

Rheology of polymer systems/ Reologia dos sistemas poliméricos

4. Polymer processing (extrusion)

Elastic fluids

Viscoelastic behaviour of polymer melts and solutions

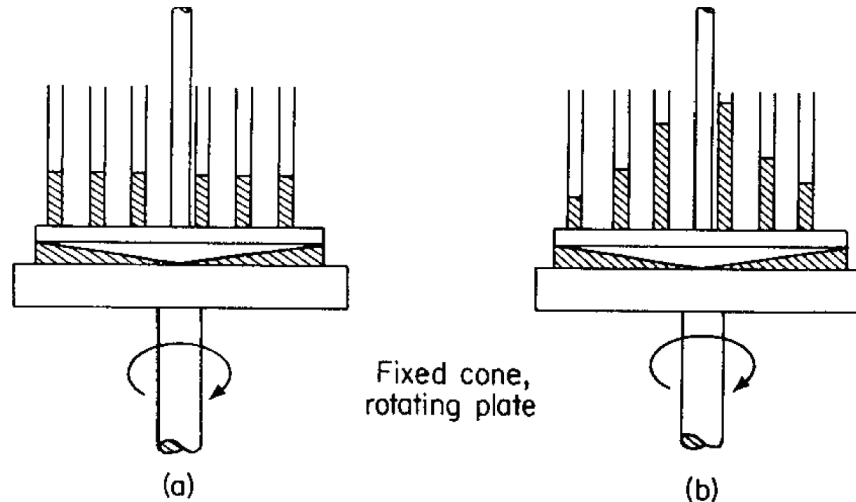


FIGURE 7-22

Relative normal pressures as shown by manometers inserted in stationary cone of cone-plate viscometer. (a) Purely viscous behavior; (b) viscoelastic behavior.

- Normal tensions are perpendicular to those imposed in a given deformation.
- The release of the elastic energy at the exit of a capillary leads to an increase of the diameter of the extrudate beyond that of the capillary_ **die swell**/inchamento de fieira.
- Normal tensions originate instabilities.

Die swell/Inchamento de fieira

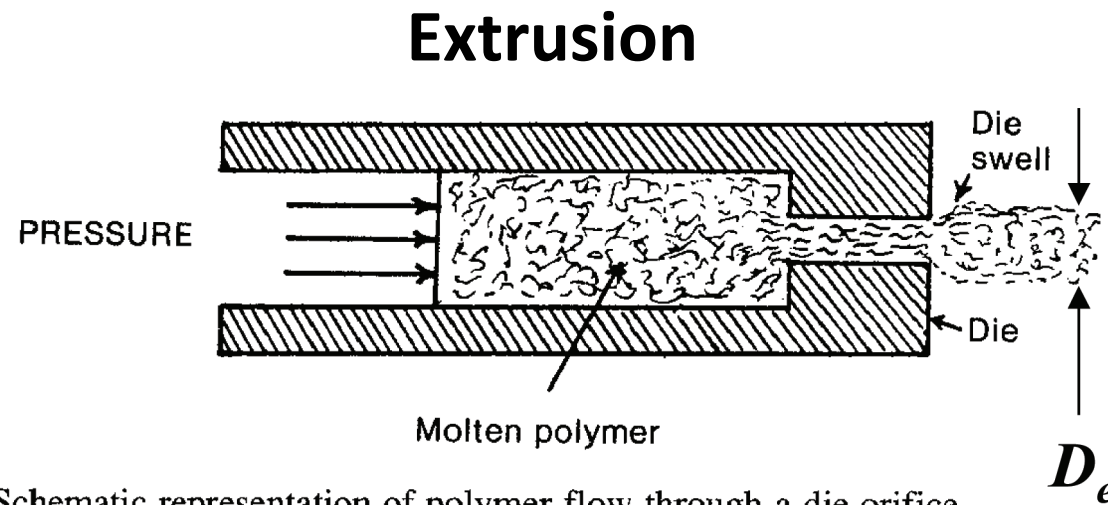


FIGURE 3.2. Schematic representation of polymer flow through a die orifice.

