Feature

Good maintenance is not enough for today's extruder

Paul Robbins, the CEO of the Canadian Castool organisation provides some practical guidance on obtaining quality extrusions at maximum speed from the first push — every time.

By definition, maintenance means to keep something in good condition.... To keep it running.... To fix it if it breaks. It has often been said that if you keep doing the same thing the same way, you're likely to keep getting the same results. The problem for many extruders today is that the same results are no longer enough. The market is expanding, but it's also becoming more demanding. Customers want more complex shapes, tighter tolerances, faster delivery, and lower prices. In this challenging business climate, the best way to remain competitive is by better extrusion. "This is the way we've always done it." is no longer acceptable. Fortunately, for most extruders, better extrusion really is possible.

Better extrusion begins with a commitment to ongoing improvement by everyone in the plant. The first step is to begin measuring and recording everything. Dimensions, temperatures, speed, unscheduled downtime, die trials, scrap, and so on. Anything that can be measured can be improved. And it has been proven many times that once a plant is sincerely committed to ongoing improvement, almost everything that is regularly and carefully monitored, measured and recorded, will improve.

Maximum productivity

Maximum productivity and maximum profit are only achieved when the alloy passes through the die at maximum speed, and produces good product with no scrap or unscheduled downtime from the first push of the first billet — every time. Until fairly recently, this was an unlikely event. Now, however, an exponential rate of improvement in the technology of aluminium extrusion equipment, plus new knowledge of the actual physics of the extrusion production process, not only makes maximum productivity achievable, it also makes possible more complex and more precise shapes. This increases the available market for extrusion. It also increases the market share of the better extruders.

Extrusion as a system

In discussing the function and effect of different parts of the extrusion process with the aim of improving productivity, care should be taken to avoid evaluating any single part individually, without regard for its interaction with other components. Maximum productivity can only be approached if all parts of the process work together, complementing each other, as a coordinated system.

System alignment

Consider the importance of exact alignment, both thermal and physical, during the extrusion process:

1. The press should always be in precise physical alignment from the ram through the exit of the container;
2. the die should be positioned exactly in the centre of the container exit;
3. before the first push, the die should be completely and uniformly preheated tot he optimum extrusion temperature of the alloy;
4. the temperature of the billet should be remain uniform as it enters the die, and
5. the temperature of the container liner should remain constant and uniform at all times — it should not change the temperature of the die in any way.

At each stage of production, precise alignment, thermal as well as physical, is critical. Zero tolerance is the goal.

Physical press alignment

The importance of the physical alignment of the extrusion press cannot be overstated. For example, if the die is not mounted precisely in the centre of the container, the flow of alloy through the die will be uneven, and the profile will be distorted. Also, the stem and dummy block must pass through the container smoothly, straight and true. For this to happen, the press itself must always be kept in complete physical alignment.

Press misalignment is a major cause of dummy block wear. Accordingly, uneven wear on the front edge or land of the dummy block is usually the first indication of physical misalignment. This can be easily detected. Unfortunately, once a press becomes badly worn, absolute alignment is often impossible. It is important, therefore, that wear on bushings and seals, particularly the ways and the main ram bushing, be checked regularly.

Physical press misalignment is insidious, because it can result from so many different factors such as the press foundation, tie rods, stem, billet loader, die changer, and so on. None of these alone may appear to be too significant, but combined they can result in one of the most common and serious problems in extrusion.

The key to maintaining good press alignment is regular, detailed and diligent inspection. Emphasis must always be on prevention, not on correction.

Physical alignment can, of course, only be accurately measured when the press is completely at operating temperature.

Thermal alignment

The need for the physical alignment of all parts of the extrusion process is obvious. It can be determined and corrected fairly easily. No deviation is acceptable. Absolute thermal alignment, however, is a goal for extruders to strive for. It is difficult to achieve.

As the dummy block pushes the billet through the container, the friction of the liner causes heat to be generated in the alloy. 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.

Heating the billet

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 programme for any shape has been confirmed by both calculation and experience, it can again be successfully used for even a single billet.

The dummy block

The function of the fixed dummy block initially appears to be quite straightforward. It is the extension of the ram and stem that actually pushes the softened alloy through the die. This is, of course its main purpose. If the extruder is aiming for maximum productivity, however, there are a number of additional functions that must be performed by an effective dummy block:

a. To quickly expand under load and maintain a secure seal with the container wall, leaving only a thin film of alloy on the liner;
b. to separate cleanly from the billet at the end of the stroke;
c. to contract immediately, and return through the container without stripping the film of alloy from the liner;
d. to cause no gas entrapment that can result in blistering;
e. to accommodate minor press misalignment, and
f. to be quickly and easily removed and replaced.

The vital feature of the contemporary fixed dummy block is its ability to contract immediately and consistently when pressure is removed at the end of the forward stroke. The fixed block can push the billet through the container like a loose block, but when the extrusion cycle ends, it is able to return back through the container without stripping the necessary film of aluminium from the wall of the liner.

A poor dummy block produces blisters, and the skull ends up in the product instead of being discarded in the butt.

The dummy block and the container

A good example of the importance of thermal alignment in all components of the extrusion production process is the relationship between the dummy block and the container, and their dependence on each other. The operation of neither the dummy block nor the container can be usefully studied individually. They should always be considered as a small system, working closely together. The effective functioning of the dummy block depends on the condition and the temperature of the container. For example, if from misalignment or temperature, the container has become distorted in any way, the operation of the dummy block will be negatively affected immediately.

