The Realities of Being a Superextruder Today

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Benchmarking procedures and the various improvements required in measurement, equipment, and processes that could potentially turn an average extruder into a Superextruder have been widely discussed in literature, but it seems that the primary beneficiaries of all this knowledge have been the Superextruders. They are the ones realizing the largest gains in productivity and profitability, while the average extruders languish behind, with only small improvements. Why is this?

Still the Same – The Physics of Extrusion

The extrusion press cycle is still the same as it was when the original benchmarking studies were done in the early 80s. Every extruder is faced with the identical exit temperature constraints for a particular profile and alloy. The physics of extrusion is the same, and each extruder must: extrude at nominal pressure (too low means billet is too hot, too high means extrusion is delayed), extrude in automatic cycle (reduce dead and wasted time), and must not extrude scrap (why waste valuable time producing scrap, when you can make butt large enough). If the extruder does not abide by these rules, they will either leave money on the table or go out of business.

Only three critical variables can be adjusted in the extrusion process: material, time, and speed. Let's break these down. When we talk about material, we are concerned with recovery—how much of the billet is converted into saleable product. We also express this as a percentage, and when we compare the average extruder and the Superextruders, the numbers are close. Average extruders convert 80% of the billet into good product, for Superextruders the number is 82%. The potential range for recovery is probably 70-90%, but trying to push this number beyond what we see the Superextruders achieve will inevitably drop productivity.

Time is essentially contact utilization—that part of the extrusion cycle where you're actually making money. The difference we see here between the average extruder and the Superextruders is also not large, perhaps 60% vs. 65% respectively. This can range from approximately 50-70% of total cycle time in the marketplace.

In recent years, there has been a trend toward longer containers, many of which are front-loading. These have allowed the use of longer billets and shorter dead cycle times in a relatively small footprint. As the dead cycle time is still the same or shorter, the relative percentage of live cycle time has been increased with an exponential increase in contact utilization. But there are downsides to this. Although some extruders have experienced the hoped-for improvement, particularly those producing coiled products, the problem is that longer billets must overcome more friction. This results in much higher temperatures, more stresses on the dummy block, and problems with metal flow and butt shearing. The only option left may be to reduce ram speeds, cancelling out any longed-for gain in productivity.

Finally, we come to speed and, of course, here we are talking about ram speed. Ram speeds have the greatest potential variability of the three factors—they range from 7 inches/min (3 mm/sec) up to 40-45 inches min (18 or even 20 mm/sec) for some 6000 series alloys. Here, the difference between average extruders and Superextruders shows a bigger gap. Average extruders run speeds of 23 inches/min (9.7 mm/sec), whereas Superextruders run at 30 inches/min (12.7 mm/sec) for 6063 alloys—approximately 30% faster. This might appear to be the best potential for improvement for the average extruder—just crank up the ram speed and become Superextruders, too! Ah, but as always, there's a catch (maybe more than one). Faster speeds are no help if the temperature rises and causes recovery to drop. Looks like we're back to square one.

The funny thing is, the faster we go, the faster we *can* go. Surface finish becomes better, and if the extra heat can be dissipated by the container, we can turn the knobs up and increase productivity and profit!

Realities

The "perfect die" can only be used as a result of an increased knowledge of the moment of extrusion and an understanding of the effective interaction of components that support the die. These include but are not limited to; mechanical and thermal press alignment, billet temperature, die temperature, and container temperature. If these are not controlled, the perfect die will require features that increase friction, cause temperatures to increase, and slow ram speed. Most die correction is temperature induced and increases friction, reducing speed, and adding variability to the process.

Long billets (those more than five times diameter) require more press force to maintain the required break through pressure, which may require a three-piece container and a stronger dummy block. They may also affect metal flow, profile dimensions and butt length calculations. Longer billets produce more heat, and unless billets, containers, and dies can compensate, ram speeds will be reduced.

The 10-12 second dead cycle exists but is typically not used by Superextruders and can cause more downtime associated with equipment reliability.

Temperature in extrusion is often not uniform. Therefore, what we aim to have is temperature stability of the billet, container, die, and profile.

The right equipment need not be the newest. Many Superextruders do not have the newest presses and equipment.

Conclusion

Extruders are required to produce profiles with thinner walls, more features, stronger mechanical strength and better finishes, and using alloys that vary in extrudability and other properties. Those extruding 6063 simple profiles are "few and far between."

Fortunately, we understand the function of the container better, not just in terms of strength, but also in its effect on the die and profile temperature, as well as metal flow. Any part of the process that increases temperature reduces ram speed! Any part of the process that causes temperature instability requires a die with more features that use friction to gain control of flow, which again reduces ram speed.

Superextruders obviously didn't get to be Superextruders purely by luck, and it's unlikely that they have all shared the same magic formula for success—but there are things they have in common. When we look at their net productivity gain over the average, we see numbers in the 40-50% range. What average extruder wouldn't want to see that kind of improvement?

The most important concept to take away from this discussion of the three factors of material, time, and speed is *balance*. If we attempt to push the envelope on any of them individually, we run the risk of failure in the others, and productivity (and of course profit) goes out the window. Understanding this balance is the first prerequisite to becoming a Superextruder. The path to getting there may vary. It depends on all of the physical factors of a given extruder's equipment, their operators, how diligent they are in following procedures, how carefully they measure and control temperatures, and ultimately how much they care about producing a final product that maximizes quality and profitability.

The information is out there. The average extruder can learn, implement new procedures and techniques, become more diligent, and—in short, *can* become Super! ■