Recitation 1 9/8/04

Comparison of viscosities

Great Molasses Flood (need website, photos) book reference, link

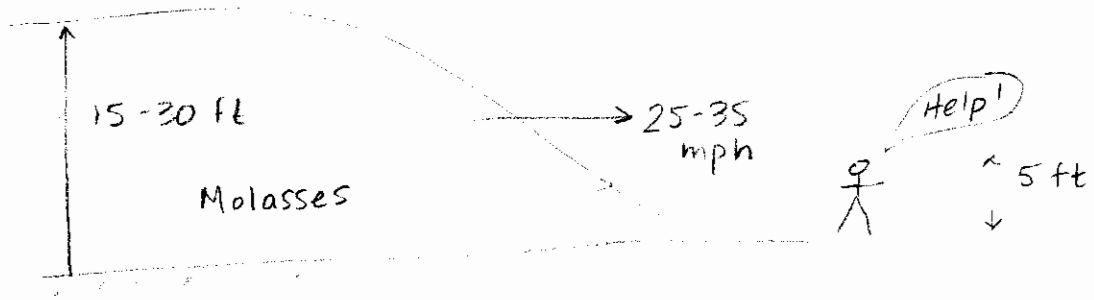
Wall of molasses 15 - 30 ft high
traveling at 25 - 35 mph

Rum + baked beans
High molasses mark, smell in North end

50 ft tank, 2.2 million gallons → 2°F → 40°F increase full tank, prohibition factor of safety

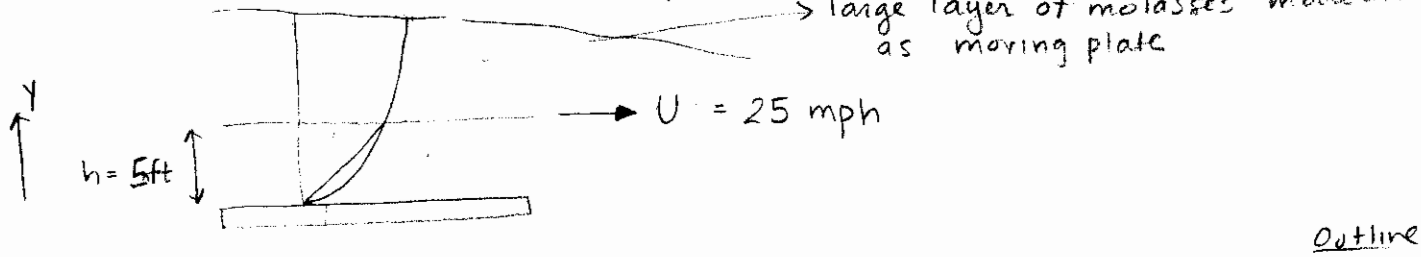
Shearing stress in molasses wave? at average height of person?

Sketch:



Assumptions:

- Model flow as flow between plates



- Assume linear velocity profile in bottom layer
- Laminar, newtonian fluid

Outline
- Problem Set-up
- Stardust example
- Surface tension example

Property values:

$\mu = 7500$ cP

1 cP $= 6.7197 \times 10^{-4}$ lbm/s·ft

1 cP $= 3.6$ Kg/hr m

Solution:

$$\tau = \mu \frac{du}{dy}$$

$$u = U\frac{y}{h}$$

$$\tau = \mu \frac{V}{h} = (7500)(6.7197\times10^{-4}\ \frac{lbm}{s\,ft})\frac{(25\ \frac{mi}{hr})}{(6\ ft)}\left(\frac{5280\ ft}{mi}\right)\left(\frac{1\ hr}{3600\ s}\right)$$

$$\tau = \frac{30.1\ \frac{lbm}{ft\,s^2}}{32.174\ \frac{lbm\,ft}{lbf\,s^2}} = 0.95\ \frac{lbf}{ft^2}\left(\frac{1\ ft}{12\ in}\right)^2 = .006\ psi$$

What caused damage?
Pressure in flowing fluid
Stickiness of molasses

Other fluids?

Review of problem solving methodology in fluids:

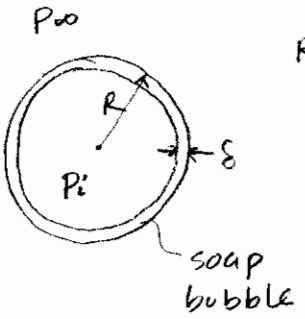
- Sketch or figure - label important features
- Assumptions - know what these are!
- Approach
- Property values - look up what you will need first + convert units if necessary
- Solution - be neat, line by line, waste paper
- Reflection - does the answer make sense? can you compare it to anything else?

Overall: 1 problem per page, ink or pencil fine

Surface tension example problem

Problem: What is the pressure difference between the inside and outside of 0.5 cm diameter soap bubble?

Sketch:



R = .25cm

Assumptions: $\delta << R$

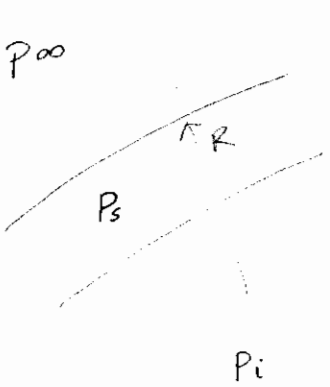
gravity is negligible

Approach: Surface tension force balance

Properties: $\sigma_{soap} = \frac{1}{3}\sigma_{H_2O} = \frac{1}{3}(.07 N/m) = .023\ N/m$

$\rho_{soap} \approx \rho_{water} = 1000\ kg/m^3$

Solution:



$$P_s - P_\infty = \frac{2\sigma}{R}$$

$$P_i - P_s = \frac{2\sigma}{R}$$

$$P_i - P_\infty = \frac{4\sigma}{R}$$

$$\Delta p = \frac{4(.023\ N/m)}{(.25\ cm)\left(\frac{1\ m}{100\ cm}\right)} = 2.3\ Pa$$

Reflections: Soap has less surface tension than H_2O → why is it harder to blow a water bubble?

[website]