This chapter covers the semi-permanent press tooling: dummy blocks, stems, containers, container liners, and their repair, maintenance, and lubrication.

**Fixed Dummy Blocks**

Most aluminum extrusion presses are now fitted with fixed dummy blocks. They offer several advantages over loose dummy blocks:

- Operator involvement is virtually eliminated.
- Expense and downtime due to a handling system for loose dummy blocks are eliminated.
- Slightly longer billets are possible (typically about 2 inches [50mm] longer.
- Butt disposal is simplified.
- Eliminates damage to front of container from loose dummy blocks.
- Eliminates the risk of extruding without a dummy block or having dummy block fall over in the loader.
- Dead cycle time may usually be reduced.

To successfully apply fixed dummy blocks to your press, several factors must be considered:

**Design of the Fixed Block.** Several proprietary designs for fixed dummy blocks are available on the market today. The design principles have been well described in previous publications\(^1\),\(^2\),\(^3\),\(^4\) and will not be reviewed here. In general, the geometry of the body of the block expands under extrusion load, causing the outer edge to expand practically to the inside diameter of the container. The expansion is caused by pushing the insert into the body of the block. At the end of extrusion, relaxation of press pressure allows the insert to retract and the body to contract in diameter, helping to push the butt away from the face of the block.

Dummy block failure is usually related to the limited elasticity of the steels used and the extreme stresses involved, which tend to expand the block past the steel’s creep limits. When the block’s outside diameter experiences a permanent increase of 0.020” (0.5mm), permanent loss of elasticity is likely to have occurred. Common problems are the build-up of excessive aluminum on the block, causing high drawback loads and blistering; and wear on the periphery of the block.

Fixed dummy blocks are commonly constructed of alloy H-13 steel, and hardened to Rockwell C 45 - 49.

**Clearance Within the Container.** The diameter of the dummy block must be selected to allow a tight seal to the container during extrusion, and sufficient clearance to pass easily through the container during the return stroke. There is no general agreement on the proper clearance, as it will depend somewhat on the design of the block. Also, poor press alignment will require greater clearance and thus poorer block performance. Recommended clearances between block and container vary: most commonly 0.030” (0.75mm); but 0.4 to 1.0mm (0.016” to 0.040”) according to

other sources. In fact, most press operators must arrive at the optimum clearance for their situation by trial and error.

**Method of Attachment to the Ram Stem.** Once again, different proprietary designs tend to prevail. The most basic method of attachment is a threaded stud connecting ram stem to dummy block; drawbacks to this design include inflexibility, seizing, difficult changing, and occasional loosening of the block. If the block becomes loose on the stud, the full force of extrusion will come to bear on the stud and will likely break it. Keys and dowels are commonly used to prevent loosening.

A second popular design is the tie bar passing through the stem to a nut at the rear. In this case the base of the block is always in contact with the stem, avoiding excessive loads on the threads.

A proprietary bayonet-type design is said to permit quick change of the block. It is also said to avoid thread damage and to accommodate a small amount of misalignment by permitting some radial movement. (See Figures 3-3 and 3-7)

**Press Alignment.** Alignment of the ram stem and container have been discussed under Chapter 2: Press Alignment. Service life of fixed dummy blocks will be dramatically reduced by poor alignment. Most authorities recommend that misalignment never exceed ±0.020” (±0.5mm).

**Preheating the Dummy Block.** Although the process of extrusion will generate considerable heat, the fixed dummy block still should be preheated before it is placed in service. Preheating will minimize thermal shock and also increase the toughness of the steel, which is higher at press operating temperatures. A recommended temperature is about 600°F (315°C). The block may be preheated in a special oven, or by leaving it in the center of the container for a few hours. However, do not leave the block in any oven for more than a couple of hours, in order to avoid decarburization and loss of temper.

