Screen Pack Pressure Drop

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Raymond Melinowski of Wiles, Michigan, sent in two questions, one of which was answered by Imrich Klein, Scientific Process of Research, Inc. The question is the following:

Question 1:
Expected Pressure Drop calculations through breaker plates and woven wired screen packs often yield results that are far from the actual run data. Please provide formulas to calculate pressure drop and if possible relate pressure drop as a function of melt index.

Answer to Question 1:
The pressure drop through screen packs can be computed by the formulae derived by Carley and Smith (1):

$$\Delta P — F_S \, \eta^0 \, (\gamma^0)^{1-n} \, (W/D^2{}_S\rho)^n \qquad \textbf{(1)}$$

where:

$\eta^0 =$ viscosity at any reference shear rate γ^0

$n =$ flow index of the plastic being extruded, that is the slope of the shear stress vs. shear rate curve plotted on a log-log scale

$W =$ Extruder output, lb/hr

$D_S =$ Diameter of screen, in. (usually equal to barrel diameter)

$\rho =$ Melt density, lb/in.^{3}

while $F_S =$ the screen resistance factor defined by the following equation:

$$F_S = 2^{n+3} \, (3+1/n)^n \, (9OO\pi)^{-n} \, [d/m^{2n} D_o{}^{3n+1}] \qquad \textbf{(2)}$$

where:

$D_0 =$ average minimal opening between adjacent wides, in.

$d =$ wire thickness, in.

$m =$ mesh number in wires/inch

$= \quad 1/D_0 + d)$

For U.S. Standard square woven screens the value of can also be read off the enclosed Figure 1 and used in equation 1.

For a screen pack consisting of several screens the pressure drop through each of the screens should be added to obtain the overall pressure drop through the screen pack. Furthermore, for a group of screens for which the ratio of wire diameter to aperture remains Constant, the individual screen resistance factors, Fs can be added to obtain an overall FS value for the whole screen pack. In this case only a single overall pressure drop is computed through the use of equation 1.

This method permits one to compute pressure drop over filter packs installed on any extruder processing any plastic with known flow properties, that is viscosity as a function of shear rate and temperature. Melt index, of course, is not an adequate measure of material viscosity as it represents a viscosity value only at a single temperature and a single, very low shear rate.

References: I. Carley, I. F. and Smith, W. C., Polymer Engineering & Science, 18, 408 (1976)

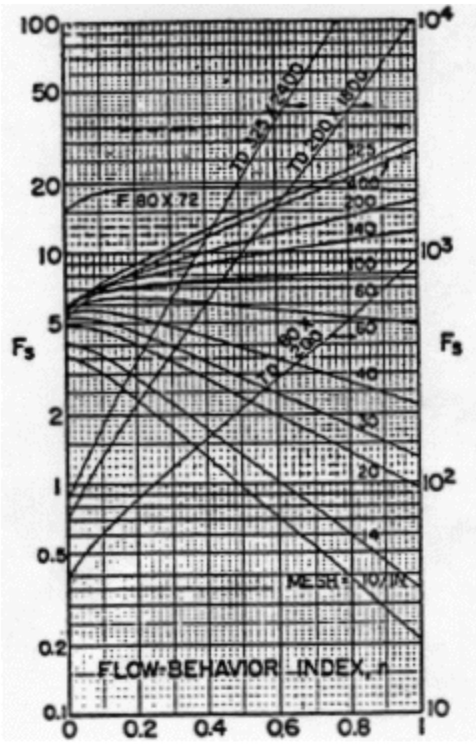

Fig. z. Screen-resistance factor, FS, for U.S. standard (2) square-woven screens from 10 to 400 mesh, a fourdrinier woven screen and three twilled-dutch woven screens. While the resistance factor generally increases with increasing mesh number (wires/in.), the increase is not steady and interpolation may not be reliable. Some Tyler mesh numbers differ from U.S. standard for the same screen dimensions and must be converted to US. before entering this plot. The same is true for metrically designated screens.

Letters to the Editor We thank Dr. J. F. Carley, Lawrence Livermore Laboratory for the following comments on Dr. Imrich Klein's August 1979 Newsletter discussion of screen pack design.

Hopefully this letter will inspire others to write a letter to the Editor on other subjects.

Jim Carley's unedited letter is as follows:

May I make a couple of amendments to Imrich's answer to the question on screen pack design in the August issue?

First, the designation of mesh number should have read: m = 1/(Do + d). Most readers probably worked this out for themselves.

Second, Imrich said that the Addition of FS value for individual screens is restricted to a "group of screens for which the ratio of wire diameter to aperture remains constant." Not so, though for the standard screens whose FS values were plotted in Figure 1 that condition is pretty closely adhered to. Actually, the only requirements for adding FS values are (1) that all the screens be of the same diameter and (2) that the same flow pass through all. Imrich may have come to his thought because the standard-state viscosity and shear rate are in the pressure-drop equation (eq. 1 of his article). But they are standard-state numbers, not actual shear rate and viscosity in the screen, and are therefore not influenced by screen dimensions. The viscosity and density are, of course, influenced by temperature, and temperature changes in the melt while passing through the screen are not included. While such changes might sometimes be as much as 10°C, they are not included because they did not need to be considered in analyzing the date collected with several polymers, over a wide range of conditions, some of which involved high pressure drops through the screen packs.

It will be useful to your readers who normally don’t read PE&S to tell them that the reference also tells how to deal with screen blockage and screens that are not square woven, and that three worked-out cases are given. Also, anyone who can use an FS calculator program for the HP 65 or 67 need only request one from me to get it by return mail."

- Dr. James F. Carley
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See also:

- Answers - preheating feedstocks for extrusion
- Polymer filtration
- Screen pack pressure drop
- Screen pack selection

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