Sidney's Big Book of Water and Wastewater Math

Indigo Water Group

Unit Conversions to Know by Heart

1 inch = 2.54 centimeters
1 meter = 3.28 feet
1 mile = 5280 feet

1 acre = 43,560 ft^2
1 m^2 = 10.76 ft^2

1 gallon = 3.785 liters
1 ft^3 = 7.48 gallons
1 m^3 = 35.31 ft^3

1 ft water = 0.433 psi

1 gallon = 8.34 lbs when specific gravity is 1.0
1 kg = 2.2 lbs

1% = 10,000 mg/L
1 mg/L = 1 ppm
1 μg/L = 1 ppb

1 day = 1440 minutes
1 hp = 0.746 kW

1 gram = 15.43 grains
1 grain per gallon = 17.1 mg/L

Water Formulas

pounds per day = (concentration in mg/L)*(flow rate in mgd)*(8.34)

chlorine dose = demand + residual

velocity = $\frac{\text{flow}}{\text{area}}$ $\quad V = \frac{Q}{A}$

flow rate = $\frac{\text{volume}}{\text{time}}$ $\quad Q = \frac{V}{t}$

overflow rate = $\frac{\text{flow rate}}{\text{area}}$

weir loading rate = $\frac{\text{flow rate}}{\text{feet of weir}}$

(concentration 1)*(volume 1) = (concentration 2)*(volume 2) $\quad C_1V_1 = C_2V_2$

(conc. 1)*(volume 1) + (conc. 2)*(volume 2) = (conc. 3)*(volume 3)

$$C_1V_1 + C_2V_2 = C_3V_3$$

horsepower = $\frac{\text{(flow in gpm)*(lift in feet)}}{3960}$

Velocity

SO

VELOCITY

1. What is the approximate volume of flow (MGD) treated in a 7' wide, 4'deep grit chamber, if a floating stick moves 24' in 30 seconds.
  a) 13.65 MGD
  b) 16.7 MGD
  c) 15.42 MGD
  d) 14.5 MGD

2. A 42" diameter pipe is flowing at a rate of 6.5 ft/sec. What is the flow rate in cu ft/sec?
  a) 17.86
  b) 35.71
  c) 62.50
  d) 521.25

3. Given the following data, calculate the average velocity in the channel. 2.5 ft wide channel, flow depth is 1.4 ft, flow rate is 7.2 MGD
  a) 1.2 ft.sec
  b) 3.2 ft/sec
  c) 11.2 ft/sec
  d) 32.2 ft/sec

4. A plastic float is dropped into a wastewater channel and is found to travel 10 feet in 4.2 seconds. The channel is 2.4 feet wide and is flowing 1.8 feet deep. Calculate the flow rate of this wastewater in cubic feet per second.
  a) 1.0 ft3/sec
  b) 2.3 ft3/sec
  c) 4.2 ft3/sec
  d) 5.7 ft3/sec
  e) 10.3 ft3/sec

5. What is the average flow velocity in ft/sec in a 12-in diameter force main carrying a daily flow of 2.5 mgd?
  a) 4.9 ft/sec
  b) 5.3 ft/s
  c) 18.0 ft/sec
  d) 18.85 ft/sec

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6. The flow velocity in a 6-in. diameter pipe is twice that in a 12-in diameter pipe if both are carrying 50 gal/min of wastewater.
  a) True
  b) False

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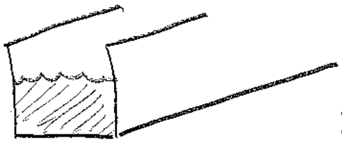
JOB VELOCITY JOB NO. 51
SHEET NO. OF
CALCULATED BY DATE
CHECKED BY DATE
SUBJECT

VELOCITY IS FLOW PASSING THROUGH OR PAST AN AREA. IN OTHER WORDS, HOW FAST IS THE WATER MOVING PAST A PARTICULAR POINT?



THE AREA IS ALWAYS THE CROSS SECTIONAL AREA OF THE PIPE OR CHANNEL.

