Processing, Quiz 1 1/11/2001

a) **-Demonstrate** that the vector of velocity gradient, (dv_z/dx) is the same as the vector of the rate of strain, ($d\gamma_{zx}/dt$) for simple shear flow between parallel plates where there is a single direction of force applied, F_z, to the top plate with normal in the x-direction, A_x, and a fixed bottom plate. (Make a sketch and show the vectors.)
-Show the vectors/equations involved in defining the static experiment to measure shear modulus, G.

b) **-Show the same** for a tensile (elongational) flow such as occurs in fiber spinning.
-Show the vectors/equation involved in defining the Young's modulus.

c) You over hear a conversation at work,

Engineer 1: "...the *blow-up* ratio was too high and the *take-up* ratio too low. "

Engineer 2: "No, I think the *frost line* was too low."

-What are the two engineers talking about?
-Define the terms in italics.
-Can both of the engineers be right? How?

d) **-Sketch** a screw extruder showing where the following processing steps occur:

solids processing
melting
pumping
mixing
devolitilization

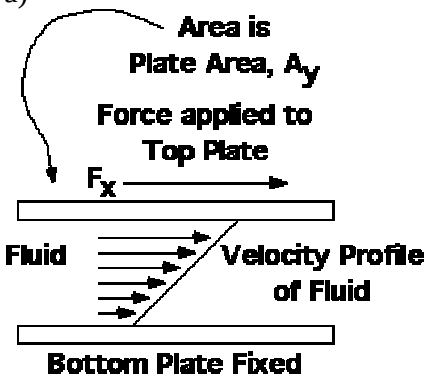
-Label the following parts on the extruder you drew,

Tine, barrel, hopper, shaft, flight, die, metering section, heaters.

e.) **-What is** a constitutive equation?
-Give 4 examples of constitutive equations.
-If you know the constitutive equation for flow of a polymer at shear rates from 100 to 1000 s^{-1} is it implied that you understand the physical mechanism of flow for this material? Why?

Answers Processing, Quiz 1 1/11/2001

a)



$\tau_{xy} = F_x/A_y$

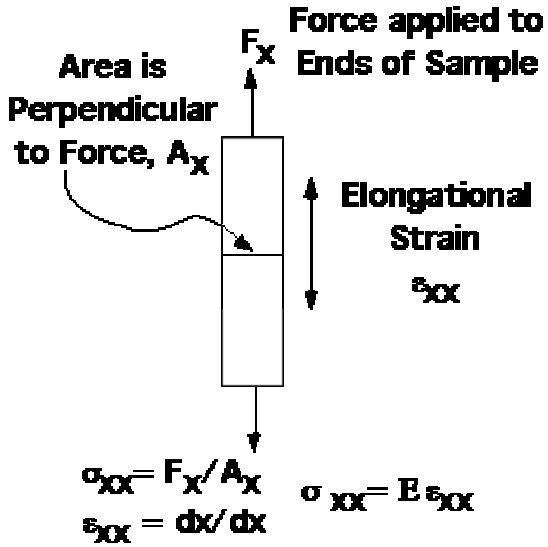
$\gamma_{xy} = dx/dy$ $\quad \tau_{xy} = \eta \dot{\gamma}_{xy}$

$\dot{\gamma}_{xy} = dv_x/dy$

$v_x = dx/dt$, so $dv_x/dy = (dx/dy)/dt = \gamma_{xy}/dt$

For the shear modulus there is no flow and $\tau_{xy} = G\,\gamma_{xy}$

b)



$\sigma_{xx} = F_x/A_x$ $\quad \sigma_{xx} = E\,\varepsilon_{xx}$

$\varepsilon_{xx} = dx/dx$

For tensile flow $d\varepsilon_{xx}/dt = (dx/dt)/dx = dv_x/dx$

c) They are talking about a film blowing process. Blow-up ratio is the bubble diameter/annular die diameter, take-up ratio is the take-up linear rate to the linear rate of extrusion. The frost line is the line on the bubble where the polymer crystallizes.

If the take-up ratio is too low this could lead to a low frost line so both could be correct.

d) See the figures in the notes handed out in class.

e) A constitutive equation relates the response of a material to a perturbation through a constitutive parameter. Examples are Hooke's law, Newton's law for viscosity, Fourier's law for heat conduction, Fick's first law for diffusion.
Knowing the constitutive equation does not imply that you understand anything about the physical mechanism at play, e.g. understanding that turning the key starts the car does not imply that you understand what a cylinder is or how internal combustion engines work.

a) b) Only a few got this, no one got it perfectly. Need to get this down.
I think I told you this question would be on the quiz?

c) Some got some didn't. I wouldn't worry about this question.

d) If you didn't get d you need to look at the book/web page (see book copy under second lab).

e) This is conceptually important and if you understand this now you will be in better shape later. Some got this totally others didn't.