WATER MATH

Chemical Dosages

The Pounds Formula

How many gallons of bleach needed?

What is the dosage of cationic polymer?

How many gallons per hour of alum?

How many pounds of iron removed?

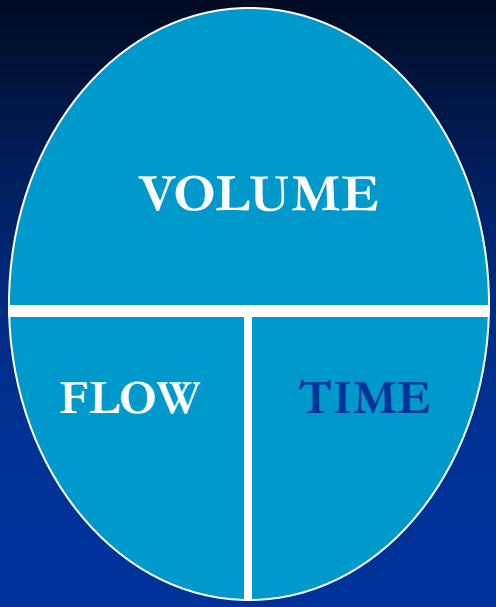
The "Pounds Formula"

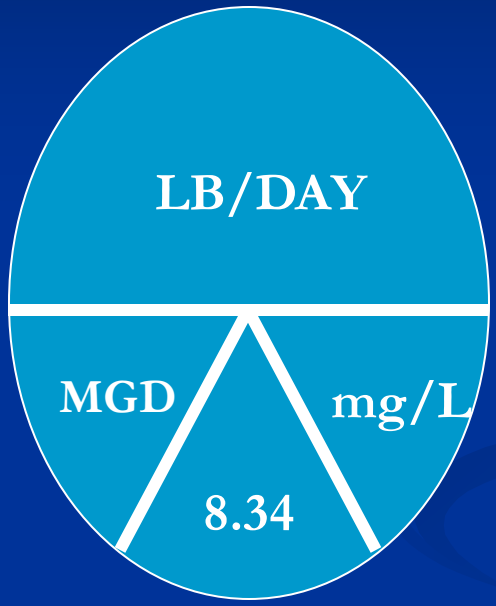
Pounds/Day = mg/L x MGD x 8.34

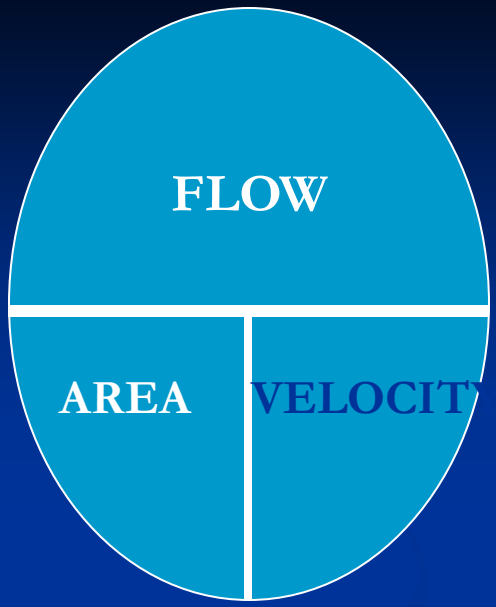
The Pounds Formula

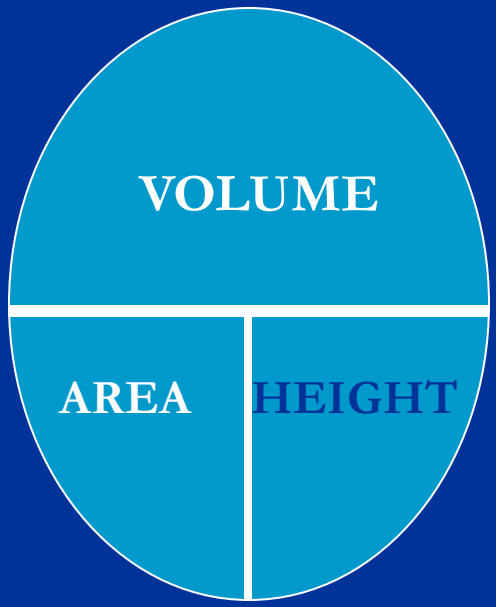
Used for *ALL* chemicals added in water treatment and distribution!

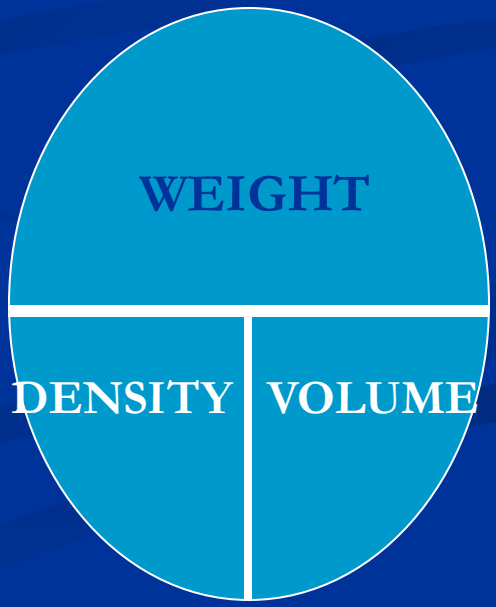
Even used to determine the amount of chemical *removed* from the water!