$$D_e > D_s$$

"Swell ratio" ou razão de expansão: $\beta = \frac{D_e}{D_s}$

Die swell/Inchamento de fieira

Effect of the length of the capillary

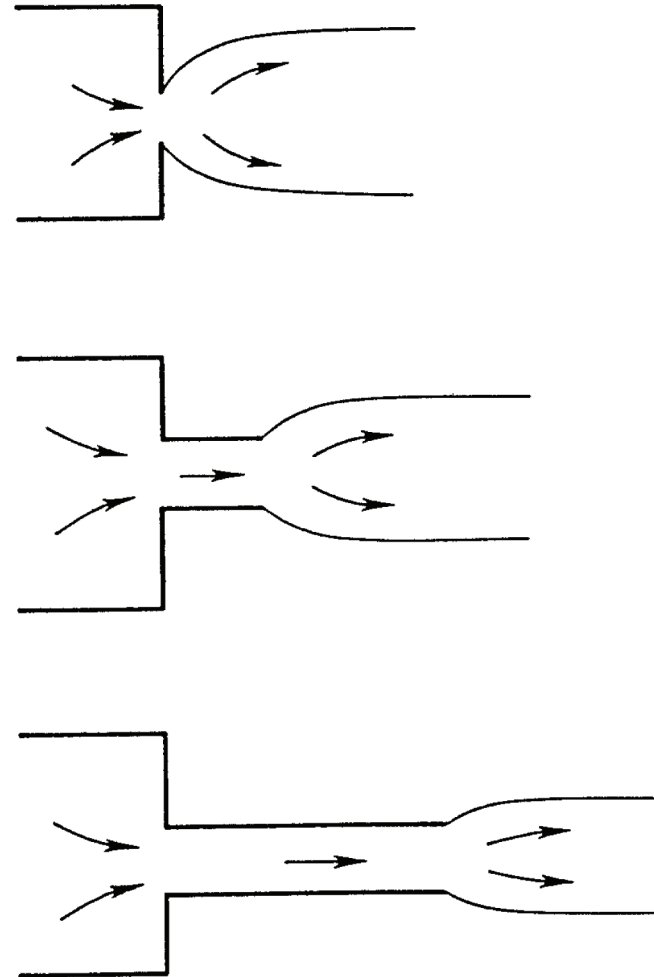


FIGURE 24. Diagram illustrating the effect of viscoelastic memory on die swell for capillaries of different lengths.