1. $v = \frac{Q}{A}$

AREA = WIDTH × DEPTH
AREA = (7 FT)(4 FT)
AREA = $28\ FT^2$

$\frac{24\ FT}{30\ SEC} = \frac{Q}{28\ FT^2}$

$0.8\ \frac{FT}{SEC} = \frac{Q}{28\ FT^2}$

$22.4\ \frac{FT^3}{SEC} = Q$

$\frac{22.4\ FT^3}{SEC} \bigg| \frac{60\ SEC}{1\ MIN} \bigg| \frac{1440\ MIN}{1\ DAY} \bigg| \frac{7.48\ gal}{1\ FT^3} \bigg| \frac{1\ MG}{1000000\ gal} = 14.5\ MGD$

2. AREA = πr^2 42" = 3.5 ft
AREA = $(3.14)(1.75\ FT)^2$
AREA = $9.62\ FT^2$

$v = \frac{Q}{A}$

$6.5\ \frac{FT}{SEC} = \frac{Q}{9.62\ FT^2}$

62.5 CFS = Q

JOB VELOCITY JOB NO. 52

SHEET NO. ____ OF ____

CALCULATED BY ____ DATE ____

CHECKED BY ____ DATE ____

SUBJECT ____

3. $\frac{7.2\ mg}{day} \bigg| \frac{1\ day}{1440\ min} \bigg| \frac{1\ min}{60\ sec} \bigg| \frac{1000000\ gal}{1\ mg} \bigg| \frac{1\ cf}{7.48\ gal} \bigg| = 11.14\ \frac{CF}{sec}$

$v = \frac{Q}{A}$

$v = \frac{11.14\ CFS}{3.5\ FT^2}$

$v = 3.18\ \frac{FT}{SEC}$

AREA = (WIDTH)(DEPTH)

AREA = (2.5 FT)(1.4 FT)

AREA = $3.5\ FT^2$

4. AREA = (WIDTH)(DEPTH)

AREA = (2.4 FT)(1.8 FT)

AREA = $4.32\ FT^2$

$v = \frac{Q}{A}$

$\frac{10\ FT}{4.2\ SEC} = \frac{Q}{4.32\ FT^2}$

$2.38\ \frac{FT}{SEC} = \frac{Q}{4.32\ FT^2}$

$10.3\ \frac{FT^3}{sec} = Q$

5. AREA = πr^2 12" = 1 FT, SO RADIUS = 0.5 FT

AREA = $(3.14)(0.5)^2$

AREA = $0.785\ FT^2$

$\frac{2.5\ mg}{day} \bigg| \frac{1\ day}{1440\ min} \bigg| \frac{1\ min}{60\ sec} \bigg| \frac{1,000,000\ gal}{1\ mg} \bigg| \frac{1\ cf}{7.48\ gal} \bigg| = 3.87\ \frac{CF}{sec}$

$v = \frac{Q}{A}$

$v = \frac{3.87\ CFS}{0.785\ FT^2}$

$v = 4.9\ FT/sec$

JOB VELOCITY JOB NO. 53
SHEET NO. OF
CALCULATED BY DATE
CHECKED BY DATE
SUBJECT

6. FALSE

$AREA = \pi r^2$
$AREA = (3.14)(0.25 FT)^2$
$AREA = 0.196 FT^2$

$AREA = \pi r^2$
$AREA = (3.14)(0.5 FT)^2$
$AREA = 0.785 FT^2$

AREA IS 4X BIGGER FOR A 12" VS 6" PIPE, SO VELOCITY IS $\frac{1}{4}$ VELOCITY AT THE SAME FLOW RATE

Velocity

1. What should the flow meter read in gallons per minute, if a 4 inch diameter main is to be flushed at 4.6 feet per second?

Answer: gpm

2. The velocity through a channel is 4.18 fps. If the channel is 4 feet wide by 2 feet deep by 10 feet long, what is the flow in cubic feet per second?

Answer: cfs

3. A 6 inch diameter pipe conveys 380 gpm from the clear well into the distribution system. What is the velocity of water in the pipe?