VOLUME
FLOW
TIME


LB/DAY
MGD
mg/L
8.34


FLOW
AREA
VELOCITY

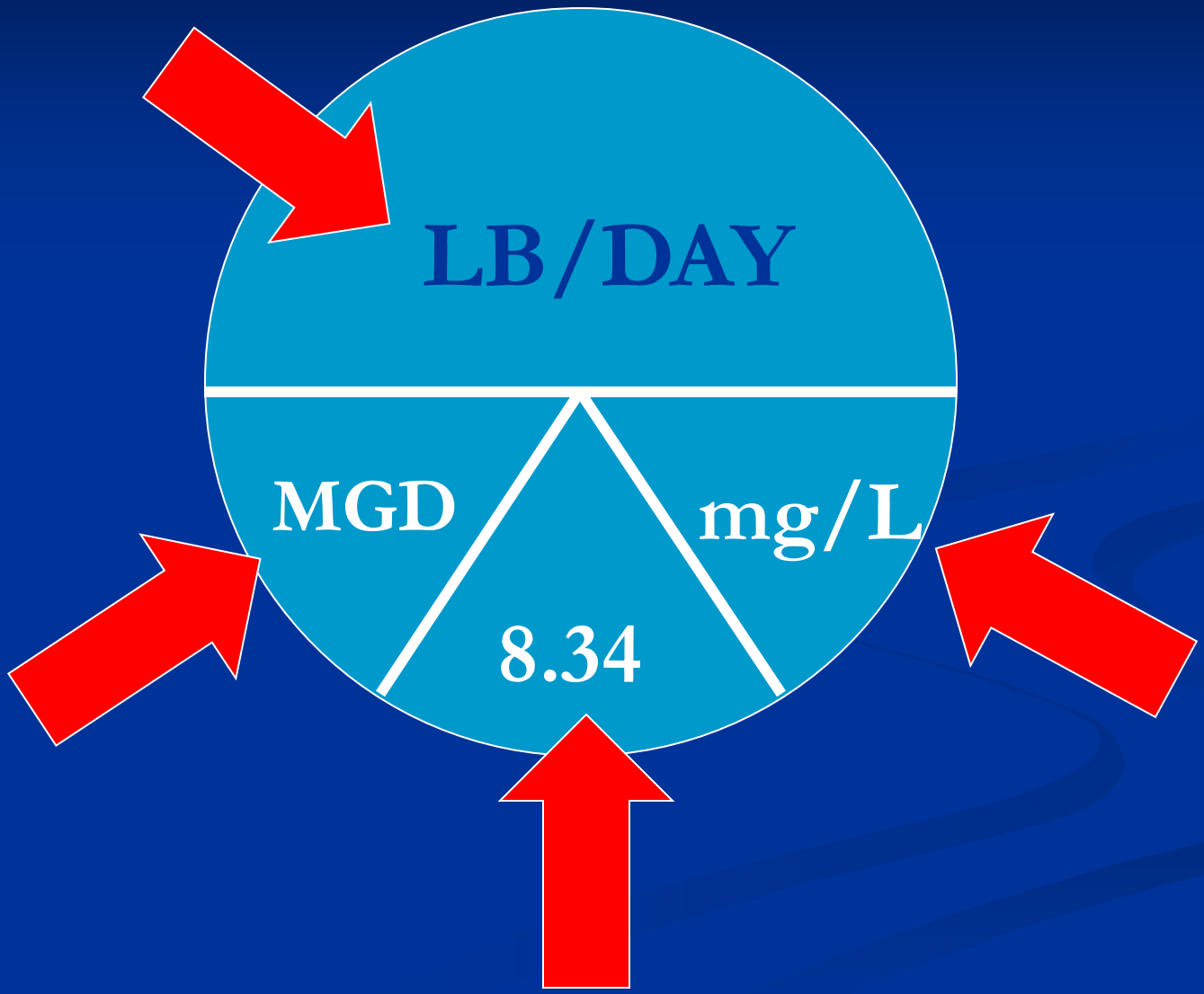

VOLUME
AREA
HEIGHT


WEIGHT
DENSITY
VOLUME

Pounds Formula: Units

This formula is very rigid when it comes to units.

We have to use the units that are built into the formula.


LB/DAY
MGD
8.34
mg/L

Deriving the 8.34

$$\frac{1\text{mg}}{1\text{L}} \times \frac{1\text{Mgal}}{1\text{day}} \times \frac{3.785\text{L}}{1\text{ gal}} \times \frac{1{,}000{,}000\text{gal}}{1\text{ Mgal}} \times \frac{1\text{gram}}{1{,}000\text{mg}} \times \frac{1\text{pound}}{454\text{g}}$$

