The final concentration of biocide is 10 parts per million (ppm). Calculate the volume of biocide needed to achieve this concentration.

$$20,000gal\left(\frac{10}{10^6}\right) = 0.2gal$$

If the solution being added is only 45% biocide, the volume of the *solution* required is larger than the volume of the active chemical. It is inferred that the remaining 55% of the solution is inactive, probably water. Calculate the volume of the solution needed to provide $0.2gal$ of biocide.

$$\frac{0.2gal}{0.45} = 0.44gal$$

Answer B

47.51 The flow of $20°C$ water through a hose with an inside diameter of $25mm$ is at the lower boundary of the fully turbulent range. How long will it take to fill a $50,000L$ swimming pool?

A. $8\,hours$

B. $27\,hours$

C. $38\,hours$

D. $59\,hours$

Pipe flow is considered Fully Turbulent once the Reynolds Number is greater than 12,000. Since the flow is at the lower boundary of the turbulent range, find the velocity which corresponds to $Re = 12,000$. Use the Properties of Water table to obtain the kinematic viscosity at $20°C$.

$$Re > 12,000$$

$$Re = \frac{vD}{\nu}$$

$$v = \frac{Re \cdot \nu}{D} = \frac{(12,000)\left(0.000001003\frac{m^2}{s}\right)}{(0.025m)} = 0.481\frac{m}{s}$$

Calculate the volume flow rate based on velocity and area. Since the pool volume is in liters, and the answer choices are in hours, convert to $\frac{L}{hr}$.

$$Q = vA = \left(0.481\frac{m}{s}\right)\left(\frac{\pi}{4}\right)(0.025m)^2 = 2.36\times10^{-4}\frac{m^3}{s}\left(\frac{1000L}{1m^3}\right)\left(\frac{3600s}{hr}\right) = 849.6\frac{L}{hr}$$

By definition, volume flow rate is volume per unit time. Rearrange to solve for the time to fill the desired volume.

$$Q = \frac{Volume}{t}$$

$$t = \frac{Volume}{Q} = \frac{50,000L}{849.6\frac{L}{hr}} = 58.9hr$$

Answer D

47.52 $800gpm$ **of gasoline** $(SG = 0.72)$ **is transported through an** $18in$ **steel pipe. The kinematic viscosity of gasoline is** $6 \times 10^{-6}\frac{ft^2}{s}$**. What is the Reynolds number?**

A. 1,800

B. 180,000

C. 250,000

D. 350,000

Use the volume flow rate and diameter to calculate the velocity of gasoline through the pipe. For larger pipes, there is no need to distinguish nominal from actual size.

$$Q = vA$$

$$v = \frac{Q}{A} = \frac{\left(800\frac{gal}{min}\right)\left(\frac{1ft^3}{7.48gal}\right)\left(\frac{1min}{60s}\right)}{\frac{\pi}{4}\left(1.5ft\right)^2} = 1.01\frac{ft}{s}$$

Use the kinematic viscosity, diameter, and velocity to determine the Reynolds Number. The specific gravity is extra information and should be ignored.

$$Re = \frac{vD}{\nu}$$

$$Re = \frac{\left(1.01\frac{ft}{s}\right)\left(1.5ft\right)}{\left(6 \times 10^{-6}\frac{ft^2}{s}\right)} = 252,177$$

Answer C

47.53 **A water main is required to transport** $8000gpm$ **of water. What is the smallest diameter of pipe that should be used?**

A. $12in$

B. $18in$

C. $24in$

D. $32in$