Answer: fps

4. Distribution main flushing is done to maintain a minimum velocity in the pipe of 5.68 fps. A particular main discharges 4.46 cfs. If the main is 450 feet long, what is the diameter?

Answer: inches

5. A stick dropped into a channel travels 15 feet in 8 seconds. What is the velocity of the water through the channel?

Answer: fps

6. The velocity through a channel is 3.96 fps. If the channel is 3 feet wide by 1.5 feet deep by 40 feet long, what is the flow in cubic feet per second?

Answer: cfs

7. A stick dropped into a channel travels 32 feet in 6 seconds. What is the velocity of the water through the channel?

Answer: fps

JOB ______ JOB NO. ______

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE ______

CHECKED BY ______ DATE ______

SUBJECT ______

1. $v = \frac{Q}{A}$

$4\text{ inches} \left| \frac{1\text{ ft}}{12\text{ inches}} \right| = 0.33\text{ ft}$ diameter

0.167 ft radius

$4.6\text{ fps} = \frac{Q}{0.0876\text{ sf}}$

$0.403\text{ cfs} = Q$

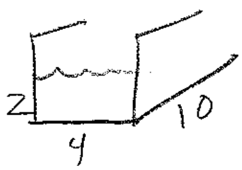
$\text{Area} = \pi r^2$

$\text{Area} = (3.1416)(0.167\text{ ft})^2$

$\text{Area} = 0.0876\text{ sf}$

$0.403 \frac{\text{cf}}{\text{s}} \left| \frac{7.48\text{ gal}}{1\text{ cf}} \right| \frac{60\text{ sec}}{1\text{ min}} \right| = 180.9\text{ gpm}$

2.



$\text{Area} = 2\text{ ft} \times 4\text{ ft}$

$\text{Area} = 8\text{ ft}^2$

$v = \frac{Q}{A}$

$4.18\text{ fps} = \frac{Q}{8\text{ ft}^2}$

$33.4\text{ cfs} = Q$

3. $380 \frac{\text{gal}}{\text{min}} \left| \frac{1\text{ min}}{60\text{ sec}} \right| \frac{1\text{ cf}}{7.48\text{ gal}} \right| = 0.847\text{ cfs}$

$6\text{ inches} = 0.5\text{ ft}$

$\text{Area} = \pi r^2$

$\text{Area} = (\pi)(0.25\text{ ft})^2$

$\text{Area} = 0.196\text{ ft}^2$

$v = \frac{Q}{A}$

$v = \frac{0.847\text{ cfs}}{0.196\text{ sf}}$

$v = 4.32\text{ fps}$

JOB ______ JOB NO. ______

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE ______

CHECKED BY ______ DATE ______

SUBJECT ______

4. $v = \frac{Q}{A}$

$5.68\text{ fps} = \frac{4.46\text{ cfs}}{A}$

$5.68A = 4.46$

$A = 0.785\text{ sf}$

$A = \pi r^2$

$0.785\text{ sf} = \pi r^2$

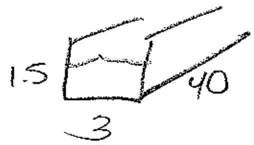
$0.25 = r^2$

$0.50\text{ ft} = r$

diameter = 1 foot

5. $\frac{15\text{ feet}}{8\text{ seconds}} = 1.875\text{ fps}$

6. $v = \frac{Q}{A}$



$3.96\text{ fps} = \frac{Q}{(1.5 \times 3.0)}$

$17.82\text{ cfs} = Q$

7. $\frac{32\text{ feet}}{6\text{ seconds}} = 5.33\text{ fps}$

Flow Velocities in Pipes and Channels

49. A 42" diameter pipe is flowing at a rate of 6.5 ft/sec. What is the flow rate in cu ft/sec?
a) 17.86
b) 35.71
c) 62.53
d) 521.25

50. Given the following data, calculate the average velocity in the channel. 2.5 ft wide channel, flow depth is 1.4 ft, flow rate is 7.2 MGD
a) 1.2 ft.sec
b) 3.2 ft/sec
c) 11.2 ft/sec
d) 32.2 ft/sec

