Single Screw Root Wear

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The causes of screw wear are numerous and often the wear is the result of more than one mechanism. It is important to recognize the exact cause(s) before taking corrective action. The easiest ones to recognize are those which act on the channel surface rather than the flight O.D. These are either due to abrasive or corrosive effects of the polymer/additive being processed. Typically, mineral fillers cause root wear in the start of the solids feeding portion of the screw. They are "loose" at that portion of the process and abrade the metal surface.

Much like sand on the beach wears down shells, the harder the filler the greater its propensity to wear the screw. Once the solid bed forms, the filler particles are trapped in place by the polymer and the wear greatly decreases. Wear due to mineral fillers occurs directly under the feed hole and dissipates 1-2 turns beyond the feed hole. The second kind of abrasive root wear is due to glass fiber. The wear is almost exactly opposite to that with mineral fillers. That is it begins once the fibers are "locked" into position by the compacted solid bed. The fibers project from the solid bed like whiskers and essentially scratch the screw like a stylus. This repeated scratching results in a very high wear rate. Before compaction of the solid bed the glass fibers are not forced against the screw with enough pressure to cause significant wear. Interestingly, once appreciable melting occurs, the fibers again cannot be rigidly forced against the screw surface and the wear dissipates. The wear from both mineral and glass fibers occurs primarily on the pushing side of the flight where the normal forces are greater due the inherent cross channel component of the conveying force.

For mineral fillers there is little that can be done via screw design to minimize the wear. Solutions are obtained by wear resistant screw materials, improved feed pressure and choice of fillers. Wear due to glass fibers is related to the onset and duration of solids bed compaction prior to sufficient melting. This can be controlled somewhat by screw design once the wear pattern has been identified. However wear resistant materials are the best solution.

Corrosive wear can occur separately or in conjunction with abrasive wear. It is usually evidenced by a pitted or grainy finish as opposed to the polished surface typical of abrasive wear. Corrosive wear can occur anywhere in the screw depending on what is causing the corrosive medium. Since fillers often have chemical additives that enhance bonding to the polymer, the likelihood of a combined abrasive/corrosive attack is very high. Often a reduction in the corrosive attack will greatly reduce the abrasive as well since the combined attack seems to cause an exponential wear rate. For corrosive wear alone the cause is typically a acid medium generated by degradation products of the base polymer or additives. These degradation products form at various points in the screw depending on temperature, residence time and the chemical components involved. Solutions can be modification of the chemical reactions or corrosion resistant screw materials. Corrosion resistant materials can either be coatings or base materials. Common coatings are chrome plating and nickel plating. Base materials are typically stainless steels or nickel base alloys. Nitrifying the screw surface is also an effective and inexpensive method of corrosion protection. Screw design occasionally can play a part when excessive shear rates or extreme back flow cause abnormal overheating.

The important thing to remember in abrasion or corrosion of the screw root is to determine the cause before selecting the solution. A lot of time and money can be saved by applying the correct solution initially rather than a trial and error approach. The most important clues are in your worn screw. Be sure to study it carefully.

- J. D. Frankland

See also:

- Barrel and screw wear
- Extrusion screw wear
- Screw and barrel wear
- The effect of flight radii size on the performance of single screw extruders
- Where's the wear?

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