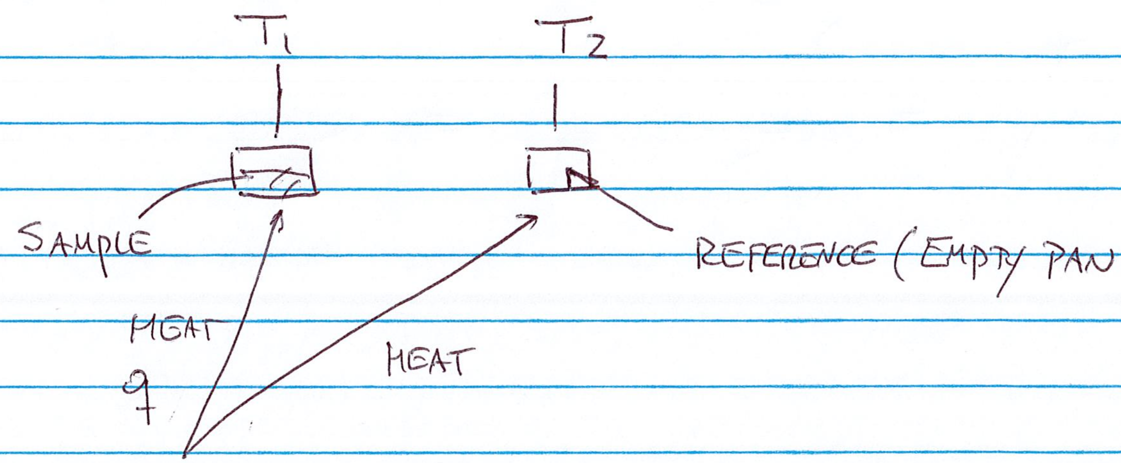
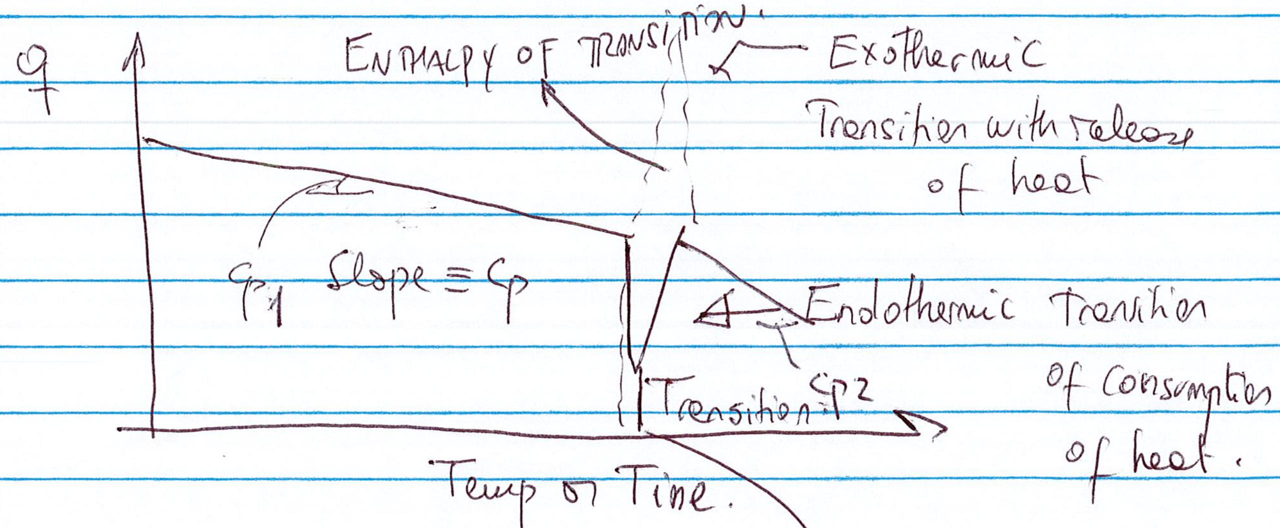
NOTES LECTURE 10-24-2017

DIFFERENTIAL SCANNING CALORIMETER (DSC)