51. What is the approximate volume of flow (MGD) treated in a 7 ft wide, 4 ft deep chamber, if a floating stick moves 24 inches in 30 seconds.
a) 1.37 MGD
b) 1.21 MGD
c) 5.42 MGD
d) 4.52 MGD

52. What is the average flow velocity in ft/sec in a 12-in diameter force main carrying a daily flow of 2.5 mgd?
a) 4.9 ft/sec
b) 5.3 ft/s
c) 18.0 ft/sec
d) 18.85 ft/sec
Operations Forum January 1997

53. A plastic float is dropped into a water channel and is found to travel 10 feet in 4.2 seconds. The channel is 2.4 feet wide and is flowing 1.8 feet deep. Calculate the flow rate of this wastewater in cubic feet per second.
a) ft3/sec
a) 2.3 ft3/sec
b) 4.2 ft3/sec
c) 5.7 ft3/sec
d) 10.3 ft3/sec

FLOW VELOCITIES

Velocity is a measure of how fast a volume of water passes by a particular point. Mathematically, it is

$$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

49. The first step is to find the cross sectional area of the pipe in ft^2. The pipe diameter is in inches, so convert it to feet.

$$42 \text{ inches} \left| \frac{1 \text{ foot}}{12 \text{ inches}} \right| = 3.5 \text{ ft} \quad \therefore \text{radius} = 1.75 \text{ ft}$$

$\text{Area} = \pi r^2$

$\text{Area} = (3.14)(1.75 \text{ ft})^2$

$\text{Area} = 9.62 \text{ ft}^2$

$$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

$$6.5 \text{ ft/sec} = \frac{\text{Flow}}{9.62 \text{ ft}^2}$$

$(6.5)(9.62) = \text{Flow}$

$62.5 \text{ ft}^3/\text{sec} = \text{Flow}$

50. Convert flow rate from 7.2 mgd to ft³/sec

$$\frac{7.2\text{ MG}}{\text{day}} \cdot \frac{1000000\text{ gal}}{1\text{ MG}} \cdot \frac{1\text{ ft}^3}{7.48\text{ gallons}} \cdot \frac{1\text{ day}}{1440\text{ min}} \cdot \frac{1\text{ min}}{60\text{ sec}} = 11.14\text{ ft}^3/\text{sec}$$

$$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

$$\text{Velocity} = \frac{11.14\text{ ft}^3/\text{sec}}{(2.5\text{ ft})(1.4\text{ ft})}$$

$$\text{Velocity} = \frac{11.14\text{ ft}^3/\text{sec}}{3.5\text{ ft}^2}$$

$$\text{Velocity} = 3.18\text{ ft/sec}$$

51. $$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

$$\frac{2\text{ ft}}{30\text{ sec}} = \frac{\text{Flow}}{(7\text{ ft})(4\text{ ft})}$$

$$0.67 = \frac{\text{Flow}}{28}$$

$$1.87\ \frac{\text{ft}^3}{\text{sec}} = \text{Flow}$$

$$\frac{1.87\text{ ft}^3}{\text{sec}} \cdot \frac{7.48\text{ gallons}}{1\text{ ft}^3} \cdot \frac{1\text{ MG}}{1000000\text{ gal}} \cdot \frac{60\text{ sec}}{1\text{ min}} \cdot \frac{1440\text{ min}}{1\text{ day}} = 1.21\text{ MGD}$$

52. We need to convert both the flow and the area into units of feet.

$$\frac{12 \text{ inches}}{} \Big| \frac{1 \text{ ft}}{12 \text{ inches}} \Big| = 1 \text{ ft diameter}$$