**Lubrication of the Dummy Block and Billet.** This subject has been discussed under Dummy Block Lubrication Best Practices – page 3-27. In general, to eliminate sticking of aluminum to the steel dummy block, lubricant(s) must be applied to the block and/or billet. Most operators lubricate the block by manual or automatic application of water-borne specialty lubes, or manual swabbing of graphite compounds. The ends of pre-cut billets may be painted with specialty lubes or graphite. Sheared billets must be coated after shearing, using flame-generated carbon or spray-applied specialty products such as Boron Nitride.

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5Castle, Alan F., Ibid.
Repairing the Fixed Dummy Block. Replacement is most commonly needed due to wearing of the land area, increase in pick-up during drawback, or loss of elasticity. Castool offers a patented design with a replaceable wear ring.

Worn land areas of dummy blocks may be repaired by welding and re-machining to the original diameter. Castle offers a welding procedure for H-13 blocks:

- Preheat to approximately 400°C (750°F)
- Weld using a gas-shielded arc process (temperature should not fall below 350°C (660°F))
- Slow cool in air to 80°-100°C (175°-212°F) -- very important!
- Double temper

Preventing Dummy Block Damage from the Container Seal Face. The main cause of stem/dummy block breakage is container shifting caused by a build-up of aluminum on the mating surfaces of the die and container seal face. This area needs to be kept in good condition and free of aluminum.

- Liner ID (inside diameter) may be constricted (coined) from using small dies.
- Dummy block should never completely pass through the exit end of the container.
- Butt shear should cut clean on the die face.
- Acetylene torches and pneumatic tools should never be used to clean the sealing face.

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7 From Castool Solutions Bulletin “Fixed Dummy Block.”
• Container travel should be slowed prior to impacting the die face.
• When a burp cycle is needed, do not open the container, only the ram and seal pressures should be reduced.
• Explosions caused by air and lubricant should be eliminated.

**Dummy Block Maintenance**\(^8\). The dummy block should be inspected daily. It should be visually checked for aluminum build-up on the face and land. The land should also be checked for signs of explosions. On blocks with springs, the mandrel should be free and forward from the face of the dummy block. This confirms that the spring is functioning. At the same time, the cap screws securing the bayonet lug and keys should be checked for tightness.

Once each week the dummy block should be removed from the press and cleaned in caustic. It should be visually inspected for wear and accurately measured across the face, the dimension recorded and compared to the original diameter when the block was first delivered. The dummy block will eventually take a set to a larger diameter during use. As the diameter increases, blisters result. Operating life is decreased.

Machining the dummy block’s diameter and/or back face of the mandrel can extend its useful life.

**Loose Dummy Blocks**

Where still in use, loose blocks should be regularly checked for aluminum build up; for stress fractures; for nicks and damage due to mechanical problems; and for dimensional tolerances. If blocks show damage, re-check alignment of the billet loader; and inspect the dummy block handling system and repair as needed.

**Clean-out Blocks**

Regular use of clean-out blocks is recommended for both process reasons and to improve dummy block life. A special block is built to a diameter larger than the dummy block; recommendations range from 0.010” (0.25mm) less than container inside diameter, to 0.030” (0.75mm) larger than the fixed dummy block. The clean-out block must be preheated to 800°F (425°C) before use.

Frequency of use varies according to the plant, some pushing clean-out unit once every shift or after changes; and others never using it. A typical frequency is once weekly.

\(^8\) Ibid.

![Figure 3-5: Clean-out block](Photo courtesy of Castool)
Stem

**Function.** The stem (or ram) transmits the compressive forces from the main cylinder to the billet, and so it must operate under compressive stress without bending, breaking, or upsetting.

**Material.** The stem is constructed of hot work tool steels, typically high in chrome, molybdenum, and tungsten, or chrome, vanadium, and molybdenum; A1S1 H-12 or H-13.

**Heat Treatment.** The stem is typically hardened, quenched, and tempered to a hardness range of 429 - 477 Brinell (Rockwell C45-50). As the stem is not normally subjected to extreme temperatures, it is hardened primarily to provide the necessary compressive strength.

**Desired Material Characteristics.** The stem material is chosen to provide very high hardness, high compressive strength, and very low ductility.