Pounds/Day = mg/L x MGD x *8.34*

Pounds Formula: Units

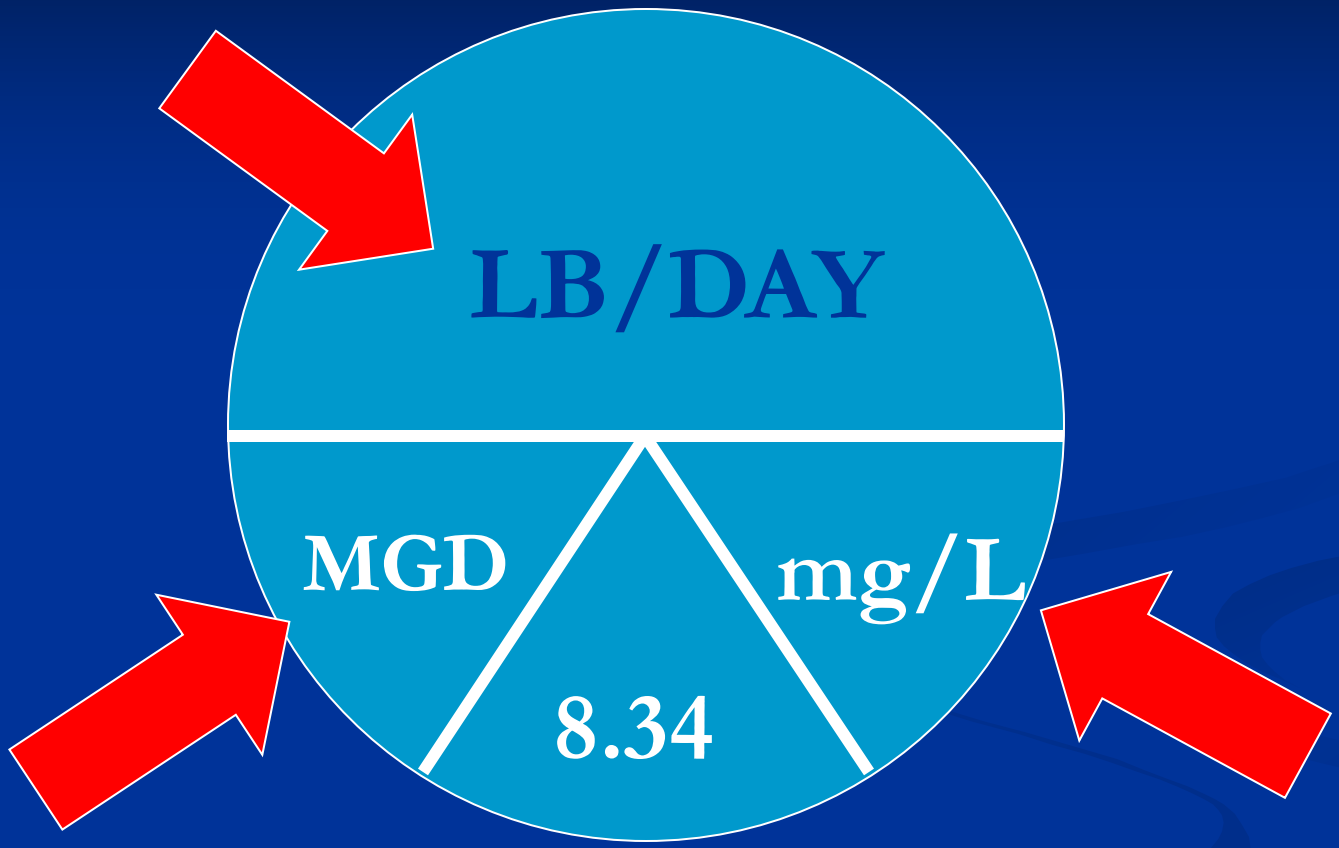
We must *always* use the following units in this formula:

Feed Rate: lb/day (ppd)

Dosage: mg/L (ppm)

Flow Rate: MGD

Chemical Feed Rate



Flow Rate

Chemical Dosage Rate

Three Variables

$$\textit{Pounds/Day} = \text{mg/L} \times \text{MGD} \times 8.34$$

$$\textit{mg/L} = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$$

$$\textit{MGD} = \frac{\text{Pounds/Day}}{\text{mg/L} \times 8.34}$$

Solving Math Problems

Read the Problem – *Twice!*

Simplify the Question

Identify the Formula

Find the "Variables"

Pounds Formula Problem

A treatment plant uses alum for coagulation at a dosage of 12.0 mg/L. What is the feed rate for the alum if the plant is treating 7.0 MGD?

Question: *What is the Feed Rate?*

Formula: lb/day = MGD x mg/L x 8.34

Pounds Formula Problem

A treatment plant uses alum for coagulation at a dosage of 12.0 mg/L. What is the feed rate for the alum if the plant is treating 7.0 MGD?

lb/day = MGD x mg/L x 8.34

= 7.0 x 12.0 x 8.34

= *701 pounds per day*

Example: Polymer Feed

A treatment plant feeds cationic polymer at a dosage of 0.75 mg/L. What is the polymer feed rate if the plant is treating 17.0 MGD?

Question: *What is the Feed Rate?*

Formula: lb/day = MGD x mg/L x 8.34

Example: Polymer Feed

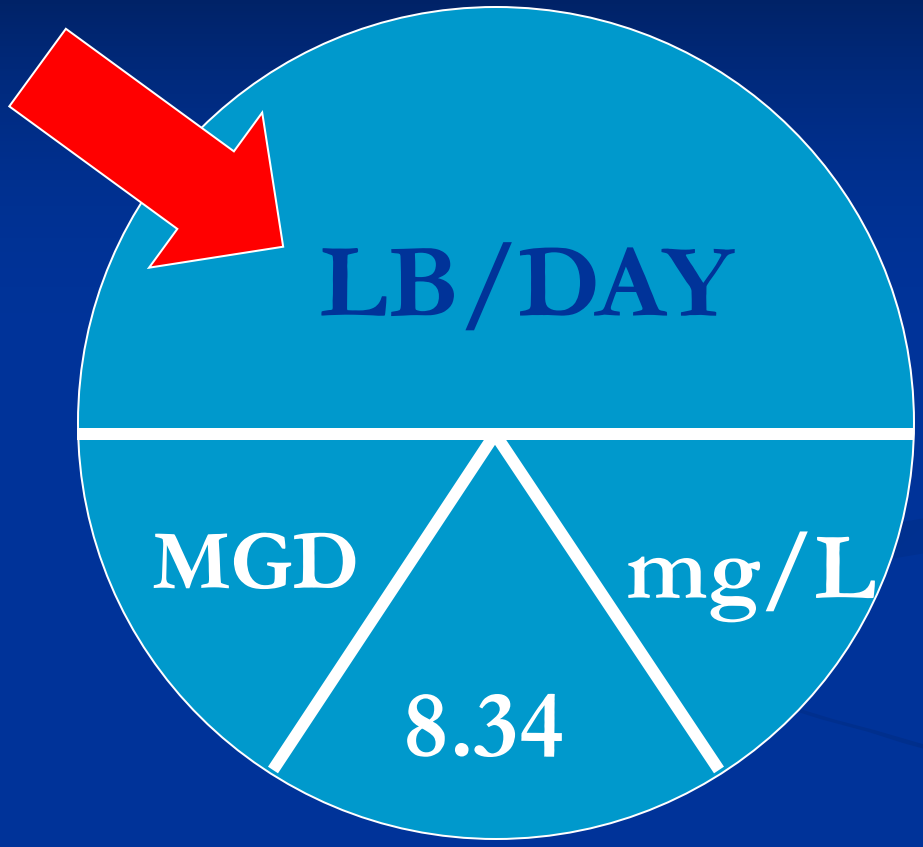
A treatment plant feeds cationic polymer at a dosage of 0.75 mg/L. What is the polymer feed rate if the plant is treating 17.0 MGD?

