


ASM320: Water and Waste Water Operations

Flow and Velocity Calculations



University of Idaho

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ASM320: Water and Waste Water Operations

Volumetric Flow Rate

- $Q = A V$
- flowrate is equal to area of flow times the velocity of flow
- Dimensions are $L^3/T = \text{Volume/Time}$
- Typical Units are Gallons/Day, Gallons/Min (gpm) Cubic Feet per second (cfs), etc.
- Top eq'n shown in units:
 $\text{ft}^3/\text{sec} = \text{ft}^2 \times \text{ft}/\text{sec}$

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Units note: CFS, cfs, gpm

- At the Univ., many science courses require SI units (e.g. L/sec, or mL/min)
- In US water plants, "Traditional" or "English" units are still used
- **$\text{ft}^3/\text{sec} = \text{cubic feet per second} = \text{cfs}$** is often used for flows in rivers, creeks, and large pipes
- **Gallons/min = gpm** is often used for smaller flowrates, such as well production, and flow through smaller pipe systems

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Memorize this conversion

- You will need to be able to convert frequently between ft³ and gallons
- As indicated on the previous slide, one cubic foot is a lot bigger than one gallon
- The conversion is:
1 ft³ = 7.48 gallons (**memorize this!**)
- Notice also that cfs has seconds, and gpm has minutes
1 min = 60 sec

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Example Problem – converting gpm to cfs

- If you drill a well for a domestic residence, you always hope for 5 gpm. What is 5 gpm when expressed as cfs?**

$$\frac{5 \text{ gal}}{\text{min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} \cdot \frac{1 \text{ ft}^3}{7.48 \text{ gal}} = .01 \frac{\text{ft}^3}{\text{sec}}$$

- Note that minutes cancel, and so do gallons.
- Note that the second 2 terms are "identities"; they are equal to 1 because the top and bottoms are equal in magnitude.
- So 5gpm, which is adequate well flow, is very small when compared to a river flow. River flowrates are usually 1000 cfs or more.

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Measuring Flowrate (volumetric)

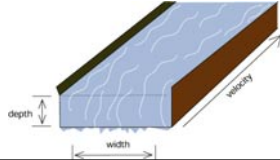
- How do you measure (volumetric) flowrate?
- With a bucket and a stopwatch!
For example, take a 5 gallon bucket, mark where it fills to 2 gallons, then measure how long it takes to fill up to the line. Assume you get 30 seconds.
Using the formula Q = volume/time, you find that Q = 2 gallons / (.5 min) = 4 gpm
- In a water plant, with meters

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What is the Area term in a Rectangular Channel

- In the $Q = A V$ equation, the cross-sectional area for a channel (or trough) is the wetted area
- Equation for flow through a rectangular channel:

$$Q = (Width) (Depth) (Velocity)$$

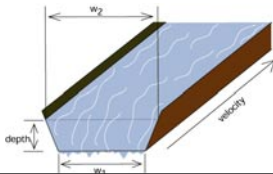


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...Trapezoidal Channel

- Equation for flow through a trapezoidal channel:

$$Q = \frac{w_1 + w_2}{2} (Depth) (Velocity)$$



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Pipe (Circular cross-section)

- Equation for flow through a pipe, where D is the pipe diameter

$$Q = \pi \frac{D^2}{4} (Velocity)$$

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Flow into or out of a Tank

- For this equation, the velocity is the "rise" or "fall" velocity

- For a rectangular tank:

$$Q = (\text{length})(\text{width})(\text{Rise or fall velocity})$$

- For a cylindrical tank,

$$Q = \pi \frac{D^2}{4} (\text{Rise or fall velocity})$$

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