**Causes of Damage.** The stem may be damaged by:

**Thermal Shock:** The stem is very sensitive to thermal shock. Heating or cooling the stem too quickly will invite cracking.

**Failure to Preheat:** At room temperature the stem is too stiff and brittle to be used safely. Preheat to 200-400°F (or 100-200°C) before use. Never use direct flame – use a slow soaking furnace to preheat the stem.

**Misalignment:** Any misalignment may greatly increase the stress concentration within the ram and result in bending or breaking. See Chapter 2 - Press Alignment.

**Impact:** Any sudden impact, such as striking the container or malfunction of the dummy block, may cause sharp stresses and eventually weaken the stem. These stresses may be relieved by following the procedure described below.

**Upsetting:** Watch the face of the stem (the face where the fixed dummy block attaches) for upsetting or deformation under load. When the stem diameter increases by 1/8-inch (3mm), or when hairline cracks appear, the stem should be turned down and re-faced.

**Work Hardening:** Continued high-pressure contact with the dummy block may result in formation on the surface of a thin layer of hard metal with many hairline cracks. To prevent these cracks from expanding and propagating into the stem, periodically remove this work-hardened layer and re-face the stem.

**Fatigue:** The stem, like all press components, is subject to fatigue failure in the form of tiny cracks at stress concentration points. To relieve this condition, stress relieve according to the following procedure:

1. Heat the stem to 1000°F (540°C), at a rate no more than 100°F (55°C) per hour.
2. Hold at this temperature for one hour per inch (25 mm) of stem diameter.
3. Remove from furnace and air cool in still air at room temperature.

Frequency of stress relief of the stem should vary according to the history of the stem; suggested intervals for normal conditions:
### Compressive Stress - Range of Operation

<table>
<thead>
<tr>
<th>Stress Range</th>
<th>Suggested Interval for Stress Relief</th>
</tr>
</thead>
<tbody>
<tr>
<td>180,000 - 200,000 psi</td>
<td>20,000 to 30,000 billets</td>
</tr>
<tr>
<td>160,000 - 180,000 psi</td>
<td>30,000 to 40,000 billets</td>
</tr>
<tr>
<td>130,000 - 160,000 psi</td>
<td>40,000 to 50,000 billets</td>
</tr>
<tr>
<td>100,000 - 130,000 psi</td>
<td>50,000 to 60,000 billets</td>
</tr>
<tr>
<td>Below 100,000 psi</td>
<td>100,000 billets</td>
</tr>
</tbody>
</table>

### Precautions
To avoid damage and maximize life of the stem:

1. Preheat the stem before use. A slow heat-up is desirable. Temperatures above 200°F (93°C) are adequate, but the temperature must be achieved through to the center of the stem.
2. Avoid any direct flame impingement.
3. Avoid any water contact (unless anticipated and a special material chosen for this application).
4. Check press alignment through the entire stroke of the ram.
5. Keep the ram clean and correct any visible damage. Re-machine to remove cracks, upsetting, impact scars, or cuts, and stress relieve after each machining.
6. Avoid welding.

### Preventive Maintenance Check List

1. Keep the stem dressed at all times. Correct any visible damage as soon as possible by machining to clean metal. Watch for small cracks, upsetting, impact scars, or cuts. Stress relieve the stem after each machining. Never weld the stem.
3. Check the end of the stem for upsetting, weekly or each time a fixed dummy block is changed.
4. Check the end of the stem for work hardening, weekly or each time a fixed dummy block is changed.
5. Stress relieve when required according to service and keep a record of stress relief.
6. Check its straightness with a straightedge.
7. Check the pressure plate to which the stem is mounted for damage, deflection, or “coining”, by using a straightedge and feeler gauges; remove and re-grind flat if damaged. The seat must also be clean.
8. The stem retention ring or other stem mounting devices must be properly tightened.

Check the stem and fixed dummy block often for signs of build-up or excessive wear. Any contact forces are transmitted back to the main cylinder and may result in premature wear of the main ram and bushings, and to the crosshead cylinders as well.