Pounds/day = MGD x mg/L x 8.34

= 17.0 x 0.75 x 8.34

= *106 lb/day of polymer*

Chemical Feed Rate



Example: Ferric Dosage

What is the dosage rate of ferric chloride if a plant is operating at 20 MGD and the ferric chloride is being fed at 250 lb/day?

Question: *What is the Dosage Rate?*

Formula: $\text{mg/L} = \dfrac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$

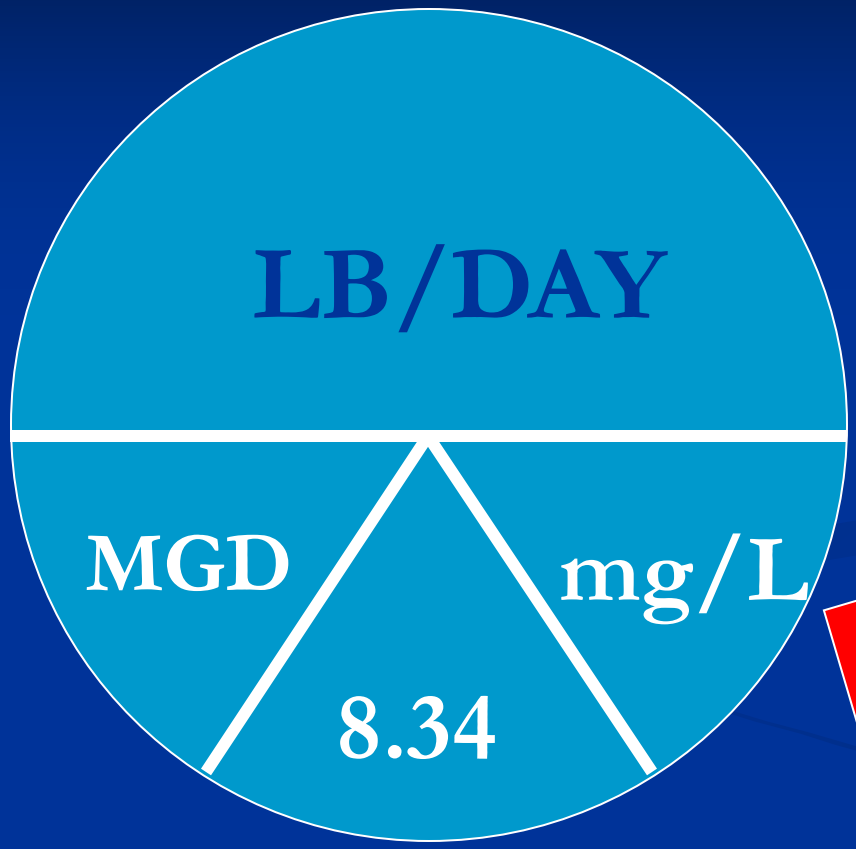
Example: Ferric Dosage

What is the dosage rate of ferric chloride if a plant is operating at 20 MGD and the ferric chloride is being fed at 250 lb/day?

$$\text{mg/L} = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$$

$$= \frac{250}{20 \times 8.34}$$

$$= \textit{1.5 mg/L}$$



Chemical Dosage Rate

Example: Flow Rate

What is the highest flow rate at which at treatment plant can operate if it must apply an alum dosage rate of 6 mg/L and the maximum feed rate is 400 lb/day?

