FLUID DYNAMICS EXPERIMENT: WATER FLOW FROM A JAR TO A STRAW

Analyzing Head Loss, Velocity, and Flow Regime

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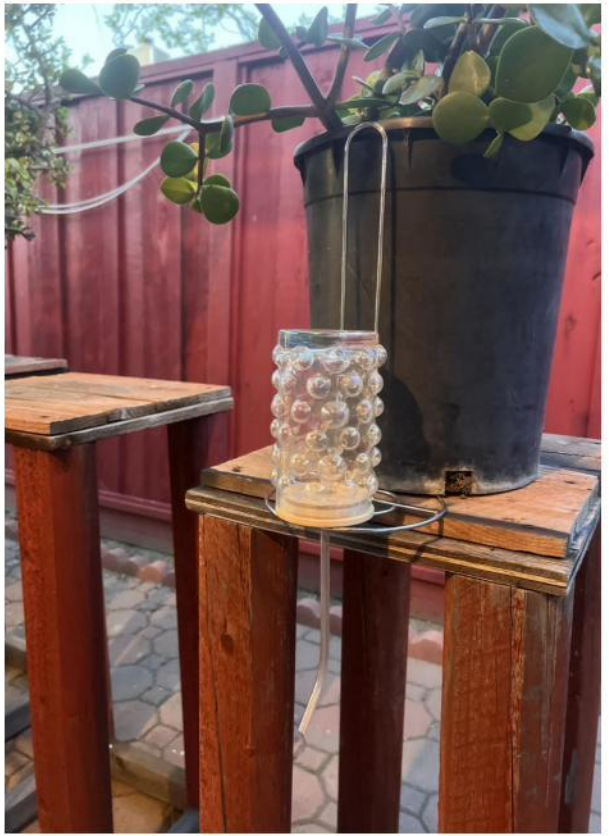
OBJECTIVE

- ANALYZE WATER DRAINNING THROUGH A GLASS STRAW FROM A CLOSED JAR
- COMPUTE:

- VOLUME FLOW RATE
- EXIST VELOCITY
- HEAD LOSS
- PRESSURE DIFFERENCE
- REYNOLDS NUMBER
- FLOW CLASSIFICATION(LAMINAR OR TORBULENT

EXPERIMENTAL SETUP

- JAR: 500 mL SEALED AT THE TOP
- STRAW: SMOOTH, GLASS SURFACE, 0.295" DIAMETER
- HEIGHT FROM WATER SURFACE TO STRAW EXIT: 0.3642m
- WATER AT ROOM TEMPERATURE (20 DEGREE CELCIUS)



KNOWN PARAMETERS

- Volume: 0.0005 m^3
- Time: 30 s
- Diameter: 0.007493 m
- Area: 4.41*10^-4 m^2
- Gravity: 9.81 m/s^2
- Viscosity: 1.002×10^-3 pas
- Density: 998 kg/m
- Height (h): 0.3642 m

FLOW RATE AND EXIT VELOCITY

- $Q = \frac{V}{t} = \frac{0.0005}{30} = 1.67 \times 10^{-5}\,\mathrm{m}^3/s$
- $v = \frac{Q}{A} = \frac{1.67 \times 10^{-5}}{4.41 \times 10^{-5}} = 0.378\,\mathrm{m/s}$

Q=VOLUME FLOW RATE
V= ABERAGE VELOCITY

HEAD LOSS DUE TO MINOR LOSSES

- Entrance loss: $K_1 = 0.5$
- Exit loss (angled 45°): $K_2 = 1.0$
- Total $K = 1.5$

$$h_L = K \cdot \frac{v^2}{2g} = 1.5 \cdot \frac{(0.378)^2}{2 \cdot 9.81} = 0.01092\,\text{m}$$

ENERGY BALANCE USING BERNOULLI'S EQUATION

$$z_1 + \frac{p_1}{\gamma} = z_2 + \frac{p_2}{\gamma} + \frac{v^2}{2g} + h_L$$

- $p_1 = p_2$ (both atmospheric)
- $\Delta p = 0$
- Total head loss = 0.0182 m (includes velocity head and minor losses)

REYNOLD'S NUMBER AND FLOW TYPE

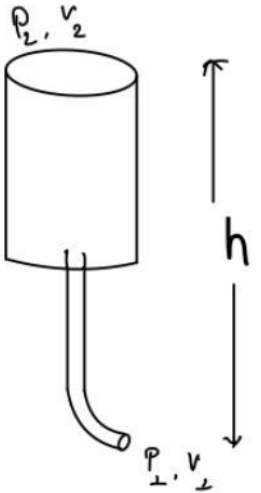
$$Re = \frac{\rho v D}{\mu} = \frac{998 \cdot 0.378 \cdot 0.007493}{1.002 \times 10^{-3}} = 2828$$

- FLOW REGIME: TRANSITIONAL
- SINCE SURVAFE IS SMOOTH, BEHAVIOUR IS CLOSE TO LAMINER

SUMMARY OF RESULT

- Flow rate: 1.67×10−5 m^3/s
- Velocity: 0.378 m/s
- Minor loss head: 0.01092 m
- Total losses: 0.0182 m
- Reynolds number: 2828
- Flow type: Transitional, closer to laminar

DIAGRAM AND VISUATION



CONCLUSION

- Flow is slow and mostly laminar due to low velocity and smooth glass.
- Minor losses are small but measurable.
- Simple gravity-based systems can be well-analyzed using Bernoulli and Reynolds equations.

FEEDBACK

ANY QUESTIONS, COMMENTS AND FEEDBACKS ARE WELCOMED

A DROP OF HUMOR TO WRAP THINGS UP!

WHY WAS THE REYNOLD'S NUMBER ALWAYS SO CALM?

BECAUSE IT KNOW HOW TO STAY BELOW 2300