Water and Wastewater Chemical Feed Applications and Process Control

SDS

AWT

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Specific Gravity

FeCl3

Mg/L

VICl

Certificate of Analysis

Maryland Center for Environmental Training

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Part 2 Math Review

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Math Review

Formulas we will cover:

Math Review

- Area and Volume
- Flows (converting)
- Pounds Formula
- Chlorine Dosage

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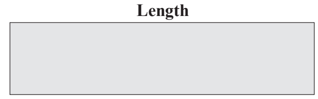
Math Review



- AREA of a **Square or Rectangle** tank
  - Length x Width = **Square feet**

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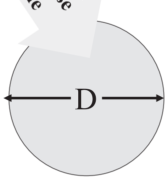
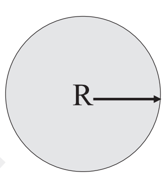
Math Review

I like to use this one



$0.785 \times D^2$

Remember this stuff



$3.14 \times R^2$

Area (Circle) 2 Ways

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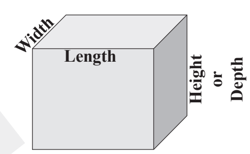
Math Review

Remember this stuff



- VOLUME **Square or Rectangular** tank
  - Length x Width x Height = **Cubic feet**
    - How do you convert Cubic feet to Gallons?

Cubic feet x 7.48

Remember 7.48 gallons per Cubic Foot

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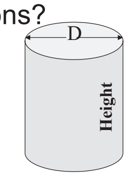
Math Review

using **Diameter**

- VOLUME of a Circular tank
  - **0.785 x D^2** x **H** = **Cubic feet**
    - Now convert to Gallons?

Cubic feet x 7.48



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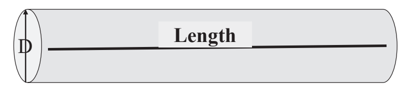
Remember this stuff

Math Review

using **Diameter**

- VOLUME of a Pipe Segment
  - **0.785 x D^2 x = Cubic feet**
    - Now convert to Gallons?

Cubic feet x 7.48



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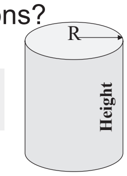
Remember this stuff

Math Review

using **Radius**

- VOLUME of a Circular tank
  - **3.14 x R^2** x **H** = **Cubic feet**
    - Now convert to Gallons?

Cubic feet x 7.48



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Math Review

CONVERTING FLOWS

- gpd
- gpm
- MGD

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Math Review

Convert 300,000 gpd

300,000 gpd / 1,000,000 = MGD

300,000 gpd / 1440 minutes/day = gpm

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Math Review

Convert 300 gpm

300 gpm x 1440 = gpd

300 gpm / 694 gpm/MGD = MGD

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Math Review

Convert 2 MGD

2 MGD x 1,000,000 = gpd

2 MGD x 694 gpm/MGD = gpm

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Math Review

POUNDS FORMULA

- Pounds/day (ppd)
- ppd = mg/L x 8.34 x MGD

MGD for flow rates

or

Pounds = mg/L x 8.34 x MG

MG for tankage and pipes

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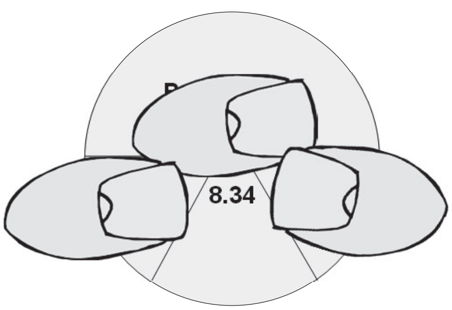
Math Review

- POUNDS FORMULA



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Math Review

CALCULATE ppd

If

mg/L = 10

MGD = 1

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Math Review

ppd = **10 mg/L x 8.34 x 1 MGD =**

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Math Review

CALCULATE mg/L

If

ppd = 83.4

MGD = 1

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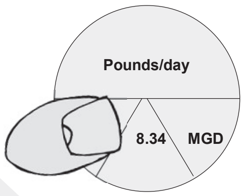
Math Review

mg/L = $\frac{83.4 \text{ ppd}}{8.34 \times 1 \text{ MGD}}$ = mg/L



Remember this stuff

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Math Review

CALCULATE MGD

If

ppd = 83.4

mg/L = 10

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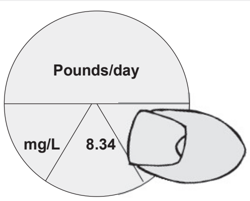
Math Review

