

There are several yield criteria:

1- The Max. shear stress theory (Tres Ca yield criterion):

The assumption of this theory states that yielding will occur. If the max. shear stress in the material reaching a critical value.

In simple tensile test; the max. shear stress is half the yield stress.  $\tau_{max} = \frac{1}{2} \sigma_{yt}$ .

In the complex stress system, the max. shear stress will depend on the relative values and signs of the three principal stresses (always half the difference between max. and min. values).

In 3-D stress system (complex stress system ) or in 2 – D case with one of the stresses compressive and the other tensile.

$$\text{Max. shear stress} = \tau_{max} = \frac{\sigma_1 - \sigma_3}{2} = \frac{\sigma_{yt}}{2} \quad \text{or} \quad (\sigma_1 - \sigma_3 = \sigma_{yt}).$$

In 2 – D stress system ( $\sigma_3 = 0$ ) ,  $\sigma_1$  and  $\sigma_2$  are both tensile. The Max. difference between the principal stresses is:  $\tau_{max} = \frac{\sigma_1 - 0}{2} = \frac{\sigma_1}{2} = \frac{\sigma_{yt}}{2}$

$$\therefore \sigma_1 = \sigma_{yt} \quad [\sigma_1 > \sigma_2 > \sigma_3 \text{ generally}]$$

Tres Ca yield criterion of limited interest in polymers.

2. Von Mises Yield Criterion:- a general yield criterion that established for metals (von mises criterion):  $(\sigma_{xx} - \sigma_{yy})^2 + (\sigma_{yy} - \sigma_{zz})^2 + (\sigma_{zz} - \sigma_{xx})^2 + 6 (\sigma_{xy}^2 + \sigma_{xz}^2 + \sigma_{yz}^2) \geq 6 C^2$ .

For plastics, von mises criterion can be modified by introducing a term of the hydrostatic pressure (P).

$$\text{For polymers: } (\sigma_{xx} - \sigma_{yy})^2 + (\sigma_{yy} - \sigma_{zz})^2 + (\sigma_{zz} - \sigma_{xx})^2 + 6 (\sigma_{xy}^2 + \sigma_{xz}^2 + \sigma_{yz}^2) - P \geq 6 C^2.$$

$$P = \frac{1}{3} (\sigma_{xx} + \sigma_{yy} + \sigma_{zz}).$$

In metals, the yield behavior is approximately independent of the hydrostatic component of stress this is not true for polymers.

If the left hand side exceeds  $6C^2$  , yield will occur. In metals ( C is constant), in plastics C varies with P (C increases linearly with P), C is also a function of temperature and strain rate.