Top 10 Worst Extrusion Practices (And How They Can be Avoided)

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Worst Practices Checklist

- ❑ Press is not precisely aligned.
- ❑ Die is not uniformly and adequately preheated.
- ❑ Die is too strong.
- ❑ Die bearings are badly oxidized.
- ❑ Billet is poorly cut, surface is not clean.
- ❑ Billet is insufficiently taper heated.
- ❑ Dummy block is no longer contracting.
- ❑ Container is overheating.
- ❑ Container liner exit temperature is vertically inconsistent.
- ❑ Too much Dag is being used.

Much has been written about Best Practices for the extruder. A number of major multi-plant extruders already have Best Practices manuals. These are usually very detailed, and are meant to ensure that all their facilities anticipate anything that may prevent 100% quality and maximum productivity. The obverse to this is the Worst Practices List. This includes common but avoidable problems in the production system between the billet and the die. From this preliminary list, an extruder may identify some of the areas in his process that can be improved. Few extruders can honestly claim to have none of these problems.

It's Not Just the Die

The die is the heart of the extrusion process and, until fairly recently, it was the main focus of the extruder's attention. Now, however, many die makers can provide dies that will make perfect product from the first push but only if the alloy is at the optimum temperature for maximum speed as it enters a properly preheated die. The prime focus of the extruder is now on improving the efficiency of his production process.

No attempt has been made to prioritize these problem practices since their real importance and frequency is impossible to quantify. For the extruder who is sincerely committed to ongoing improvement, concentrating on the basic purpose and function of each component involved in managing the temperature of the billet, and utilizing the state-of-the-art technology currently available, is a certain formula for immediate improvement in both productivity and profit.

In discussing the function and effect of different parts of the extrusion process for the purpose of improving efficiency, it is advisable to avoid evaluating any part individually, without regard for its interaction with other components. Maximum productivity can only be achieved if all parts of the process work together as a coordinated interactive system.

Overcoming Worst Practices

Press is not precisely aligned: Press alignment should always be the first item on any list of extrusion practices. Good extrusion depends on all components of the press being physically in precise alignment, and the die being mounted exactly in the center of the container. If this is not done, good extrusion is impossible. Regular inspection at operating temperature is essential, with emphasis always on preventing rather than correcting misalignment.

Die is not uniformly and adequately preheated: The die is usually designed to already be completely at operating temperature when the first push begins. If it isn't, a perfect profile is usually impossible until one or two billets are wasted in heating the die. The answer to this problem is the single-cell die oven. This will bring the die quickly and uniformly to operating temperature. To avoid the initial capital expense of a complete battery of single-cell ovens, dies may be held at a moderate temperature for some time in a traditional chest oven, then the necessary heating quickly completed in a single-cell oven when the die is needed.

An extruder today should be able to assume that his die will produce good product immediately, and concentrate on optimizing his production process.

The die is too strong: Anything that prevents the die from creating good product at maximum speed and with minimum scrap, is counterproductive. Unfortunately the die maker usually does not have the luxury of making a perfect die for perfect operating conditions. In real life he must provide a die that is best suited for its anticipated actual use.

If the die maker knows that his die will not likely be uniformly at operating temperature before the first push, he must make it strong enough to withstand the resulting high breakthrough pressure. Press speed can then never be maximized. A strong die is a slow die.

If the die maker knows that the die will be uniformly at operating temperature before the first push, the breakthrough pressure may be reduced by 30-40%. A lower breakthrough pressure allows cooler billet temperatures, and thus greater press speed.

The die corrector used to modify dies primarily to bring the profile to the required tolerances. The integrity of the profile can now usually be taken for granted. The die corrector's prime function now is to provide feedback on temperatures and breakthrough pressures to help the die maker to provide more productive dies.

Very high breakthrough pressure, for example, can bend the die, and cause the core to deflect and distort the profile. Once this danger has been understood and included in the design equation, large, thin, complex shapes that were previously thought impossible to efficiently extrude now become viable.

Die bearings are badly oxidized: When a die is held too long at or near operating temperature in a chest oven, the bearings will oxidize. A satisfactory finish cannot then be obtained on the extruded product. The solution to this problem is, of course, the rapid and controlled heating of single-cell die ovens.

Billet is poorly cut, and surface is not clean: To avoid the air entrapment and blisters from poorly sheared and two-part billets, logs can now be precisely cut with an in-line narrow-cut saw, then welded together before being automatically cut into billets. When the end of the current log is detected, a new log from the magazine is positioned in the cutting line. The logs are then locked firmly in place, and their ends welded together. The joined logs then pass through the cutting and loading process as if no weld existed.

Billets should always be kept clean, because the skin may be inadvertently carried into the product. Scrap will inevitably result.

Billet is insufficiently taper heated: The friction of the die bearings causes heat to be increasingly generated in the alloy as it is pushed through the die. In order to achieve isothermal extrusion, that is, to allow the alloy to pass through the die at its maximum operating temperature and speed at all times, the billet must be initially heated to a temperature that reduces from front to back in order to compensate for this heat of friction.