Question: *What is the Flow Rate?*

Formula: $$\text{MGD} = \frac{\text{Pounds/Day}}{\text{mg/L} \times 8.34}$$

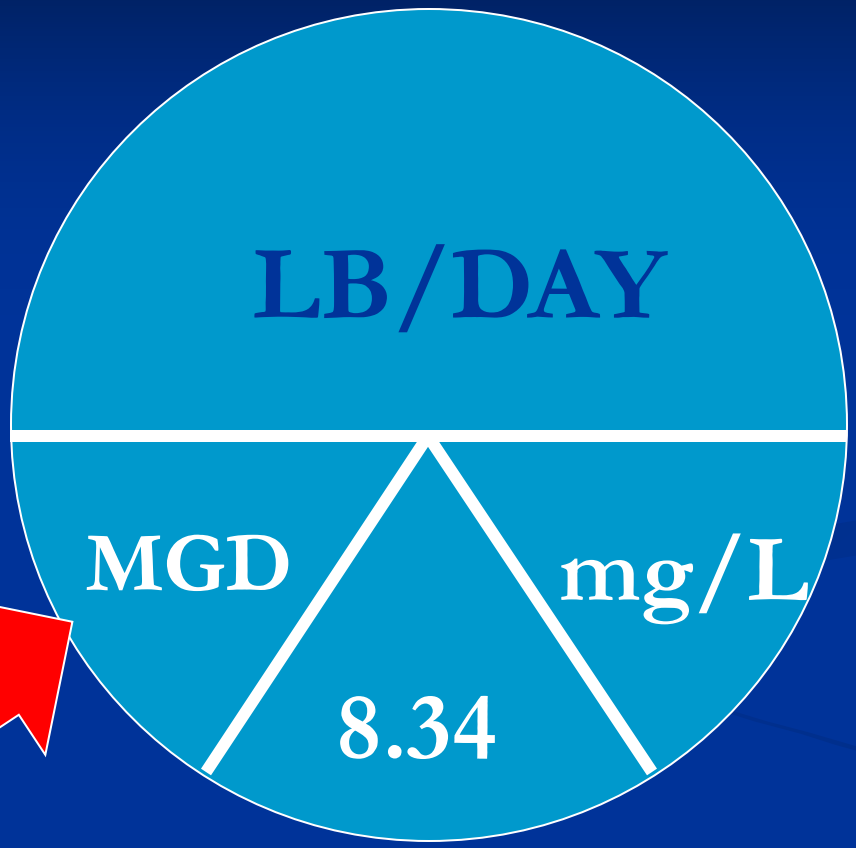
Example: Flow Rate

What is the highest flow rate at which a treatment plant can operate if it must apply an alum dosage rate of 6 mg/L and the maximum feed rate is 400 lb/day?

$$MGD = \frac{\text{Pounds/Day}}{\text{mg/L} \times 8.34}$$

$$= \frac{400}{6 \times 8.34}$$

$$= \textit{8.0 MGD}$$



Flow Rate

Example: Alum Feed Rate

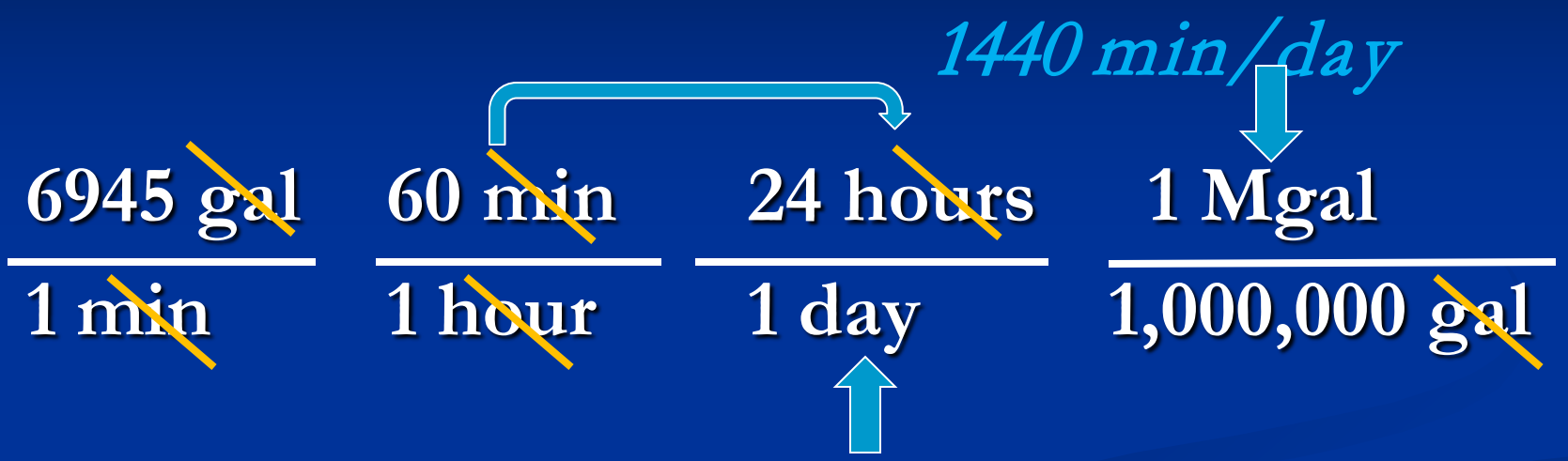
How much alum must be fed to coagulate a flow of 6945 gpm at a dosage 2 mg/L?

Question: *What is the Feed Rate?*

Formula: lb/day = MGD x mg/L x 8.34

But the flow rate is not in MGD!

Unit Dimensional Analysis



$= 10.0\ MGD$

Example: Alum Feed Rate

How much alum must be fed to coagulate a flow of *6945 gpm* at a dosage 2 mg/L?

Pounds/day = MGD x mg/L x 8.34

= *10* x 2 x 8.34

= *167 lb/day of alum*

Example: Ferric Dosage

What is the dosage rate of ferric chloride if a plant is operating at 31 cfs and the ferric chloride is being fed at 250 lb/day?

Question: *What is the Dosage Rate?*

Formula: $\text{mg/L} = \dfrac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$

Unit Dimensional Analysis

$$\frac{31\ ft^3}{1\ sec}\ \frac{7.48\ gal}{1\ ft^3}\ \frac{60\ sec}{1\ min}\ \frac{1440\ min}{1\ day}\ \frac{1\ Mgal}{1{,}000{,}000\ gal}$$