Maintain accurate drawings of all tools, for purchase or repair of replacement of spares.

Inspect spare tools when received (new or repaired) for condition and conformance to dimensions – don’t wait until they are needed for use.

Store spare tools in a warm place, to minimize preheat time and avoid thermal shock.

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**Note:** Stems are subject to sudden, catastrophic failure. See the photos in Chapter D – Safety & Environment, Figures D-2 and D-3.
**Container**

**Function.** The container holds and supports the liner to prevent it from breaking under the extreme forces of extrusion. The stress on the liner must be transmitted uniformly to the container, so an accurate shrink fit is required. The shrink fit also induces compressive stresses in the liner, allowing it ultimately to withstand higher stresses. The support must remain uniform and continuous during the extrusion cycle; without it the elastic limit of the liner may be exceeded, causing the liner to fail.

**Material.** The container is a forging, usually chrome-nickel-molybdenum or chrome-molybdenum-vanadium steel, of SAE 4350 or SAE 4150 modified type.

**Heat Treatment.** The container is typically hardened, quenched, and tempered to a hardness range of 280 - 350 Brinell. Draw temperatures over 1000°F (540°C) are used to insure stability at normal operating temperatures; no permanent softening of the container should be experienced during normal service.

**Desired Material Characteristics.** The container material is chosen to provide toughness, high strength, and good ductility when warm.

**Potential Causes of Damage.** The container may be damaged by:

- **Thermal Shock:** Any sudden heating or cooling of the container may cause stress cracking or other damage to the container.
- **Excessive Heat:** At elevated temperatures, the container material will soften and weaken. At about 1100°F (590°C), permanent softening will occur and the container may become unfit for further use.
- **Non-uniform Temperature:** During operation, uneven heat retention may result in a higher temperature near the center of the container. The hotter area will also be weaker and may yield under the pressure of extrusion, causing a “belly” or distortion of the diameter near the center. At lower temperatures (400-600°F/ 200-315°C) this distortion may not be a problem, but at higher temperatures it may become permanent and require re-boring of the container.

**Precautions.** To avoid damage to the container:

1. Preheat the container before use.
2. Heat up slowly – 100°F (55°C) per hour rate of heat-up.
3. Avoid direct flame impingement.
4. Avoid welding. If welding is unavoidable, follow this procedure:
   - Preheat to 1000°F (540°C) before welding
   - Weld
   - Anneal immediately after welding: heat to 1600°F (870°C), soak, furnace cool, re-heat treat.
5. Avoid sudden cooling shocks.

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Figure 3-8: Container cracked through hole for lifting eye. Container was also overheated.
*(Photos courtesy of Lake Park Tool)*

Figure 3-9: Alternative "dove tail" design for container lifting.
6. Operate at the minimum container temperature consistent with good extrusion practices.

7. Check thermocouples often.

8. Visually inspect the container’s keyways periodically for cracks. Cracks found in the bottom radii should be milled or ground to stop their migration into the container body.

9. Check the container for signs of relative movement in the container holder and repair as needed.

**Container Preventive Maintenance Check List.**

1. Maintain good press alignment.
2. Check thermocouples at least weekly.
3. Check radii of keyways for cracks each time container is out of the press.
4. Check container hardness each time a new liner is installed.
5. Re-bore each time a new liner is installed.
6. Check for signs of relative movement in the container holder and repair as needed.
7. Check the faces of the container for nicks, scores, or metal build-up; clean and de-burr, and readjust if needed.

*For additional information on Container maintenance, see “Extrusion Container Care and Maintenance” by James M. Pope, page 3-11.*
Container Liner

Function. The container liner resists the abrasive effects of the aluminum and oxides during extrusion. High hardness at elevated temperatures is achieved at the expense of reduced ductility, so the liner must depend on the support of the container to resist breakage.

Material. The liner is typically an A1S1 H-12 forging. It is a separate part from the container for increased strength and so that it may be replaced when required by wear or damage.