Die swell/Inchamento de fieira

Effect of the shear rate at the wall of the capillary

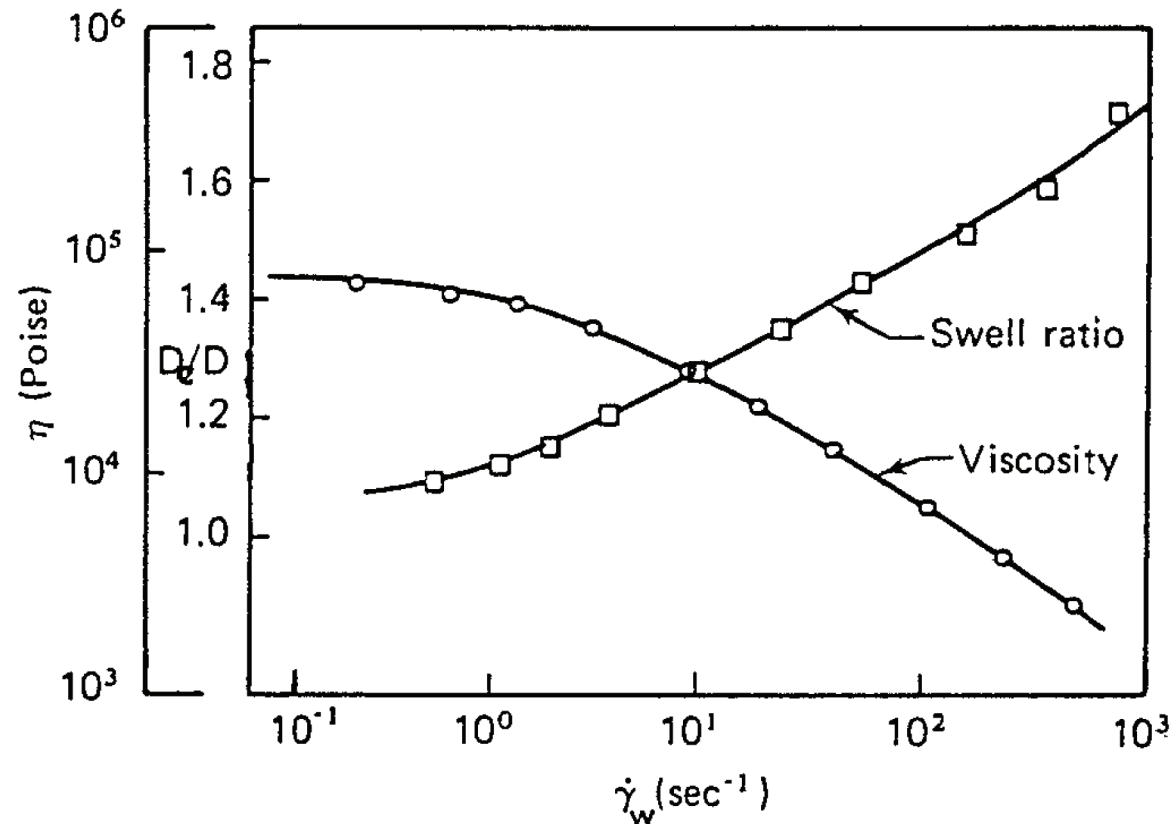


FIGURE 25. Viscosity and swell ratio versus shear rate at the wall for a commercial polystyrene in capillary flow. (Reproduced with permission from reference 16. Copyright 1975 Syracuse University Press.)