$\therefore$ radius = 0.5 ft

$$\frac{2.5 \text{ MG}}{\text{day}} \Big| \frac{1000000 \text{ gal}}{1 \text{ MG}} \Big| \frac{1 \text{ ft}^3}{7.48 \text{ gal}} \Big| \frac{1 \text{ day}}{1440 \text{ min}} \Big| \frac{1 \text{ min}}{60 \text{ sec}} \Big| = 3.87 \frac{\text{ft}^3}{\text{sec}}$$

$$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

$$\text{Velocity} = \frac{3.87 \text{ ft}^3/\text{sec}}{\pi r^2}$$

$$\text{Velocity} = \frac{3.87 \text{ ft}^3/\text{sec}}{(3.14)(0.5 \text{ ft})^2}$$

$$\text{Velocity} = \frac{3.87 \text{ ft}^3/\text{sec}}{0.785 \text{ ft}^2}$$

$$\text{Velocity} = 4.9 \text{ ft/sec}$$

53. $$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

$$\frac{10 \text{ ft}}{4.2 \text{ sec}} = \frac{\text{Flow}}{(2.4 \text{ ft})(1.8 \text{ ft})}$$

$$2.38 \text{ ft/sec} = \frac{\text{Flow}}{4.32 \text{ ft}^2}$$

$$10.3 \text{ ft}^3/\text{sec} = \text{Flow}$$

Weir Loading Rates and Surface Overflow Rate

Weir Loading Rates

40. Calculate the weir loading for a sedimentation tank that has an outlet weir 480 ft long and a flow of 5MGD.
a) 9,220 gpd/ft
b) 9,600 gpd/ft
c) 9,920 gpd/ft
d) 10,420 gpd/ft

41. Find the wier loading rate in gpd/ft for a circular tank. The tank is 40 feet in diameter and the influent flow rate is 4 mgd.
a) 31847 gpd/ft
b) 3185 gpd/ft
c) 7960 gpd/ft
d) 15794 gpd/ft

Surface Overflow Rates

42. Find the surface overflow rate in gpd/ft2 for a circular tank. The tank is 40 feet in diameter and the influent flow rate is 4 mgd.
a) 3185 gpd/ft2
b) 796 gpd/ft2
c) 1325 gpd/ft2
d) 1760 gpd/ft2

43. A circular tank receives 12.5 mgd of flow and has a SOR of 100 gpm/ft. What is the diameter of the tank?
a) 27.6 ft
b) 10.5 ft
c) 75.0 ft
d) 14.7 ft

44. A water plant is equipped with six sedimentation basins that are operated in parallel. Each basin is 30 ft long by 25 ft wide. If the finished water demand is 30 mgd, how many basins need to be on-line to maintain a surface overflow rate of approximately 10 gpm/sft?
a) 2
b) 3
c) 4
d) 5
e) 6

WEIR LOADING RATES

The weir loading rate is simply the flow rate per linear foot of weir. The weir length can be one side of a tank or the perimeter of a tank.

40. WEIR LOADING = $\frac{Q}{\text{length}}$

WEIR LOADING = $\frac{5{,}000{,}000 \text{ gpd}}{480 \text{ ft}}$

WEIR LOADING = 10,417 gpd/ft

41. Perimeter = $2\pi r$

Perimeter = πd

$P = (3.14)(40 \text{ ft})$

$P = 125.6$ ft ← this is the weir length

WEIR LOADING = $\frac{Q}{\text{length}}$

WEIR LOADING = $\frac{4{,}000{,}000 \text{ gpd}}{125.6 \text{ ft}}$

WEIR LOADING = 31,847 gpd/ft

SURFACE OVERFLOW RATE

The Surface overflow rate or SOR is the flow rate per unit area of tank. In other words:

$$SOR = \frac{Q}{Area}$$

42. First, find the area of the tank.

$A = \pi r^2$
$A = (3.14)(20\ ft)^2$
$A = (3.14)(20\ ft)(20\ ft)$
$A = 1256\ ft^2$

$SOR = \frac{Q}{A}$

$SOR = \frac{4{,}000{,}000\ gpd}{1256\ ft^2}$

$SOR = 3185\ gpd/ft^2$

43. This is the same problem as #42, but going backwards.

$SOR = \frac{Q}{A}$

$100\ gpm/ft^2 = \frac{12500\,000\ gpd}{A}$

$100\,A = 12500\,000$

$A = 125000\ ft^2$

$Area = \pi r^2$
$125000\ ft^2 = (3.14)(r^2)$
$39808.92\ ft^2 = r^2$
$r = 200\ ft$