Applying heat to keep $T_1 = T_2$

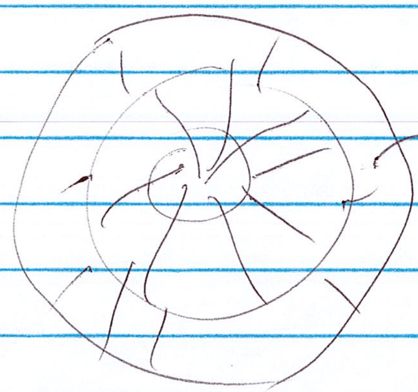


T_{glass} related to $\Delta G = C_{p1} - C_{p2}$

$T = 60°C$

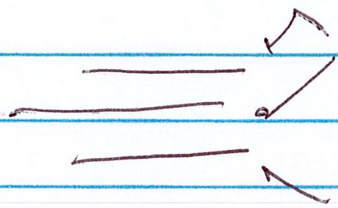
if we compare with slide 45

STARCH

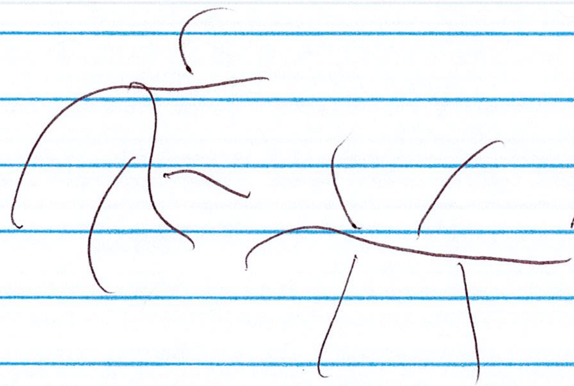


layered structure
Formed by two Starch fractions

SMALLER MOLECULE
1° FRACTION is AMYLOSE (LINEAL MOLECULE)
2nd FRACTION is AMYLOPECTIN (BRANCED MOLECULE)
LARGER MOLECULE



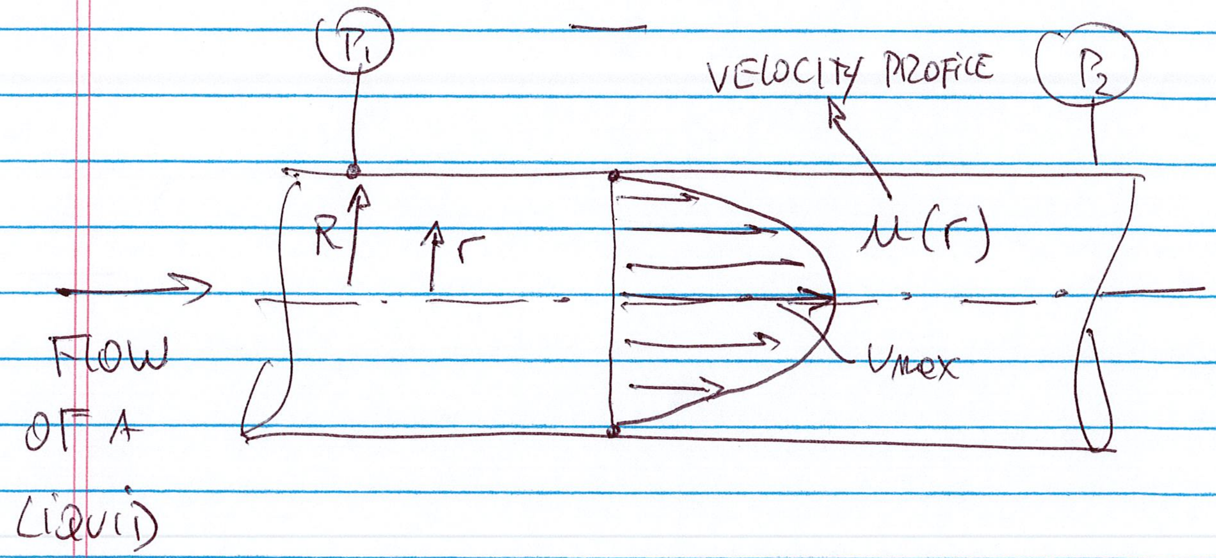
Amylose chains FORMS CRYSTALLINE STRUCTURE



AMYLOPECTIN MOLECULES FORM AMORPHOUS STRUCTURE

WHAT IS THE DIFFERENCE BETWEEN VISCOSITY & RHEOLOGY ?