MGD = $\frac{83.4 \text{ ppd}}{10 \text{ mg/L} \times 8.34}$ = MGD



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Math Review

CHLORINE DOSAGE

- **DOSAGE:** **TOTAL amount delivered**
- **demand:** **what's in the water that consumes the chlorine**
- **residual:** **what's left over**

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Math Review

DOSAGE

demand

residual

Remember small boxes = Big Box

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Math Review

CALCULATE CHLORINE DOSAGE

If

demand = 1.0 mg/L

residual = 0.5 mg/L

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Math Review

Write the down the Demand and Residual

DOSAGE

DOSAGE =________

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Math Review

CALCULATE CHLORINE demand

If

DOSAGE = 1.5 mg/L

residual = 0.5 mg/L

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Math Review

Write the down the DOSE and Residual

demand

demand =

Remember this stuff

Post Test

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Math Review

CALCULATE CHLORINE residual

If

DOSAGE = 2.5 mg/L

demand = 0.5 mg/L

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Math Review

Write the down the DOSE and Demand

residual

residual =

Remember this stuff

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Calculate Chemical Dosages

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Calculate Chemical Dosages

Formulas we will cover:

- Chemical Feed
  - Dry Products 100% available
  - Dry Products < 100% available
  - Liquids calculating ppg of available compound or element

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Calculate Chemical Dosages

DRY PRODUCTS
100% Available by weight

If a product is 98 or 99% available OK to assume 100%

- **Example:**
  CHLORINE GAS

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Calculate Chemical Dosages

DRY PRODUCTS
100% Available by weight

- **Assume:**
  10 mg/L Dosage
  flow of 1 MGD

10 mg/L x 8.34 x 1 MGD =

Pounds Required = pounds added when product is 100% available

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Calculate Chemical Dosages

DRY PRODUCTS <u>Less Than</u>
100% available by weight

- **CALCIUM HYPOCHLORITE (65%)**
  65% available chlorine (Cl_2)

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Calculate Chemical Dosages

CALCIUM HYPOCHLORITE (65%)

- **Step 1:**
  - **Calculate based on 100% Cl_2**

10 mg/L x 8.34 x 1 MGD = 83.4 ppd of Cl2

83.4 pounds of Cl2 required

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Calculate Chemical Dosages

CALCIUM HYPOCHLORITE (65%)

- **Step 2**
  - **DIVIDE ppd of Cl2 by % (in decimal)**

<u>83.4 ppd Cl2</u> = ppd

128.3 ppd of calcium hypochlorite 65% is necessary to provide 83.4 ppd of Cl_2

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Calculate Chemical Dosages

LIQUID PRODUCTS

- **Best way to set up dosages for liquid products.**
  - **Is to first calculate ppg of what you are dosing**

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Calculate Chemical Dosages

LIQUID PRODUCTS

- **What is Specific Gravity?**
  - **Ratio of the density of a Liquid to Water (or a gas to air)**
  - **Water has a Specific Gravity of 1.0**
  - **Remember Water Weighs ppg**

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Calculate Chemical Dosages

LIQUID PRODUCTS

- **Liquid (X) has a Specific Gravity of 1.2**
- **Liquid (X) Weighs**

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Calculate Chemical Dosages

Pounds per Gallon (ppg) Example:

12.5% Sodium Hypochlorite has a sg of 1.2

So, 12.5% Sodium Hypochlorite Weighs ppg

12.5% Available Chlorine

ppg as Cl2

Remember this stuff

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Calculate Chemical Dosages

LIQUID PRODUCTS

1) **Calculate the pounds per day (ppd) required**
   - **Examples:**
     - **100 ppd of chlorine**
     - **100 ppd of Alum**
     - **100 ppd of Fe**

OK now let's start from the beginning?