Die swell/Inchamento de fieira

Effect of the flow rate

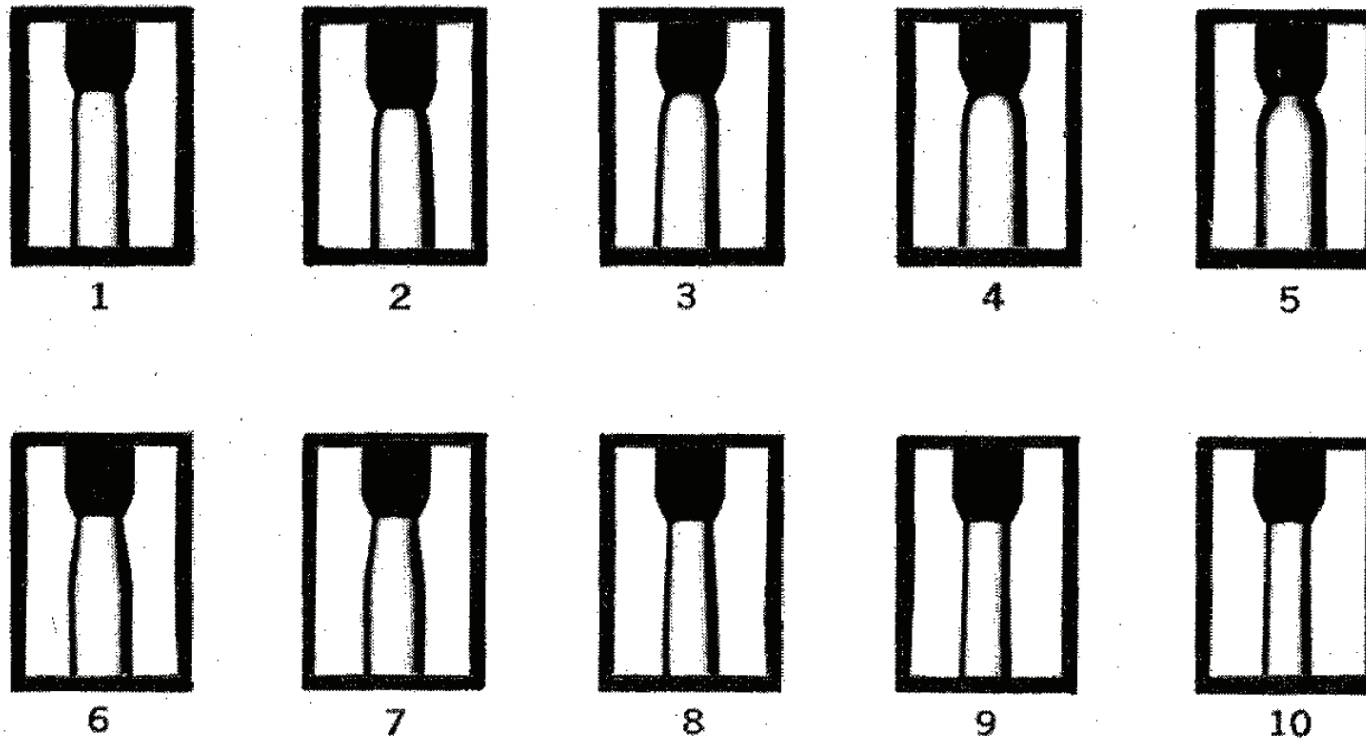


Figure 3-15. Sequence of photographs showing swelling of the free stream in the exit region. Flow rate increasing from 1 through 10 (Ref. 13).

Melt fracture/Fractura de fundido

Upon increase of the of the elastic energy put into the polymer entering the pipe, the elastic limit is reached and a pulsating irregularity in flow appears.

This is an important limitation for extrusion.

