More on the Drag Flow Equation

Print
(6) » Screen/Barrel Clearance » PVC Gels » **More on the Drag Flow Equation**
More on the drag flow equation
Vol. 7 #3. December 1978

Answer: The drag flow equation is correct as presented in the article and was taken from page 174 of Bernhardt[1]. It was kept in its most general form since we occasionally find extruders which use a design other than the square pitch (helix angle of 17.7°). To make the equation specific for a square pitch screw, we can substitute the value of cos2 17.7° and combine the other constants to get:

QD = 1.426 D(t - e)Nhrm.

(QD in lbs./min) If t = D (square pitch)

and if e = 0.12D, which is typical, then:

QD = 1.255 D2 Nhrm

3. Given:

a. 4½", 24/1 extruder producing ½ to 1 mil PVC film (35-45 phr plasticizer).

b. Melt uniformity and rate uniformity critical for appearance and gauge uniformity — 380°F < T melt < 410°F. Limits are approximate - low temperature creates dull hazy film - high temperature leads to bubbles and thermal instability.

c. No HP limit.

d. RPM limits—case 1—100 RPM.

e. Feed is a pelletizer compound.

To determine or estimate:

1. Reasonable maximum rate which can be achieved at 100 RPM or at any RPM.
2. Screw design or description to achieve this maximum rate.

_____

[1]Processing of Thermoplastic Materials, edited by E.C. Bernhardt, Reinhold Publishing Co. 1959.

_____

Answer: There are three approaches to solving this problem. The first involves use of a computer program to determine the optimum screw design, generally using simulation techniques. The success of this approach depends on having accurate information concerning the polymer properties; viscosity as a function of shear rate and temperature, enthalpy, bulk density, melt density, coefficient of friction of the solid plastic against metal, etc. Estimating these properties can be very risky since small amounts of additives or the types of additives used can have profound effects on the processing characteristics of plasticized PVC.

In addition, we must know how much pressure the screw is required to provide to cause the polymer to flow at various rates through the die system. If a slide plate type screen changer is used, some allowance must be provided for pressure build-up due to screen clogging.

Estimates of output rate as a function of the control parameters are generally quite good but prediction of melt quality is a more difficult task. Since this application has three factors affecting quality, namely clarity, plasticizer volatility and thermal stability, the computer program would have to incorporate temperature limits, time-temperature history and total shear strain considerations.

A second approach is to make laboratory scale experiments on a small extruder and use the data developed to scale up to the production extruder. Again, computer programs can be utilized to analyze the data developed and provide the scaled-up design.

A third approach is to run a full scale experiment with an existing screw and se the results to design a screw for optimum performance. It is here that the programmable calculator is useful in that it quickly points out design flaws or suggests alternate operating conditions to achieve the desired results.

In summary, there is no simple way of estimating output rates without having specific information describing the polymer characteristics. Estimating outputs attainable based on similar compounds can be misleading because of differences in the polymer properties or because of differences in quality requirements for different applications.

- L. Sansone

See also:

- Designing high performance screws
- Naming screws for materials,. . . .
- Technical developments
- Ten key principles of extrusion
- The programmable calculator
- Two stage extrusion