RHEOLOGY "MEASURES" VISCOSITY AND OTHER THINGS [OTHER THINGS ARE "ALL MECHANICAL PROPERTIES]

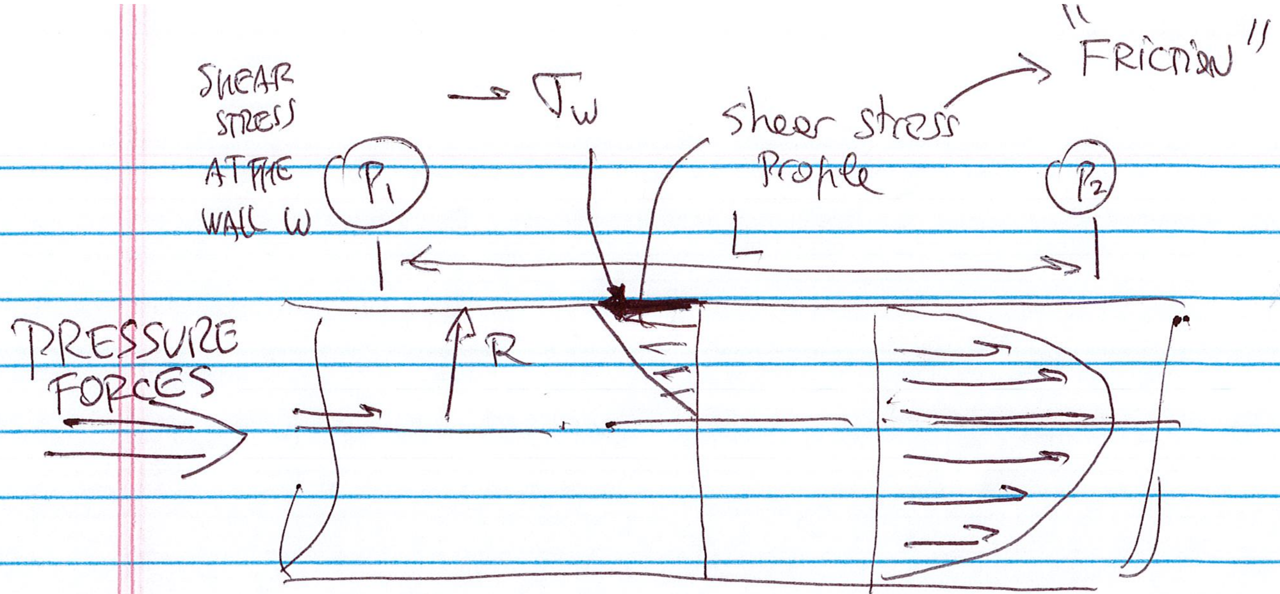


How P_1 compares with P_2 ?

$P_1 > P_2$ BECAUSE FRICTION

$$u(r) = \begin{cases} \text{at } r = R & u(r=R) = 0 \\ \text{at } r = 0 & u(r=0) = u_{max} \end{cases}$$

what need to know what $P_1 - P_2$ we need to apply to make the fluid to flow in the pipe



PRESSURES FORCES (NEWTONS) $= (P_1 - P_2) \times A = (P_1 - P_2) \times \pi R^2$

[ASIDE $P = \frac{F}{A}$]

FRICTION FORCES $=$

$\tau_w = \frac{\text{SHEAR FORCE}}{A} \longrightarrow$ SHEAR FORCES $= \tau_w \times A_T$