$$= \quad 20.0\ MGD$$

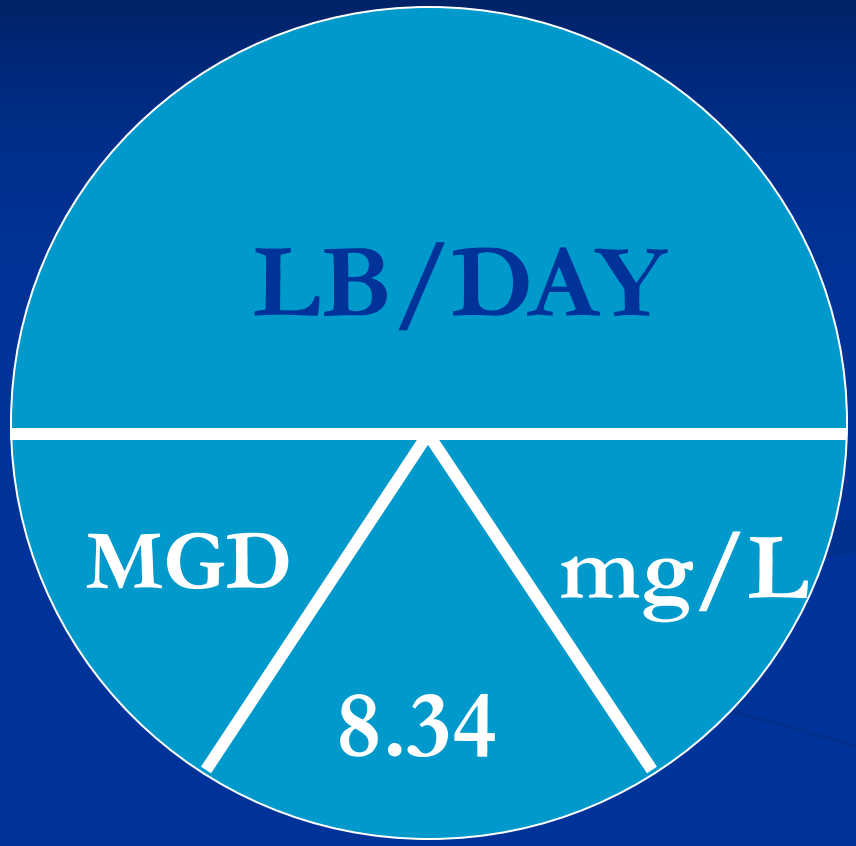
Example: Ferric Dosage

What is the dosage rate of ferric chloride if a plant is operating at *31 cfs* and the ferric chloride is being fed at 250 lb/day?

$$\text{mg/L} = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$$

$$= \frac{250}{20.0 \times 8.34}$$

$$= 1.5 \text{ mg/L}$$


LB/DAY
MGD
mg/L
8.34

Water Math: The Pounds Formula

Practice Problems

Question #1

How many pounds per day of polymer must be added to a flow of 12 MGD, if the water is to be treated at a dosage of 0.8 mg/L?

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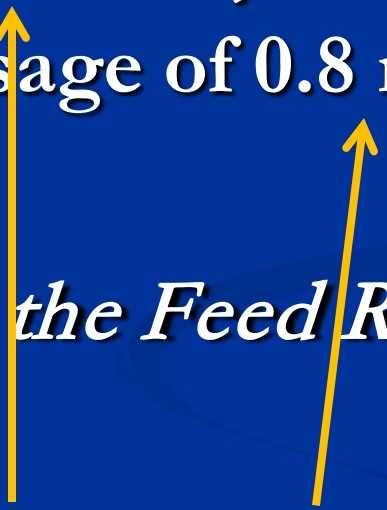

Question: What is the Feed Rate?

Formula: lb/day = MGD x mg/L x 8.34

Question #1

How many pounds per day of polymer must be added to a flow of 12 MGD, if the water is to be treated at a dosage of 0.8 mg/L?

Pounds/day = MGD x mg/L x 8.34

= 12 x 0.8 x 8.34

= *80 lb/day*

Question #2

What is the actual polymer dosage when 93 pounds are applied each day to a flow of 16 MGD?

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What is the actual polymer dosage when 93-pounds are applied each day to a flow of 16 MGD?

Question: *What is the Dosage Rate?*

Formula: $\text{mg/L} = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$

Question #2

What is the actual polymer dosage when 93 pounds are applied each day to a flow of 16 MGD?

$$mg/L = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$$

$$= \frac{93}{16 \times 8.34}$$

$$= 0.7\ mg/L$$

Question #3

What is the maximum flow rate at which at treatment plant can operate if it must apply chlorine at a rate of 3.75 mg/L and the maximum feed rate is 500 lb/day?

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What is the maximum flow rate at which a treatment plant can operate if it must apply chlorine at a rate of 3.75 mg/L and the maximum feed rate is 500 lb/day?

Question: *What is the Flow Rate?*

Formula: $$\text{MGD} = \frac{\text{Pounds/Day}}{\text{mg/L} \times 8.34}$$

Question #3

What is the maximum flow rate at which at treatment plant can operate if it must apply chlorine at a rate of 3.75 mg/L and the maximum feed rate is 500 lb/day?

$$MGD = \frac{\text{Pounds/Day}}{\text{mg/L} \times 8.34}$$

$$= \frac{500}{3.75 \times 8.34}$$

$$= \textit{16.0 MGD}$$

Question #4

How much alum must be fed to coagulate a flow of 8000 gpm at a dosage 25 mg/L?

Question #4

How much alum must be fed to coagulate a flow of 8000 gpm at a dosage 25 mg/L?

Question: *What is the Feed Rate?*

Formula: lb/day = MGD x mg/L x 8.34

But the flow rate is not in MGD!

Unit Dimensional Analysis

$$\frac{8000\ \text{gal}}{1\ \text{min}} \times \frac{60\ \text{min}}{1\ \text{hour}} \times \frac{24\ \text{hours}}{1\ \text{day}} \times \frac{1\ \text{Mgal}}{1{,}000{,}000\ \text{gal}}$$

$$= \textit{11.5 MGD}$$

Question #4

How much alum must be fed to coagulate a flow of *8000 gpm* at a dosage 25 mg/L?