2.4 mg/L Fe (dose) x 8.34 x 5 MGD = 100 ppd

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Calculate Chemical Dosages

LIQUID PRODUCTS

2) **calculate pounds per gallon (ppg) of what you are dosing (ppg FeCl3)**
   - **A) total ppg (8.34 x sg of the liquid)**
   - **B) % by weight of what you are dosing**
   - **C) ppg of what you are dosing**

39% FeCl3 has a specific gravity (sg) of 1.26
8.34 ppg of water x 1.26 = 10.5 ppg
10.5 ppg of product x 0.39 (39%) =
4.10 ppg of FeCl3

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Calculate Chemical Dosages

- So now we know the pounds per gallon (ppg) of FeCl3 in 39% liquid Ferric Chloride.
- Sometimes that will be what you will need to calculate your dosage
- Other times you may need to calculate pounds per gallon (ppg) of Iron (Fe)

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Calculate % of Fe in FeCl3

3) Calculate % of Iron in Ferric Chloride

– If the Atomic Weight of Fe is 56 and the Atomic Weight of Cl is 35 Calculate the percent of Iron in FeCl3

Find % of Fe in FeCl3

Let's do the math

Fe Cl3

56 + **(35 x 3)** = **161 Total Atomic Weight**

56 Fe / 161 Total =

% Fe

Post Test

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Calculate Chemical Dosages

LIQUID PRODUCTS

4) calculate pounds per gallon (ppg) of what you are dosing (ppg Fe)

- **A) total ppg (8.34 x sg of the liquid)**
- **B) % by weight of what you are dosing**
- **C) ppg of what you are dosing**

10.5 ppg 39% FeCl3
x 0.39 (39% FeCl3)
x <u>0.348</u> % Fe in FeCl3
1.43 ppg Fe

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Calculate Chemical Dosages

LIQUID PRODUCTS

5) Divide ppd required by ppg available

100 ppd Fe required / 1.43 ppg Fe = 69.9 gpd of 39% FeCl3 (required)

6) Set Chemical Feed Pump for gpd or gph rate

Set Chemical Feed Pump for 70 gpd or 2.9 gph

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Calculate Chemical Dosages

LIQUID PRODUCTS

Let's practice a little more:

- Product X is 100% available by weight
- Product X has a specific gravity of 1.37

Great
Next step is to calculate ppd required

OK Now Calculate Pounds per gallon (ppg) of Product

ppg of product = 11.4

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Calculate Chemical Dosages

LIQUID PRODUCTS

Product X is 100% available by weight

- Recommended dosage is 6 mg/L of product
- Flow is 2 MGD

OK Now Calculate Pounds Per Day (ppd) required

ppd = 2 MGD x 8.34 x 6 mg/L

OK Great Now what do we do?

ppd of product required = 100

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Calculate Chemical Dosages
LIQUID PRODUCTS

Product X is 100% available by weight

- We calculated 100 ppd of product is required
- Product weighs 11.4 ppg

OK tell me the gpd feed rate?

gpd feed rate = 100 ppd / 11.4 ppg

Great now set the chemical feed pump to 9 gpd.

gpd feed rate = 8.77 say 9 gpd feed rate

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Calculate Chemical Dosages
LIQUID PRODUCTS

- **Hydrogen Peroxide**
- Product is 50% H_2O_2 (Hydrogen Peroxide) by weight
- Product weighs 10 ppg
- How many ppg of pure H_2O_2?

5

Great now let's figure out how many ppd of H_2O_2 are require?

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Calculate Chemical Dosages

50% Hydrogen Peroxide

- H_2O_2 Dosage (pure) for Odor Control is 10 mg/L
- Flow is 5 mgd

OK now let's calculate ppd of H_2O_2 required?

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Calculate Chemical Dosages

50% Hydrogen Peroxide

- Calculate H_2O_2 (pure) Dosage
  10 mg/L x 8.34 x 5 mgd = ____ **ppd**
- Calculate gpd of 50% H_2O_2
  417 ppd H_2O_2 / 5 ppg
  = ____ **gpd** of 50% H_2O_2

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Typical Compound Question
Convert Flow then use Pounds Formula

What would be the expected chlorine residual of a water under the following condition?

- Flow rate is **2,000 gpm** (continuous)
- Chlorine demand of the water is **1.9 mg/l**
- The amount of chlorine fed is **100 pounds per day** of chlorine

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Typical Compound Question
Convert Flow then use Pounds Formula

Step No. 1 Convert 2,000 gpm to flow in MGD.
2,000 gpm / ____ gpm/MGD = ____ MGD

Step No. 2 Use Pounds Formula for mg/L Dose
100 ppd / (8.34 x ____ MGD) = ____ mg/L

Step No. 3 Calculate Chlorine Residual
____ mg/L Dose – 1.9 Demand = ____ **mg/L Residual**

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