Shrink Fit. The liner is subject to axial loading from friction between the billet and container, so a shrink fit between the liner and container is used to prevent slippage between the components. A shrinkage of 0.24% of the mantle ID is considered the maximum that may be used.

Heat Treatment. The container is typically hardened, quenched, and tempered to a hardness range of 400 - 450 Brinell. A minimum of 2 draws is recommended, three where a final hardness in excess of 477 BHN (50 Rc) is required. Each draw should be held at temperature for 2 hours per inch of thickness, to insure proper soak.

Desired Material Characteristics. The container liner material is chosen to provide high hardness, low strength, and very low ductility.

Potential Causes of Damage. The container liner may be damaged by:

Thermal Shock: The liner is very sensitive to any thermal shock. Any sudden or severe heating or cooling of the container may cause breaking.

Lack of Support: The liner must be fully supported by the container by means of an accurate shrink fit, or it will fail due to the tensile stresses of extrusion. If the container becomes hotter than the liner, the shrink fit will be lost, resulting in failure.

Excessive Heat: At elevated temperatures, the liner material will soften, resulting in premature wear-out. Lower operating temperature will result in longer life and lower costs.

Precautions. To avoid damage and maximize liner life:

1. Preheat the liner before use. A long, slow heat-up (100°F/55°C) per hour is recommended.
2. Be sure that the preheat procedure does not result in loss of the shrink fit.
3. Keep the liner warm when the press is not operating. As a minimum, close the ends of the container to prevent cooling; advance the ram so that the dummy block is inside the container bore. During longer delays, an electrical resistance heater should be placed in the bore of the liner and the ends of the container covered.
4. Be sure that the container temperature never exceeds liner temperature enough to result in the loss of the shrink fit.
5. Avoid any direct flame impingement.
6. Avoid any contact with water.
7. Avoid welding.
8. Keep the sealing face clean; avoid any accumulation of dirt, aluminum flash, lubricants, or water.

Preventive Maintenance Check List.

1. Keep the bore from cooling when the press is not operating.
2. Keep the sealing face clean.
3. Do not operate with a cracked or broken liner.

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Notes:
Introduction. For those of you who work in an extrusion plant, that big hunk of steel referred to as “the press” appears to simply sit there and effortlessly produce extrusions. To the contrary, however, this machine is doing tremendous work, and very high stresses are being induced in all the major components. During every push the tie rods are stretching, the main cylinder is bowing and elongating, the front platen is bending, the stem is being compressed, and the container liner assembly is subject to very high hoop stress forces. In this presentation we are going to examine the container-liner assembly and how to obtain the maximum life from it.

Container-liner assemblies are considered expendable tooling and are therefore expected to have a finite service life. Unfortunately they are also one of the most abused parts of an extrusion press. Excluding the dies they are the only part of the press that has to do its work at a constantly elevated temperature. The stem also gets hot, but it is normally half the temperature of the container. Due to the combination of high stresses and heat under which it must perform it is imperative that certain procedures be observed in order to get the maximum possible life out of your container-liner assemblies.

Following are the most common causes of premature container or liner damage and failure:

- Improper pre-heating
- Over-heating
- Fatigue cracks
- Misalignment between the stem and the container
- Misalignment of the press frame (tie rods)
- Insufficient bearing area between the die and the liner face
- Aluminum buildup on the face of the die
- Caved platen pressure ring or caved platen

Pre-heating. Let us start with a review of the proper pre-heat procedures for a new or cold container. The most preferred way to pre-heat a container is in a dedicated pre-heat oven with accurate temperature controls. Lacking this piece of equipment some extruders use their aging oven or die pre-heat oven. When using an extrusion aging oven for pre-heating, the container can only be brought up to 400 to 450°F (200 to 230°C). The remainder of the heating process will have to be done in the press.