Uh – this isn't one of my choices! What went wrong?

looking at the equation, I can see that my units don't match. I need to convert gpd to gpm.

$$\frac{12.5 \text{ MG}}{\text{day}} \Big| \frac{1000000 \text{ gal}}{1 \text{ MG}} \Big| \frac{1 \text{ day}}{1440 \text{ min}} \Big| = 8680.56 \text{ gpm}$$

$$SOR = \frac{Q}{A}$$

$$100 \text{ gpm}/ft^2 = \frac{8680.56 \text{ gpm}}{A}$$

$$AREA = 86.81 \ ft^2$$

$$AREA = \pi r^2$$

$$86.81 \ ft^2 = (3.14)(r)^2$$

$$27.65 = r^2$$

$$r = 5.25 \quad \therefore \text{ diameter} = 10.5 \text{ ft}$$

44. Find the SOR if all of the flow were moving through 1 tank.

$$\frac{30 \text{ mg}}{\text{day}} \Big| \frac{1000000 \text{ gallons}}{1 \text{ mg}} \Big| \frac{1 \text{ day}}{1440 \text{ min}} \Big| = 20833 \text{ gpm}$$

$$SOR = \frac{Q}{A}$$

$$SOR = \frac{20833 \text{ gpm}}{(30 ft)(25 ft)}$$

$$SOR = \frac{20833 \text{ gpm}}{750 \ ft^2}$$

$$SOR = 27.8 \text{ gpm}/ft^2$$

∴ I need 3 tanks on line

Filter Loading and Backwash

Filter Loading and Backwash Rates

45. A sand filter with dimensions of 12 feet by 15 feet receives 0.75 mgd. What is the hydraulic loading rate in gpm/sft?

a) 2.9 gpm/sft
b) 29.0 gpm/sft
c) 4167 gpm/sft
d) 69.4 gpm/sft

46. At what rate in gpm must wash water be delivered to a mixed media filter to attain a backwash rate of 15 gpm/sq ft if the filter is 20' wide and 30' long.

a) 600
b) 2400
c) 3000
d) 9000

47. Your filter filters at a rate of 200 GPM. On your last filter run you filtered 728,000 gallons of water before backwashing. How many hours did this filter run?

a) 6.1 hours
b) 60.7 hours
c) 3,640 hours
d) 607 hours
e) 36.4 hours

48. The optimum hydraulic loading rate for a new type of filter is 30 gpm/sft. If the flow going to the filter is 1.85 mgd, what should the dimensions of the filter be? Round to the nearest whole foot.

a) 43 sft
b) 32 sft
c) 60 sft
d) 52 sft

FILTER LOADING & BACKWASH RATES

45. $HLR = \frac{Q}{A}$

The first step is to convert the flow rate into gpm.

$\frac{0.75\ MG}{day} \Big| \frac{1\,000\,000\ gallons}{1\ MG} \Big| \frac{1\ day}{1440\ min} \Big| = 520.8\ gpm$

$HLR = \frac{520.8\ gpm}{(12\ ft)(15\ ft)}$

$HLR = \frac{520.8\ gpm}{180\ ft^2}$

$HLR = 2.9\ gpm/ft^2$

46. Same formula, but we need to solve for a different variable.

$HLR = \frac{Q}{A}$

$\frac{15\ gpm}{ft^2} = \frac{Q}{(20\ ft)(30\ ft)}$

$15 = \frac{Q}{600\ ft^2}$

$9000\ gpm = Q$

47. This is really a unit conversion problem in disguise.

$$\frac{728{,}000 \text{ gallons}}{} \left| \frac{1 \text{ minute}}{200 \text{ gallons}} \right| \frac{1 \text{ hour}}{60 \text{ minutes}} \right| = 60.7 \text{ hours}$$