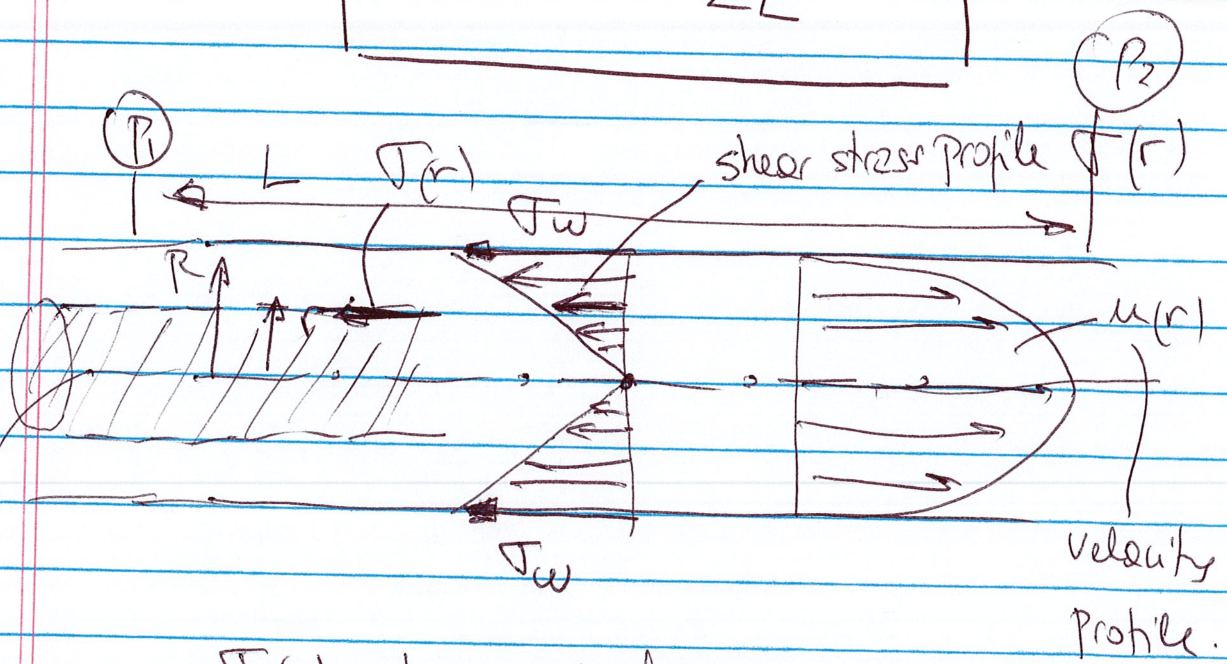
shear stress at the wall.

SHEAR FORCES $= \tau_w \times 2\pi R L$

PRESSURE FORCES $=$ SHEAR FORCES

$$\underbrace{(P_1 - P_2)\cancel{\pi} R^{\cancel{2}}}_{\text{PRESSURE FORCES}} = \tau_w \times 2\cancel{\pi}\cancel{R} L$$

$$\boxed{\tau_w = \frac{(P_1 - P_2) R}{2L}}$$



$\tau(r)$ at a particular r

Use a balance in a tube of radius r

$$\text{PRESSURE FORCES} = (P_1 - P_2)\pi r^2$$

$$\text{SHEAR FORCES} = \tau(r) \times 2\pi r \times L$$

$$(P_1 - P_2)\cancel{\pi} r^{\cancel{2}} = \tau(r)\, 2\cancel{\pi}\cancel{r} L$$

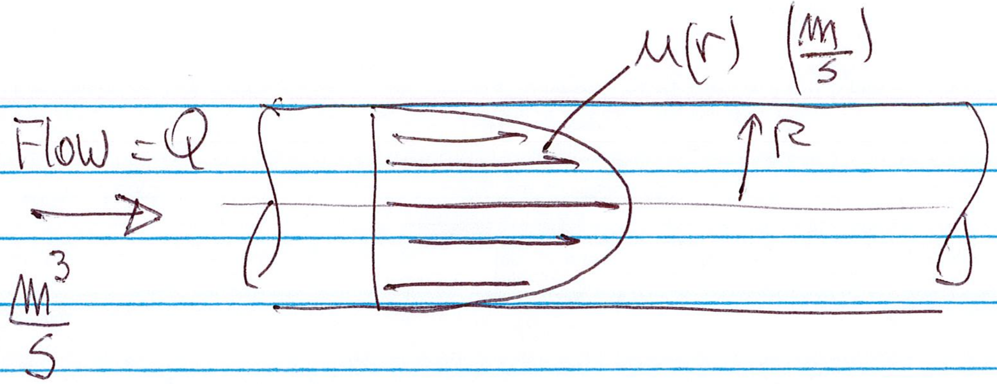
$$\boxed{\begin{aligned} \tau(r) &= \frac{(P_1 - P_2)\,r}{2L} \\ \tau_w &= \frac{(P_1 - P_2)\,R}{2L} \end{aligned}}$$

INFORMATION FROM A FORCE BALANCE

$$\tau(r) = \begin{cases} \text{at } r=0 & \tau(r=0)=0 \\ \text{at } r=R & \tau(r=R)=\tau_w \end{cases}$$

$$u(r) = \begin{cases} \text{at } r=0 & u=u_{max} \\ \text{at } r=R & u=0 \end{cases}$$