During pre-heating the container should be brought up to extrusion temperature of 700 to 800°F (370 to 425°C) in increments of 100°F (55°C). It is recommended to allow a 15 minute minimum soaking time between raising the temperature increments when the container is below 400°F (200°C). Once it is above 400°F (200°C) the soaking time should be 30 minutes between raising the temperature increments. The container should have a thermocouple inserted in it to verify the temperature. If the container is being pre-heated in the press there should be a minimum of two thermocouples used, one to read the internal temperature at the liner and another to read the temperature of the outside diameter. It is important to monitor the outside diameter temperature in order to not over heat and anneal the container. If a bore heater is being used in tandem with the press heaters, care should be taken to balance the heating between the two systems. A bore heater should never be used as the only source of pre-heating a container as there is a great risk of splitting the liner and container. A container should never be put into production under 650°F (340°C) with 700°F (370°C) being the recommended minimum.
Over heating. Evidence of over heating is scaling or erosion of the container outside diameter. In most instances of over heating the container has also lost its proper hardness. In extreme cases the entire container will be bowed.

Annealing of steel is a basic function of time versus temperature. The annealing temperature for H-12 and H-13 steels starts at 1100 °F (590°C). However prolonged use at lower temperatures has the same effect. Therefore it is of utmost importance to limit the temperature of containers to 750°F (400°C) or less. Overheating can usually be attributed to inadequate temperature controls or in some cases failed controls. Very few presses built prior to the late 1980’s had more than a single thermocouple to monitor the container temperature. Due to increasing complaints about short container life, the press builders began to install a second thermocouple to monitor the temperature on the outside of the container. This controller was normally set at 900 to 950°F (480 to 510°C) and would shut off the container heating system if the container reached this temperature. If your press does not have an over-temperature protection thermocouple one should be installed as soon as possible.

Today all new presses are being built with four to six zones of temperature controls. Another feature now being used in containers is air cooling of the liner in the front half next to the die. This is being done as a production enhancement, however it has also contributed to keeping the container in the desired temperature range. The zone heating and liner cooling are also features that are now being incorporated into retrofit packages for older presses.

Fatigue Cracks. Cracking begins to occur in containers that have been in service long enough to begin to lose their hardness. Most cracks start to show in keyways and this is due to several factors. A loss of hardness is the most common reason and this is due to over heating. Another reason is improper machining. No sharp corners should exist in internal corners. They should be machined with at least a .125 inch (0.30mm) radius. Sometimes the container design can be modified to eliminate keyways being cut the entire length of the container. If cracks start to show up around lift holes or thermocouple holes this again is usually due to a loss of hardness and the resultant bowing. Once cracking has started to occur, the container’s useful life is basically over.

Misalignment Between the Stem and the Container. Some 15 to 20 years ago, before widespread use of fixed dummy blocks, container alignment was not a real critical component of extrusion press operation. As long as the container was close to being centered on the die and the billet would go into the liner bore and the stem was close to being in line with the liner bore, this was good enough as the loose dummy blocks of that era had excellent self aligning properties. Today, with almost universal use of fixed dummy blocks, accurate container alignment is critical to the operation of an extrusion press. Some fixed dummy blocks are designed to float or adjust for small amounts of misalignment. However the ability for dummy block self alignment should not be an excuse for not having precise guiding of the container and good alignment adjustment capability. Misalignment between the fixed dummy block and the liner bore can cause chips to be cut out of the entry end of the liner face. Longitudinal score lines on the inside of the liner bore are also an indication of the container bore not being concentric with the press centerline.
**Misalignment of the Press Tie Rods.** If the tie rods have lost their pre-stress or the cylinder and front platens are out of tram this could cause the container to shift away from the press centerline during extrusion. This condition would cause longitudinal scoring inside the liner bore. This condition cannot be detected by simply checking the clearances between the stem and liner bore when the press is at rest as the container shifts out of alignment only after pressure has been applied. A pre-stress and tram check of the press is required to find and correct this problem.