48. $$\frac{1.85 \text{ MG}}{\text{day}} \left| \frac{1000\,000 \text{ gallons}}{1 \text{ MG}} \right| \frac{1 \text{ day}}{1440 \text{ min}} \right| = 1284.7 \text{ gpm}$$

B $$HLR = \frac{Q}{A}$$

$$\frac{30 \text{ gpm}}{\text{sft}} = \frac{1284.7 \text{ gpm}}{A}$$

$$30A = 1284.7$$

$$A = 42.8 \text{ ft}^2$$

Fixed Film Processes

FIXED FILM PROCESSES

1. Calculate the lbs of BOD entering the trickling filter. Raw wastewater flow = 1.5 MGD, Raw wastewater BOD = 150 mg/l, 30% reduction in BOD through primary treatment.

a) 562 lb/day
b) 870 lb/day
c) 1314 lb/day
d) 1880 lb/day

2. A rotating biological contactor treats a flow of 2.2 MGD with a BOD of 110 mg/L. The surface area of the media is 550,000 sq ft. What is the organic loading in lb BOD/day/1000 sq ft

a) 2.7
b) 3.0
c) 3.5
d) 3.7

3. At what rate in gpm must wash water be delivered to a mixed media filter to attain a backwash rate of 15 gpm/sq ft if the filter is 20' wide and 30' long.

a) 600
b) 2400
c) 3000
d) 9000

4. The flow to a trickling filter is 2.5 mgd. The filter has a diameter of 100 ft and a media depth of 4 ft. The recirculation rate is 0.75:1. Calculate the hydraulic loading rate in gallons per day per square foot.

a) 438 gal/d/ft2
b) 557 gal/d/ft2
c) 785 gal/d/ft2
d) 995 gal/d/ft2

JOB Fixed Film JOB NO. 58

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE ______

CHECKED BY ______ DATE ______

SUBJECT ______

1. ppd = (mg/L)(Q, mgd)(8.34)
   ppd = (150 mg/L)(1.5 mgd)(8.34)
   ppd = 1876.5
   ↑ only 70% goes to TF

   (1876.5 ppd)(0.7) = 1314 ppd

2. ppd = (mg/L)(Q, mgd)(8.34)
   ppd = (110 mg/L)(2.2 mgd)(8.34)
   ppd = 2018

   $\frac{550{,}000 \text{ sft}}{1000} = 550$

   ORGANIC LOAD = $\frac{\text{ppd}}{1000 \text{ sft}}$
   = $\frac{2018 \text{ ppd}}{550}$
   = 3.7 ppd/1000 sft

3. AREA = (LENGTH)(WIDTH)
   AREA = (20 FT)(30 FT)
   AREA = 600 FT^2

   $600 \text{ FT}^2 \left| \frac{15 \text{ gpm}}{1 \text{ FT}^2} \right| = 9000 \text{ gpm}$

JOB FIXED FILM JOB NO. 59

SHEET NO. OF

CALCULATED BY DATE

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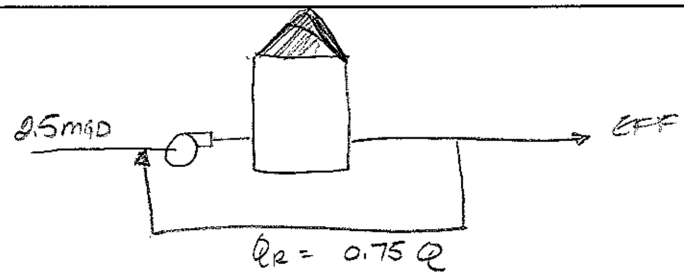
SUBJECT

4.



TOTAL FLOW TO FILTER = $Q_{INF} + Q_{RECYCLE}$

= 2.5 MGD + (2.5 MGD)(0.75)
= 2.5 MGD + 1.875 MGD
= 4.375 MGD

AREA = πr^2
AREA = (3.14)(50 FT)(50 FT)
AREA = 7850 FT^2

$$HLR = \frac{FLOW}{AREA}$$

$$HLR = \frac{4{,}375{,}000 \text{ gpd}}{7850 \text{ ft}^2}$$

HLR = 557 gpd/ft^2