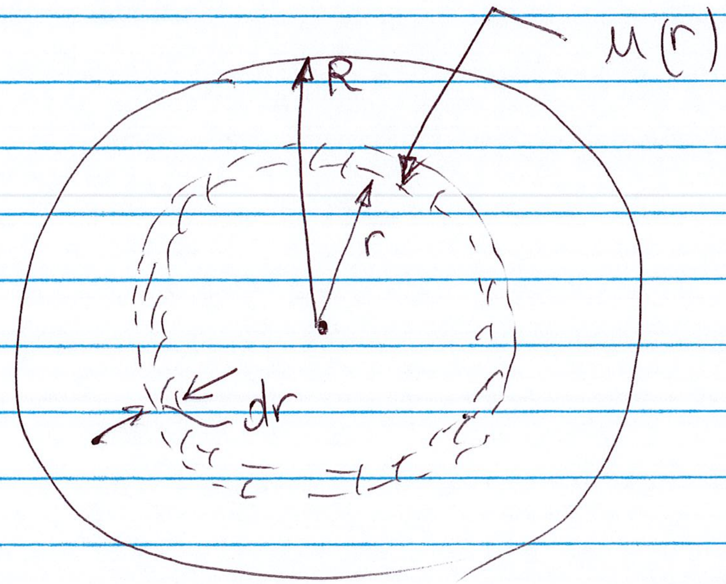
How the Rheology will affect the velocity profile



How could we calculate Q from u(r) ?

$$Q \cancel{=} u(r) \times A = u(r) \times \pi R^2 \qquad ?$$

$$\left|\frac{m}{s}\right| \left|m^2\right| = \frac{m^3}{s}$$



dr : "differential" ring.

how is the flow in the ring? ~~big~~ Big flow or a tiny "differential" flow?

$$dQ(r) = u(r) \times \underbrace{2\pi r \times dr}_{\text{cross-sectional of the ring.}}$$

differential flow

$$\boxed{dQ(r) = 2\pi r\, u(r)\, dr}$$

"TINY" FLOW IN THE RING

TOTAL FLOW Q

$$Q = \int_{r=0}^{r=R} dQ(r) = \int_{r=0}^{r=R} 2\pi r\, u(r)\, dr$$

$$\boxed{Q = 2\pi \int_{r=0}^{r=R} r\, u(r)\, dr}$$

FIXED BY THE RHEOLOGY

BY ALGEBRA $\Downarrow$

$$\boxed{Q = \frac{\pi R^3}{\sigma_w^3} \int_0^{\sigma_w} \sigma^2 f(\sigma)\, d\sigma}$$

RHEOLOGY

$$Q = \frac{\pi R^3}{\sigma_w^3} \int_0^{\sigma_w} \sigma^2 f(\sigma)\, d\sigma \qquad (9$$

RHEOLOGY (SHEAR RATE)

FOR A NEWTONIAN FLUID $\sigma = \mu \dot{\gamma}$

$$\dot{\gamma} = \frac{\sigma}{\mu} \equiv f(\sigma)$$

$$Q = \frac{\pi R^3}{\sigma_w} \int_0^{\sigma_w} \sigma^2 \frac{\sigma}{\mu}\, d\sigma = \int_0^{\sigma_w} \frac{\sigma^3}{\mu}\, d\sigma \, \frac{\pi R^3}{\sigma_w^3}$$

$$Q = \frac{\pi R^3}{\sigma_w^3 \mu} \left. \frac{\sigma^4}{4} \right|_0^{\sigma_w} = \frac{\pi R^3}{\mu \cancel{\sigma_w^3}} \frac{\sigma_w^{\cancel{4}}}{4}$$

$$\left.\begin{aligned} \sigma_w &= \mu \frac{4Q}{\pi R^3} \\ \sigma_w &= \mu \dot{\gamma}_w \end{aligned}\right\} \quad \boxed{\dot{\gamma}_w = \frac{4Q}{\pi R^3}}$$

$$\tau_w = \frac{4\mu Q}{\pi R^3}$$

$$\frac{(P_1 - P_2)R}{2L} = \frac{4\mu Q}{\pi R^3}$$

$$\boxed{(P_1 - P_2) = \frac{8\mu L Q}{\pi R^4}}$$

HAGEN-POISEUILLE EQUATION