Taper heating the billet can best be achieved by electrical induction heating. To combine the economy of gas heating with the accuracy and repeatability of induction heating, billets may be first preheated to a base temperature in a gas-fired oven. The hot billets are then transferred to an auxiliary induction billet heater where multiple separately controlled heating zones are programmed to quickly and accurately provide the necessary taper heating. Once the taper heating program for any shape has been confirmed by both calculation and experience, it can again be successfully used for even a single billet. If the temperature of the billet is not adequately tapered before extrusion begins, maximum press speed is impossible.

Dummy block is no longer contracting: For the dummy block to work properly, a thin film of alloy must remain between the block and the container liner at all times during the extrusion process. Its thickness should be uniform. With a soft alloy, the clearance that creates this film will be only about 0.006 in. If the clearance is more, the alloy will penetrate the gap in the first push. If much less, this essential film of alloy will be stripped from the liner. Stripping the film of aluminum off the liner results in scrap due to blisters, and also to inferior alloy being carried into the extrusion, instead of being discarded in the butt.

An effective dummy block must expand quickly under load. It must separate cleanly from the billet at the end of the stroke, then contract immediately and return through the container without stripping the film of alloy from the liner. The measure of the real value of a dummy block is its ability to continue to contract fully after an unusually large number of pushes, before it takes a permanent set and no longer contracts. The operating lives of contemporary dummy blocks can vary widely.

Container is overheating: If the container temperature sensors and heating elements are not close to the liner, overheating can easily occur. Heating elements, unless properly controlled, can reach temperatures of 1,300°-1,400°F. The container mantle is usually of 4340 steel, which may begin to temper and soften at 1,000°F. If the mantle softens, bellying of the liner will likely occur. This will allow a buildup of impurities from the billet skin that will eventually end up in the extrusion. Scrap will result.

Container liner exit temperature is vertically inconsistent: At the die end of the container, the temperature of the top of the liner is usually considerably higher than at the bottom. This is caused primarily by the heat rising inside the container housing. The result is that the alloy entering the die at the top is less viscous than at the bottom, and therefore flows at a greater velocity through the upper apertures.

A rule of thumb is that every 10°F difference between the top and bottom of the liner will cause 1% difference in the runout length. On a long table, unless the upper die apertures are choked, major problems will occur, especially when using a puller. The solution is for the container thermal control system to have top and bottom as well as axial temperature control zones.

Too much Dag is being used: In the billet delivery system, the final factor is the introduction of lubrication. Ideally, the dummy block would pass smoothly through the container liner, and at the end of the stroke, the butt would fall off. Unfortunately this just doesn't always happen.

Too much lubrication has always been anathema to extruders. The old saying used to be, "Use no lubrication, then wipe off any surplus." We have learned much about extrusion since then, and much about the necessity and the effective use of lubrication.

At the end of each extrusion cycle, the fixed dummy block must separate instantly and cleanly from the butt, without pulling the extruded section from the die and also without breaking the mandrel or stud in the dummy block. Sticking can be a serious problem. It is essential, therefore, that both the dummy block and the billet are properly lubricated to provide immediate and effortless separation.

Effective lubrication ensures instant and clean separation of the dummy block from the butt. It also ensures clean butt release from the shear. It keeps the container seal face clean and free of alloy, and reduces scrap due to blisters.

Powder or liquid boron nitride, developed specifically for light metal extrusion, is today universally considered to be the ultimate lubricant.

Conclusion

Over the years, the buying practice of most extruders has gradually evolved. At one time, relationship buying was a common practice. The extruder's supplier very often became a personal friend. He then usually had an opportunity to meet any competing supplier's price. Next, almost all tooling was treated as a commodity, and price took precedence over all else. Now, the astute extruder is making every effort to measure the real value of his purchases. He understands the importance of the interaction between some components, the value of undivided responsibility whenever possible, and the need for a detailed and tight specification to ensure that competing suppliers will provide products of at least equal value.

The successful extruder's focus now is on improving profit by improving productivity. We can no longer afford any poor practices.

Key Temperatures

Tempering Temp. of Common Materials			
	H-13	46-48 HRC	585°C (1,085°F)
	4340	34-38 HRC	540°C (1,000°F)
Max. Billet Temp.	485° to 500°C (900° to 930°F)		
Max. Exit Temp.	570°C (1,085°F)		
Alloy Melt Pt.			
	6063	600° to 650°C (1,110° to 1,200°F)	
	2024	500° to 640°C (930° to 1,185°F)	
	7075	475° to 640°C (885° to 1,185°F)	
Heating Elements			
	Not Controlled	700° to 760°C (1,300° to 1,400°F)	
Torch (Open Flame)			
	Not Controlled	3,000°C (5,000°F) Plus	

Editor's Note: After reading the most recent issue of Light Metal Age *which included an illustration of a press operator with an open torch near an extrusion die, Paul Robbins sent this quick guide to key temperatures. We are including this key as part of Robbins' instructive extrusion practices article to encourage better practices in the extrusion industry.*