**Insufficient Bearing Area Between the Die and Liner Face.** To prevent flashing of the aluminum between the die and the liner, a positive clamping force is applied to seal the container against the die. This force is greatly augmented at the beginning of extrusion by the force of the press. This is due to a good percentage of the press tonnage being transmitted into the container due to friction of the billet against the liner bore. This force diminishes as the billet is extruded until a point is reached whereby a reverse force is actually induced into the liner. One would think that it would be easy to calculate the force of the liner on the die and allow for sufficient bearing area. However it is not so simple.

The sealing pressure exerted on the die by the press container shift cylinders is easy to calculate. The additional forces emanating from the press are very difficult if not impossible to determine as they vary with the pressure required to extrude each billet and are constantly diminishing as the ram advances through the container. To reduce or prevent die indentation into the liner face, ideally there should be a minimum of 1 ½ inches of bearing area around the liner. This means that a 7-3/8 inch bore liner should have a 10 3/8 inch die face. In the real world this does not usually happen due to the costs of the larger dies. Most presses with a 7-3/8 liner bore have die faces of only 8-1/2 inches and sometimes even less. This is the reason that the die coins itself into the face of the liner and it must be periodically faced off. When a container is relined a minimum of ¼ inch but no more than ½ inch should be allowed for future facing. In no case should the liner be allowed to become flush with the container.

**Aluminum Build Up on the Face of the Die.** The build up of aluminum on the face of the die will cause flash outs and damage to the face of the container. The internal bore of the liner could also experience scoring if the build up is of sufficient thickness and is unevenly distributed around the die to such an extent that it forces the container off centerline. The dies need to be kept

![Figure 3-11: Liner with badly coined face, probably due to insufficient contact surface between die and liner face. (Photo courtesy of Lake Park Tool)](image-url)
clean and free of this buildup. The buildup of aluminum is mainly caused by the butt shear not severing the butt cleanly off the die. This can be the fault of the shear in that its design is not conducive to clean shearing. Another contributing factor to aluminum buildup is the fact that in most presses the die tooling is not held in position securely enough to prevent moving during shearing. Spraying the face of the die is one remedy but not a cure. A more long term solution is to install a butt shear that has a well guided blade carrier and a sharp cutting angle on the shear blade itself. For the shear to operate most efficiently a positive die hold-down that is hydraulically activated is required. This device will hold the die tooling securely in place during shearing.

**Caved Pressure Ring and/or Caved Platen Seat Behind the Ring.** If the die support ring in the platen or the platen itself is dished or caved in, this will cause the container to move off centerline and cause the same problems as die build up. This condition will also cause numerous die problems, however this subject is not part of this presentation.

**Inspection before relining.** When a container does need to be relined, a thorough inspection of the unit in your plant could save you the cost of shipping a heavy piece of scrap to a reline shop. If the container has extensive cracks in the keyways or in lift holes or in thermocouple holes or is annealed and bowed, it is probably not worth relining. New containers made from 4340 forged steel are heat treated to 34-38 Rockwell “C” scale. If H-13 is used for the container they are heat treated to 38-42 Rockwell “C”. The liners are mostly made from H-13 and are heat treated to 44-48 Rockwell “C”. If A-286 or Inco alloys are used for the liners they are solution aged to 40-44 Rockwell “C”.

In summary there are a number of corrective measures that can be taken to get the most life possible out of your containers and liners. Understanding the cause of the problems will allow you to take the proper corrective measures that will extend the life of your container/liner assemblies.
Recent Improvements in Container Design

**Container Heating.** In years past, most containers were heated by electric heating elements located outside the container, in the container housing (Figure 3-12). However, the need for more uniform container temperatures as well as improved container life led, some years ago, to development of systems to heat the container from inside the mantle (Figure 3-13). In the case of external heaters, it is possible that the heat source combined with the heat from extrusion may cause the mantle to overheat and become annealed\(^{10}\) (Figure 3-14).

Another improvement designed to improve temperature uniformity is the change to multiple zones of control. Newer presses often offer 4 or 6 zones of control, divided into 2 or 3 zones axially, as well as separate zones top and bottom (Figure 3-15).