Pounds/day = MGD x mg/L x 8.34

= *11.5* x 25 x 8.34

= *2,400 lb/day of alum*

Question #5

What is the maximum flow rate at which the treatment plant from the last problem can operate if it can only deliver an alum feed rate is 2000 lb/day?

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What is the maximum flow rate at which the treatment plant from the last problem can operate if it can only deliver an alum feed rate is 2000 lb/day?

Question: *What is the Flow Rate?*

Formula: $$\text{MGD} = \frac{\text{Pounds/Day}}{\text{mg/L} \times 8.34}$$

25 ppm

Question #5

What is the maximum flow rate at which the treatment plant from the last problem can operate if it can only deliver an alum feed rate is 2000 lb/day?

$$MGD = \frac{\text{Pounds/Day}}{\text{mg/L} \times 8.34}$$

$$= \frac{2000}{25 \times 8.34}$$

$$= \textit{9.59 MGD}$$

Question #5

$$\frac{9.59\ \text{Mgal}}{1\ \text{day}} \times \frac{1{,}000{,}000\ \text{gal}}{1\ \text{Mgal}} \times \frac{1\ \text{day}}{24\ \text{hours}} \times \frac{1\ \text{hour}}{60\ \text{min}}$$

$$= \quad 6{,}660\ gpm$$

Question #6

What is the dosage rate of ammonia if a plant is operating at 17.5 cfs and the ammonia is being fed at 115 lb/day?

Question #6

What is the dosage rate of ammonia if a plant is operating at 17.5 cfs and the ammonia is being fed at 115 lb/day?

Question: *What is the Dosage Rate?*

Formula: $\text{mg/L} = \dfrac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$

Question #6

$$\frac{17.5\ ft^3}{1\ sec}\times\frac{7.48\ gal}{1\ ft^3}\times\frac{60\ sec}{1\ min}\times\frac{1440\ min}{1\ day}\times\frac{1\ Mgal}{1{,}000{,}000\ gal}$$

$$= \textit{11.3 MGD}$$

Question #6

What is the dosage rate of ammonia if a plant is operating at *17.5 cfs* and the ammonia is being fed at 115 lb/day?

$$\text{mg/L} = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$$

$$= \frac{115}{11.3 \times 8.34}$$

$$= 1.22 \text{ mg/L}$$

Bonus Question!

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?

??? Bonus Question

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?

Question: *What is the Dosage Rate?*

Formula: $\text{mg/L} = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$

Bonus Question

Step 3

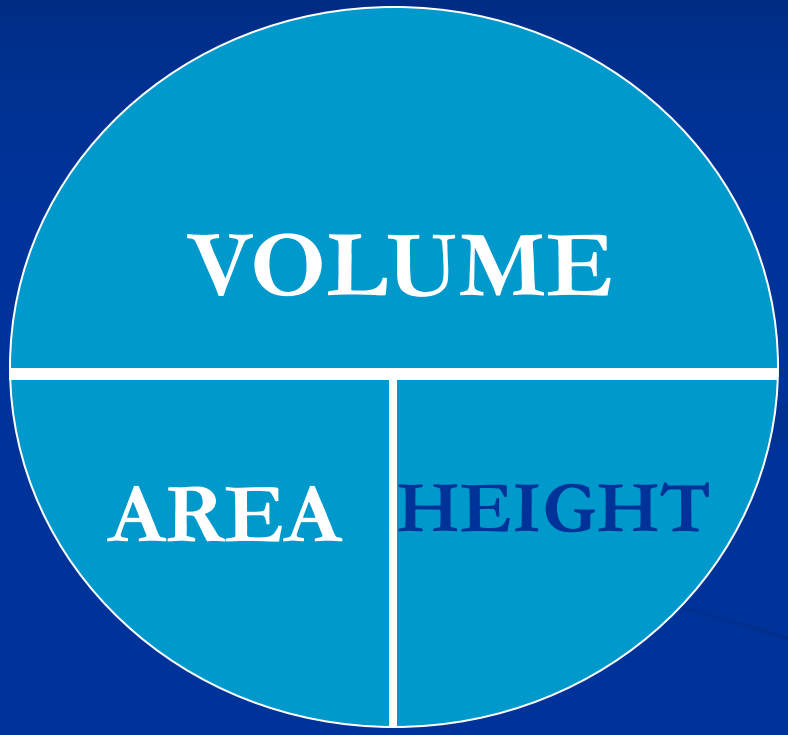
$$\text{mg/L} = \frac{\text{Pounds/Day}}{\textit{MGD} \times 8.34}$$