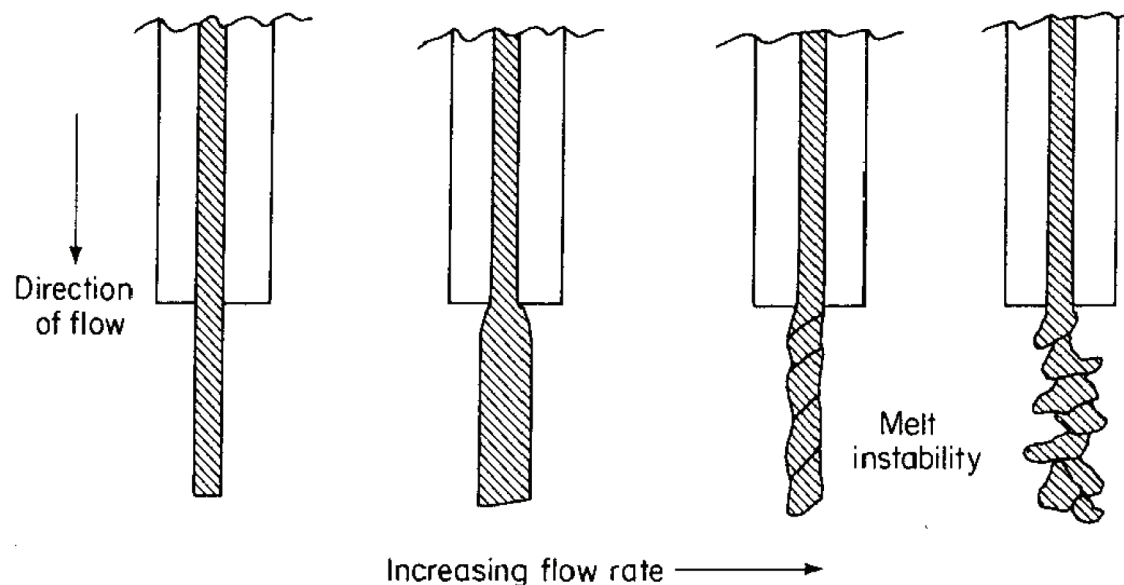
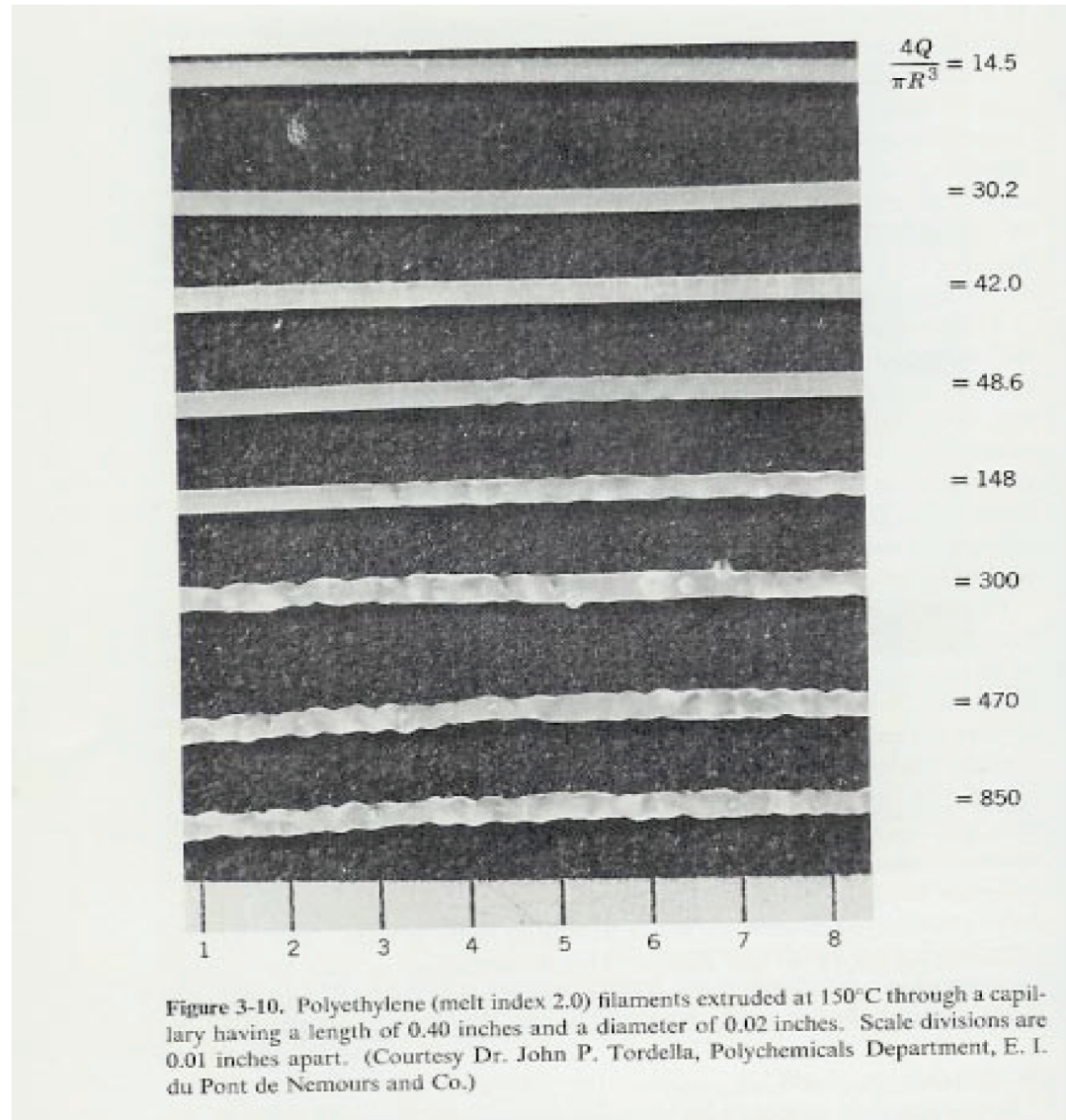


FIGURE 7-23

Typical stages in extrusion of polymer melt through capillary of diameter D_s . The die swell β is the extrudate diameter/ D_s .

Melt fracture/Fractura de fundido



- $\gamma_{w,ap}$

References

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