM) x Dose (mg/L) x 0.3785] / [Concentration w/v %]

WE USE 0.3785 BECAUSE WE NOW HAVE GPM NOT MGD

Water flow is 35 gpm and chlorine solution strength is 0.7% NaOCl (w/v). What is the chemical feed rate (mL/min) needed to achieve a chlorine residual of 1.3 mg/L as Cl2?

$$\frac{35\text{gpm} \cdot 1.3\text{mg/L} \cdot 0.3785 \frac{\text{lb}}{\text{mg}}}{0.7\%} = 24.6 \frac{\text{mL}}{\text{MIN}}$$

MGD → GPM

$$\frac{\text{MG}}{\text{D}} \left(\frac{1{,}000{,}000\text{gal}}{1\text{MG}}\right)\left(\frac{1\text{D}}{24\text{hr}}\right)\left(\frac{1\text{hr}}{60\text{mn}}\right)$$

Chemical Dosage

Monday, November 17, 2025 5:16 PM

Chemical Dosage and Feed Rate

Chemical dosage and feed rate problems are typically solved by using the Pounds Formula. The Pounds Formula has three common forms

$$\text{Mass (lbs./day)} = \text{Flow (MGD)} * \text{Dosage (mg/L)} * 8.34$$

$$\text{Mass (lbs.)} = \text{Volume (MG)} * \text{Dosage (mg/L)} * 8.34$$

$$\text{Feed Rate (lbs./day)} = \frac{\text{Flow (MGD)} * \text{Dosage (mg/L)} * 8.34}{\text{Chemical Purity (\%)}}$$

Poll Question #3

Monday, November 17, 2025 5:51 PM

Determine the pounds per day of chlorine used if a treatment plant is treating 2.25 MGD with a chlorine dosage rate of 1.20 mg/L.

$$\frac{lb}{day} = Q(MGD) \cdot DOSE\left(\frac{mg}{L}\right) \cdot 8.34$$

$$= 2.25 MGD \cdot 1.2 \frac{mg}{L} \cdot 8.34$$

$$= 22.5 \frac{lb}{day}$$