Step 2

$$\text{Flow Rate} = \frac{\textit{Volume}}{\text{Time}}$$

Step 1

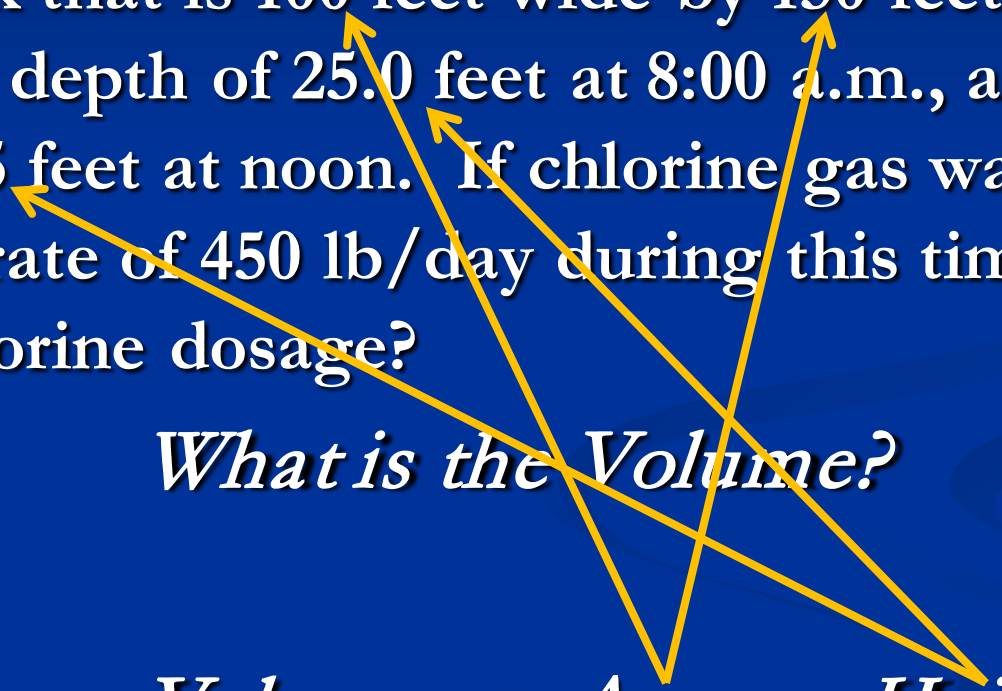
$$\text{Volume} = \text{Area} \times \text{Height}$$



MOST Course WM-3

Bonus Question: Volume

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?



Question: *What is the Volume?*

Formula: *Volume = Area x Height*

Bonus Question: Volume

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?

$$\text{Volume} = (100\ \text{ft} \times 150\ \text{ft}) \times (25.0 - 6.5\text{ft})$$

$$= 277{,}500\ \text{ft}^3$$

$$= \frac{277{,}500\ \text{ft}^3}{1} \times \frac{7.48\ \text{gal}}{1\ \text{ft}^3}$$

$$= 2{,}075{,}700\ \text{gal},\ \textit{or 2.076 Mgal}$$

Bonus Question

Step 3

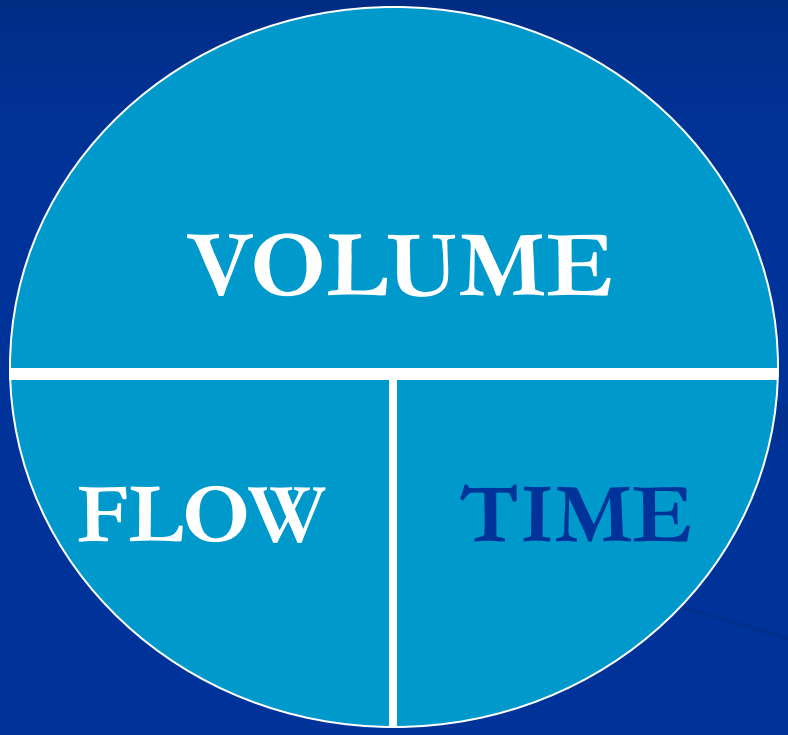
$$\text{mg/L} = \frac{\text{Pounds/Day}}{\textit{MGD} \times 8.34}$$

Step 2

$$\text{Flow Rate} = \frac{\textit{Volume}}{\text{Time}}$$

Step 1

$$\text{Volume} = \text{Area} \times \text{Height}$$



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Bonus Question: Flow Rate

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?

Question: *What is the Flow Rate?*

Formula: $\text{Flow} = \frac{\textit{Volume}}{\text{Time}}$

Bonus Question: Flow Rate

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?

$$\text{Flow Rate} = \frac{2.076\ \text{Mgal}}{4\ \cancel{\text{hours}}} \quad \frac{24\ \cancel{\text{hours}}}{1\ \text{day}}$$

$$= \textit{12.45 MGD}$$

Bonus Question

Step 3

$$\text{mg/L} = \frac{\text{Pounds/Day}}{\textit{MGD} \times 8.34}$$

Step 2

$$\text{Flow Rate} = \frac{\textit{Volume}}{\text{Time}}$$

Step 1

$$\text{Volume} = \text{Area} \times \text{Height}$$

Bonus Question: Dosage

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?

Question: *What is the Dosage Rate?*

Formula: $\text{mg/L} = \dfrac{\text{Pounds/Day}}{\textit{MGD} \times 8.34}$

Bonus Question: Dosage

A storage tank that is 100 feet wide by 150 feet long has a water depth of 25.0 feet at 8:00 a.m., and a depth of 6.5 feet at noon. If chlorine gas was fed at a constant rate of 450 lb/day during this time, what was the chlorine dosage?

$$mg/L = \frac{\text{Pounds/Day}}{\text{MGD} \times 8.34}$$

$$= \frac{450}{12.45 \times 8.34}$$

$$= 4.33\ mg/L$$