A problem, of course, is that when it is heated, the dummy block expands. During extrusion, the dummy block operates at the same temperature as the billet and the container. Care must be taken, therefore, to preheat the block to operating temperature before it enters the hot container. For every 80°C difference between initial block temperature and operating temperature, a 200-mm dummy block will expand by about 0.25 mm. Most of this expansion will occur during the first push.

Preheating the die

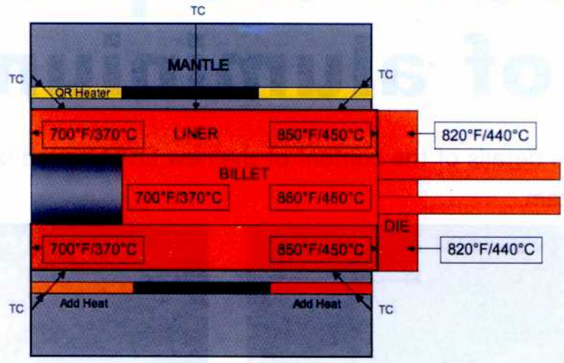
The die is designed to already be completely at operating temperature when extrusion begins. If it isn't, a perfect profile is usually impossible until one or two billets are wasted in bringing the die to a completely uniform temperature. The answer to this problem is the single-cell die oven that will bring the die quickly and uniformly to operating temperature. Also, when the die is uniformly preheated, break-through pressures are usually reduced considerably. An extruder today should be able to assume that his die will produce good product immediately, and concentrate on press speed, scrap reduction and optimising his production process.

Thermal alignment of the container

A high level of technology is required in a container and its thermal control system to allow the extruder to operate his press confidently and consistently at close to maximum speed. The die designer must assume that the flow of alloy into the die during extrusion is uniform. The sizing of die bearings, pockets and ports is based on this assumption.

The total rate of flow of alloy from the container depends, of course, solely on the speed of the ram. The billet, however, is extremely thermoplastic. The viscosity of the alloy changes almost instantly with any change in temperature. As the dummy block moves through the container, if the temperature at any part of the periphery of the billet changes, the rate of the flow of alloy from that point will also change.

Runout lengths remain equal with Castool's QR Container



During extrusion, unless controlled, the top of the container usually becomes hotter than the bottom. Although conduction is the principle method of heat transfer within the container, some of the heat lost from the bottom of the container rises inside the container housing, and increases the temperature at the top. Also, the thermal mass of the container is much greater than that of the die stack. The liner forms a seal with the face of the die, and by conductivity, thermal transfer begins between them as soon as the die is installed. Measurements have shown that during extrusion, the die has the same vertical temperature difference as the top and bottom of the exit of the liner. In a conventional container, without vertical thermal control, this temperature variance may amount to 85 - 100°

If the temperature at the top of the billet becomes hotter than at the bottom, the rate of flow from the top of the container into the die will increase, and the flow from the bottom will accordingly decrease. On a large section, this can distort the shape of the profile. Also, with a large multi-hole die, the length of the runouts will vary. A 5°C difference in liner exit temperature top to bottom will result in about 1% difference in length of runout. This will, of course cause problems both with pullers and with cutting to length. For many years, extruders have been aware of this problem, and correcting it by choking the upper holes in the die

It is difficult to regulate the flow by cooling the top of the liner. The practical solution is therefore to heat the bottom of the liner. This makes it an advantage to have a heating system that can heat a lower zone independently from the upper, making the temperature, and thus the rate of flow of alloy into the die, uniform. Continual uniform billet temperature can only be maintained if the container can immediately correct any change in liner temperature when and where it occurs

As both front and back of the container are exposed, they lose more heat than the centre. If the temperature is not closely controlled, this will result in the centre section of the container becoming hotter than the ends. Furthermore, the temperature at the die end of the container will be slightly higher than at the back, because the billet heats it for a longer period of time.

Maintaining a consistent thermal profile in the axial direction usually requires the addition of only relatively small amounts of heat applied near both ends of the container when needed, to offset the heat loss from the exposed faces. For effective temperature control, however, the container should have a least four separate heating zones, front and back, plus top and bottom.

Controlling container temperature

Both the performance, and to a lesser extent the useful life of a container, are affected by the temperature of the billet during extrusion. They are also affected considerably by the configuration of the container heating system. That is, the location of the heat sources, and of the thermocouples that control them. Ideally, the heat source will close to the need. That is, close to the liner. Also, the heat source should be close to the thermocouple that controls it, so that its response to the demand will be more immediate.

Summary

- Components of the extrusion production process should never be evaluated in isolation, but always as part of a coordinated system.
- Precise thermal as well as physical alignment is essential to maximum productivity.
- The ultimate goal is profit, not simply productivity. The operating life of any component is therefore always a factor to consider.
- A measure of the operating life of any dummy block is the number of times it will immediately contract at the end of the extrusion stroke before remaining permanently expanded, and stripping the liner on the return stroke.
- The billet should be at the calculated and tapered optimum operating temperature when it enters the preheated container. The container should then simply maintain its liner temperature, immediately correcting any fluctuations as they occur. Ideally, the container should not alter the die temperature in any way.

The first step toward better extrusion is regularly measuring and recording everything that can be usefully measured. With better extrusion, maximum productivity and maximum profit are today actually achievable.

Runout lengths vary with conventional containers