More on Screw Flight Wear

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Most processors of high density polyethylene will attest to the characteristic of that polymer "to promote rapid screw wear on the surface of the flights in the extruder screw transition and first metering section. Clearly, this is a major problem to consider when designing a screw which will provide the performance life expected by the HDPE converter.

The extreme wear rate problem is not an exclusive property of HDPE. Extruders processing glass or mineral filled polymers have a similar problem. Even low density polyethylene with some pigments will parallel the wear of HDPE.

What is the source of this problem and why is its location on a screw so definite? While none of us is capable of a first hand peek at the transition section of a screw while running, it is possible to theorize some of the possible reasons.

You may wish to refer to the March, 1974 Extrusion Division newsletter for a preliminary discussion of flight wear. In that article it was suggested that a screw, being a relatively limber structural member cantilevered into a more rigid barrel, will deflect into barrel contact some predictable distance down the axis of the screw. From the contact point on to the downstream end of the screw, the bottom of a horizontal barrel will support the screw.

If a screw is rotated with the contact described and with no lubricant between the flight land and the barrel, the resulting metal to metal rubbing can be expected to expedite the wear rate of both the screw and the barrel.

How can a screw and barrel combination be expected to produce a reasonable wear life in the face of this problem? Enter the theory of lubrication. By definition, lubrication has for its objective the reduction of the friction between parts which slide on one another. "Perfect" lubrication occurs when unbroken layers of moving fluid separate the metal surfaces.

The lubrication of an extruder screw must be provided by the polymer between the flight land and the barrel. The theory of "journal bearing" lubrication is old. Many references (1,2) appear in nineteenth century literature.

Without laboring into the details of the theory, it is sufficient to say that molten plastic must be pulled between the flight land and the barrel to effectively lift the screw from a metal to metal contact. Film lubrication is dependent upon an unbroken flow of the plastic.

It is easy to understand that foreign additives to the polymer will disturb the integrity of the film lubrication in an extruder. Thus, filled polymers do present an obvious lubrication problem.

Why does unfilled HDPE present a unique wear problem? The answer appears to relate to the lack of integrity of the lubricating polymer film in the transition section of the screw. It might be that the slip-stick phenomenon (3) witnessed by the melt fracture off-set of HDPE rheology causes intermittent breaks in the film between the flight land and the barrel. The results of a loss of lubrication in this critical area are obvious.

If the continuity of the desired lubrication film is uncertain in these extreme wear cases, a special set of good wear resistant alloys can be used to retard the rate of wear caused by the intermittent metal to metal contact. A paper (4) presented recently indicates a significant difference in wear rate exists between flight materials such as Stellite 6 or Colmonoy 6 and Xaloy 101, 306, and 800 barrel materials.

Recent tests have been conducted using a Norton ceramic coating on the screw flight in order to further retard the wear rate. The successful use of this coating in many high wear applications is not known.

The problems of screw wear are significant. Many extruders are operated in an inefficient manner due to the reduced diameter and increased flight clearance in critical sections of the screw. In addition, significant investments are expended annually to mea sure screws, barrels, rebuild screws and hone barrels. Should our industry be involved in an indepth study of the causes and effects of wear? The economic impact of this problem appears to justify this proposed effort.

REFERENCES:

1. Tower, Beauchamp "Proceedings, Institute of Mechanical Engineers" (1883) pg. 632.

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3. Blyler, L.L.. Hart, A.C., Polymer Engineering and Science, Vol. 10 No. 4 (July 1970) pg. 193 and 194.

4. Saltzman, G.A., Olson, .l.H. SPE 32nd ANTEC Vol. 20 (May, 1974) pg. 173-175.

- Robert B. Gregory

See also

- Barrel and screw wear
- Extrusion screw wear
- Old vs new extruders
- Screw flight wear
- Vector forces in extrusion design

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