Have a Molding Problem?

The Answer Might Be Viscosity!

By Chris Nomura, Consultant/Trainer

A student once joked with me that, "9 out of 10 times when you ask a question, the answer is viscosity."

While I don't think it's quite 9 out of 10, the student did have a point. I like asking students why things happen, and quite often viscosity is the answer. Put another way, if the viscosity of the material was either consistent or predictable, this whole injection molding thing would be easy.

If, by the student's estimation, 90% of our issues come back to viscosity, it sure would make sense to track it.

One of the most common ways of measuring viscosity is MFI, or melt flow index. When a supplier calls a plastic a "10 melt" or a "14 melt", they are refering to the MFI.

The melt flow test is very simple: plastic is put into a heated pot and then pushed out of this pot through a small hole via a piston with weights pushing on it. Different plastics have specified temperatures and weights that are used to make the test valid for different materials. After ten minutes, the material that has been pushed out of the heated pot is weighed. This value in grams is the MFI.

Materials with lower viscosities will result in more material being pushed out of the heated pot, therefore a "16 melt" has a lower viscoisty (is easier to flow) than a "12 melt".

When a new lot of material comes in, the vendor will often specify what results that lot received from the MFI test. In our classes, we teach that we can expect up to a 20% viscosity shift in the material itself, irrespective of any damage the molder may or may not do to it. If this sounds like a large number, look at your next lot and you will see that the tolerance range on a "12 melt" material maybe as large as 7 to 15 percent, or even a bit over 20 percent!

As valuable as knowing the MFI of a particular lot is, consider that this is a very small sample (quite literally a few grams) of a tremendous amount of material—perhaps hundreds of tons.

Even molders who are aware of MFI often relegate it to the realm of the material suppliers—once the lot is out of the shipping dock, MFI becomes a forgotten concept.

This is unfortunate, because the MFI test can tell us a great deal about our material. Plastics can degrade in different ways, one of which is polymer chain degredation. Polymer chain degredation is a simple breaking of the polymer chains. Two important things happen when polymer chain degredation occurs: the material becomes weaker and the viscosity lowers. There are clear part performance issues with weaker material, and lower viscosity plastic will tend to give us issues, such as out of spec dimensions or flash.

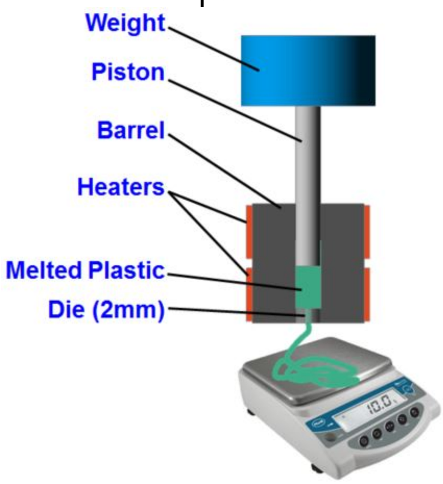

Figure 1: A basic Melt Flow Indexer. Machines range in complexity from ones not much different from the one drawn here, to computer-controlled, fully integrated systems.

A Melt Flow Indexer can be purchased for much less than the far more common moisture analyzer and can be a very helpful tool for helping to determine if our material has degraded.

For example, if we compare the condition of the plastic in the feedthroat to the condition of the plastic after it has been molded, we can determine if we are indeed degrading our material and take action to correct the situation. Although we often assume that all degredation occurs in the barrel, we can damage plastic at multiple phases of the value stream. Chemical contaminants during shipping, overdrying, or exposure to UV light can all cause polymer chain degredation, and isolating the root cause is the first step in fixing the issue.

The Melt Flow Indexer uses a weighted plunger to push plastic out of a heated pot, and although not every molder has this particular piece of equipment, they all have something very similar—an injection molding machine.

Viscosity can be thought of as how hard we are working to flow the material. If I asked you, "What is more work: moving 50 pounds, 10 feet or moving 100 pounds, 5 feet," you could make the argument that they are both equal amounts of effort. We can use the same thought process to calculate the effective viscosity of our material. By multiplying the fill time by the injection pressure at transfer, we can approximate how hard the machine is working and for how long.

If we track viscosity changes over time, we can often be alerted to problems well before quality has a chance to inspect the parts. When viscosity rises, pressure in the cavity drops, which yields smaller parts or parts with sinks and shorts. As confusing as it may seem, higher injection pressures typically indicate lower cavity pressures.

Many students have trouble believing that viscosity changes really are important. An activity I like to have students do is track effective viscosity and quality issues. Often we find that short shots correlate with higher viscosities and flash correlates with lower ones. Figure 2 shows an example of data over time. Notice the clear correlation between viscosity and cavity pressure—molders who are already using instrumented molding are likely familiar with this correlation. Since variations in cavity pressure influence most of our issues (dimensional variation, shorts, sink, flash, warp, etc.), tracking one of its drivers is tremendously valuable.

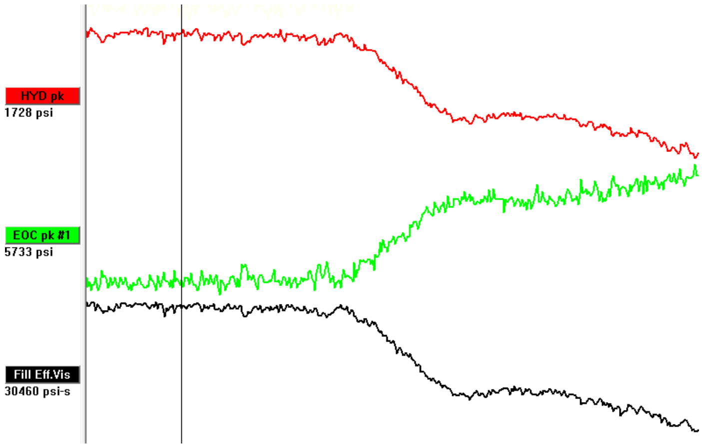

Figure 2: An example of a viscosity shift and its effect on cavity pressure. Note that the peak injection pressure correlates inversely with cavity pressure.

Tracking viscosity is a vital step in solving a great deal of your molding problems. Next time a solid process turns into a headache, you won't have to guess whether or not the viscosity changed, or by how much.

Chris Nomura is an RJG Consultant/Trainer. Chris is a certified Master Molder^{SM} that is qualified to teach Scientific and DECOUPLED MOLDING^{SM} methodologies and techniques. Chris is the only RJG trainer who is certified to provide RJG training courses in Pig Latin. He enjoys curling up with a good book, loves caramel macchiatos, and is the 3-year champion of the RJG hotdog eating competition.