## SELECTED MATH PROBLEMS FOR SOLIDS HANDLING MATH

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## Math Problem Solving Strategy

- 1. Read the question carefully and underline what they are asking you to find.
- 2. Write down the formula you need to solve the problem. Look in the front of the test booklet if necessary.
- 3. Fill in everything you know. Sometimes filling in what you know might require you to find something else first like area or volume.
- 4. Check your units! Make sure they are correct for the formula and agree with each other.
- 5. Convert units where needed.
- 6. Put the new units into the formula.
- 7. Solve.
- 8. Check the units of your answer. Are they what the question asked for?
- 9. Convert units if necessary.



## THE RULES FOR BASIC ALGEBRA

- 1. For Unit Conversions
  - a. Only tops and bottoms can cancel
  - b. Everything on the top gets multiplied
  - c. Everything on the bottom gets divided
- 2. You can rearrange any equation by following these simple rules:
  - a. Do anything you want.
  - b. Do the opposite.
  - c. Do it to both sides.
- 3. Simplify any equation correctly by following the Order of Operations. Whenever you CAN do things in this order, you MUST do them in this order.
  - a. Parenthesis, Powers or Exponents (x2), Multiply, Divide, Add, and Subtract
  - b. PMDAS or PEMDAS
  - c. Polly Makes Donuts After School
  - d. Please Excuse My Dear Aunt Sally

## SOLIDS HANDLING MATH

- 1. The anaerobic digester must be maintained at 95 °F plus or minus 1 degree per day. What is this in degrees Centigrade?
- 2. MLSS is pumped to an anaerobic digester. The MLSS is 3,000 mg/L and contains 80% volatile solids. The digester contains 1.82% total solids. Biosolids removed from the digester are only 67% volatile. What was the percent volatile solids reduction through the digester?
- 3. Backwards much harder! A digester is being fed with 78% volatile solids. The plant has historically had difficulty meeting the minimum 38% volatile solids reduction required by the 503 Regulations prior to land application. How low does the percent of volatile solids need to be in the digester in order to meet the minimum reduction rate?
- 4. A digester holds 0.45 MG. It is fed a mixture of primary and secondary sludge that is 5% total solids and the solids are 82% volatile. Find the loading rate to the digester in pounds of volatile solids per cubic foot per day when the feed rate is 2000 gpd.
- 5. Find the solids detention time for an aerobic digester that is 100 feet long by 40 feet wide by 12 feet deep. The digester is full and the solids concentration in the digester is 2% total solids. The digester is decanted daily at a rate of 2,000 gallons per day. The decant liquid contains 400 mg/L of total suspended solids on average. Solids are removed from the digester for ultimate disposal at a rate of 4000 gallons per day. WAS is added to the



- digester at a rate of 7500 gallons per day and contain 6,200 mg/L of total suspended solids.
- 6. A WWTP produces 240 dry tons of biosolids per year. The biosolids are land applied to a quarter section (160 acres). Lab results indicate that the concentration of Cadmium in the biosolids is 22 mg/kg. What is the annual cadmium loading rate to the site? Express your answer as pounds of Cadmium per acre.
- 7. Calculate the volatile solids loading rate in pounds per day per cubic foot to a conical bottomed, cylindrical digester that receives 13,000 gpd of sludge that is 5% solids. Assume the solids are 75% volatile. The digester is 40 feet in diameter and has a side water depth of 25 feet. The cone is an additional 10 feet deep at its deepest point.
- 8. A belt filter press receives a feed sludge at 3% total solids and produces a cake that is 21% total solids. If the influent flow rate to the press is 50 gpm, how many cubic yards of finished cake will be produced if the press runs for 8 hours?
- 9. A belt filter press receives 8,250 gallons of WAS each day. The WAS concentration is 12,000 mg/L. If the press captures 98% of the incoming solids, how many pounds of solids will end up in the filtrate?
- 10. For the filter press in problem #9, if the average feed rate is 900 pounds per hour. How many hours will the press need to operate?

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gaz nagyanyan di Malakana kanandahan dadi ini mana	1. °C = <u>F-32</u>
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	2. PERCENT VOLATHE SOLIDE = (In -Out) REDUCTION = (In Yout) 100
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4. Loading Rate = 165 VS two pieces cubicft to find. 5% 10000 "8/L = 50000 "8/L 2000 gal 1MG = 0.002 MG 165 V5 - [M8/L Y mg Y 8.34 Y 9. Volatile) lbs VS = (50000 MB/LY 0.002 MG X 8.34 X 0.82) lbs VS = 683.88 we have the first piece 0.45 mg 1000 000 gal 1 cf = 60160.42 cf Pluz + Chiq Loading Rate = 165 VS = <u>683.88</u> b 60160.42 cf = 0.01136 lb/cf TYPICAL WOULD BE 0.1-0.3 of

-PAGE 3-

5. SDT = SOLIDS IN DIGESTER (SOLIDS IN - SOLIDS OUT)/2 A. Find volume of digister and los inside it. V= LXWXH V = (100 F+ Y 40 F+ X 12 F+) V= 48000 cf 48000 cf 7.48 3al 1 NG 0.35964 MG 1/2 10.000 mg/L 20,000 mg/L | bs in digister = [ m8k \ MGD \ 8.34) = [ 20,000 m8k \ 6.35904 mg \ 8.34) = *59,88*8 lbs was being [MS/LX MGDX8.34) lbs WAS = (6200 M8/LX 0.0075 MGOX 8.34) 165 WAS = 387.81 165 LEAVING = (MSILX MGD X8.34) 165 LEAVING = (20,000 ms/L X 0.004 mgd X 8.34) 165 LEAVING = 667.2 some concentration leaving as inside the digister. -PAGE 4I am going to ignore solids in the decant. Very small compared to every thing else. SDT = 16 in digester (incoming - outgoing)/2 5DT = 59888 | bs (387.81 - 667.2)/1SDT = 59888 (-279.39)/1 SDT = 59888 139.69 SDT = 428 days A VERY LONG TIME. 20-40 DAYS 15 TYPICAL - PAGE 5 -

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7. Let's find the volume of the diagester first. V = 0.785 d2h V = (0.785 X 40 F+ X 40 F+ X 25 F+) V = 31400 cf \* just the cylinder. Now find volume of the cone. V = 0.785d2h V = (0.785 X40 ft X40 ft X10 ft) 31400 cf cylinder + 4186.7 cf' cone 35586.7 cf total volume Now find pounds of volatile solids. 5% 10000m3/ = 50,000 m8k 13,0005al 1M6 lbs volatiles = ( MS/LXMGD X 8.34 X 9. volatile) 165 Volatiles = (50,000 MLX 0.4B mg 18.34 10.75) 165 volatiles = 4065.75 LOADING = 165 volatiles cubic ft 4065.75 lbs 35586.7cf = 0.11 lbs vs/cf A- PERFECT! TYPICAL IS 0.1-0.3

	8. START BY FINDING TOTAL GALLONS SENT
	TO THE PRESS
	8 lors 60 min 50 zal = 24,000 gallons Lbc Imia
	C, V, = C <sub>2</sub> V <sub>2</sub> * THIS IS CALLED THE  NORMALITY EQUATION  START END IN THE TEST BOOK  (2:1) Y24 000 - 01) = (21:1) Y V V
	(31/124,000 gal) = (211/11/2) 12,000 - (211/11/2)
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	gallons.
	3428.6 gallons   1 cf   1 cy   = 16.98 cubic   7.48gal 27 cf   yards
	So, if my truck holds  5 cubic unds. I will need to
ACTORNATION	5 cubic yards, I will need to
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