Where's the Wear? Part II

Where's the Wear? Part II - Some comments on screw and barrel wear
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The last newsletter had PART I of this article. It primarily addressed subjects related to screw wear. PART II discusses barrel wear and offers solutions to screw and barrel wear problems.

Machine it Again Sam
If the preceding reasoning is followed, a lot of worn screws will be acquitted of their alleged crimes. For those that are indeed found worthy of repair or replacement, a new set of problems is generated: make it like before, alter the material, alter the de sign, or both.

Making it like before may be the cheapest and best answer, but in cases where "before" was just a flame-hardened flight surface, it is almost as cheap to use a harder flight surface, as the flight will have to be ground down and rewelded in any case. There is a wide variety of available metals and surface treatments, and the choice will depend on cost, how soon the screw can be finished (if the line is down while waiting), and material of the barrel it is to go into. This last factor is based on the possibility of metal-to-metal contact (thus possible galling) even though this should not occur in normal extrusion; the need for barrel-screw compatibility was publicized by a barrel maker about ten years ago, and has become commonly accepted.

The problem of design is even more complicated, as once it is decided to make a new screw, a new set of options arises: should we add a mixing head, should we have a barrier section, what are the radii at the screw root, what should flight-wall clearances be, should flights be beveled or otherwise varied from usual rectangular cross-section, and (most important) what are the channel depths and lengths in each zone? Beware the term "compression ratio" (ratio of volumes of first to last flights); although it has some utility, it doesn’t specify a screw exactly, and the same compression ratio can be used to make very different screws. Be sure to specify actual dimensions, and measure the screw when it arrives to ensure it is made accordingly. This is standard quality control, and can save a lot of headaches and downtime later on. Furthermore, a record of original dimensions and the temperature at which they were taken will be needed to ascertain future wear.

It should now be clear why the simple decision to repair a screw is something to be made carefully, including the internal cost of the people charged with specifying dimensions or reviewing the ones proposed by suppliers. Performance guarantees should be viewed with respectful caution, and must specify material, melt temperature, die resistance and precision (pressure or amperage fluctuation) to be meaningful.

Sometimes a screw is damaged so much that it must be repaired or replaced. This is not needed if there are just a few chipped flights; remember that the entire length of the screw does the pumping and a few chips will not have a noticeable effect. Really serious damage might be a screw so badly bent that it cannot fit into the barrel, or (worse yet) it fits but still puts a lateral stress on the bearing. Sometimes, too, a screw root is so rough that, with sensitive plastics such as PVC, degradation starts there. Be sure this is the case before spending much money having the root refinished, and don’t get a brand new screw until at least two "doctors" say the case is hopeless.

Barrels
What about the barrel? A barrel wears, too, but typically less than the screw because it is usually harder. Also, its area is around ten times greater; if wear were equally divided between screw and barrel, the barrel would wear down at 1/10 the rate.

In cases of abrasion and corrosion, barrel materials should be selected from the start to resist such actions. Misalignment can create unusual barrel wear, e.g., oval, and its detection by borescoping the barrel may be useful in determining the origin of the problem.

Even toll-gate wear can signal an increase in barrel dimensions, which would make pumping efficiency even worse at that point. This may not be real wear, but rather a permanent expansion of the barrel (creep), plus some elastic deformation, due to the extremely high temperatures and pressures there.

Another barrel problem at the toll gate is longitudinal cracking, resulting from the same high pressure. The liner is

usually more brittle than the outer steel shell and may show cracks even though the shell does not fail. These cracks can be seen with a proper light, and indicate the need for borescoping to determine actual barrel diameter. If there isn't much change, operation can continue (don't conclude too quickly that the cracks are causing trouble), but measurement and inspection should be done frequently to make sure things aren't getting worse very fast.

Since we can never be sure of what the real pressures are in a blue-screw situation, we can't make reliable calculations of the actual flight-to-wall clearance. We can get an idea by using computer simulation to get a pressure profile along the screw. If the modulus at extrusion temperatures and the dimensions of both liner and barrel are known, the deflection (expansion) of the barrel can be calculated. This may not always be worth the trouble, but is certainly a reasonable requirement before commitment of thousands of dollars to repair or replacement.

Barrels can be damaged, too, but seldom so badly that they need repair. A nut or other bit of hardened steel may lodge at some place down the screw (a Maddock section is a favorite place) and grind circumferential grooves in the liner, but these are harmless, except for their capacity to harbor degradation. Grinding out a barrel is normally not a good idea, as some or all of the liner will be lost (it is typically around 1.5mm = 1/16"), and in any case, the original screws will no longer fit. However, a worn screw can be built up to a slightly larger diameter, and then can match a widened barrel.

With barrels and screws that are lightly nitrided, or some very inexpensive ones that are neither nitrided nor lined, excess wear can be expected and the life of such equipment is limited. This is why every extruder buyer should know the screw and barrel materials beforehand, and plan accordingly.

- Allan Griff

See also:

- Alternatives for extruder barrel construction
- Barrel and screw wear
- The effect of flight radii size on the performance of single-screw extruders
- Excessive screw wear
- Extrusion screw wear
- Where's the wear?

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