An important requirement is to provide thermocouples for each zone and also for the mantle itself, to prevent over-temperature and annealing.

Note that axial variations in temperature along the liner, caused by heat loss at the container end faces, may result in a higher temperature near the center and result in “bulging” or “barrel” effect.

**Container Cooling.** Most new presses now offer optional cooling of the container liner, by means of passages for compressed air to circulate around the container liner. Air flow is typically controlled by PLC. Combined with multi-zone heating control, PLC controls may maintain liner temperature within a range of 10°C (18°F).

**FEM Analysis** is an essential tool for analyzing the sum of stresses in the container and liner, including thermal stresses. Figure 3-17 illustrates a FEM analysis of a container mantle and liner with cooling, indicating increased stress levels at the cooling grooves. Similar analyses allow design improvements to reduce stress levels and improve container life.

\(^{10}\) Hahnel, Werner, and Herder, Manfred, Ibid.
Further references on modern improvements in container design are listed in the footnotes\(^\text{11,12,13}\).

\(^{11}\) Wieser, Volker; Sommitsch, Christof; Haberfellner, Kurt; and Lehofer, Paul; "New Developments in the Design and Production of Container Assemblies," *Proceedings of 8th International Aluminum Extrusion Technology Seminar*, (2004).


Spare and Replacement Tools

The following recommendations are offered for maintaining spare tools such as container, liner, ram, etc.:

- Maintain accurate drawings of all tools, for purchase or repair of replacement of spares.
- Inspect spare tools when received (new or repaired) for condition and conformance to dimensions.
- Store spare tools in a warm place, to minimize preheat time and avoid thermal shock.

Dies & Back-up Tooling

While not normally considered a part of “press maintenance,” proper care and handling of dies and support tooling are critical to smooth press operation. For example, in plants where the outside dimensions of the tooling stack do not adhere to strict tolerances, excessive maintenance to the butt shear and die changer will result.

Additional information on maintenance of dies and back-up tooling is contained in the following article, “Preventive Maintenance of Extrusion Tooling,” by Gary Dion, Nova Tool and Die, Inc.

Die and Tooling Cleaning

Dies, dummy blocks, and other tooling must periodically be cleaned of aluminum build up.

“The use of sodium hydroxide for die cleaning, rather than employing emery paper, can result in a decrease in extrusion pressure, permit lower temperatures, higher speeds, and less metal pickup, partly because of their superior finish on bearing surfaces. Solutions of 10% to 25% are customary. When tanks are employed, “standard” solutions are the rule, but a higher concentration is necessary if wiped on. Tank solutions are heated to about 140°F (60°C). Thorough rinsing is necessary following cleaning to guard against caustic effects on the aluminum. Precautions against excessive breathing of fumes as well as direct contact with the skin, particularly the eyes, should be taken. Potassium hydroxide also is used for cleaning but the cost may be prohibitive. Cleaning caustics may stain extrusions.”

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Note: The following paper provides useful information about the inspection, handling, and preventive maintenance of extrusion dies and back-up tooling. It was first presented by the author at the AEC Press Maintenance Seminar, in Chicago, May 2, 1995, and is reprinted here with his permission.

PREVENTIVE MAINTENANCE OF EXTRUSION TOOLING

by Gary Dion
Extrusion Consultant (former owner of Nova Tool and Die)

How does preventive maintenance relate to extrusion tooling? From surveying many extruders it was found that proper preventive maintenance of tooling plays a very important role in the success of an extrusion operation. Improper maintenance can and most likely will result in poor performance in one or more of the following areas:

- Pounds per hour of aluminum produced
- Extrusion die life
- Die and support tooling breakage
- Press downtime which is very expensive
- Maximizing die life while minimizing weight per foot

Even though with dies you don’t check the oil level, inspect roller bearings, or monitor wear of motor brushes, there are many aspects of the extrusion tooling to be checked and maintained properly. As the Fram oil filter man says, “You can pay me now, or pay me later,” and in some cases a whole lot more! The possible checks and maintenance steps for extrusion tooling can be broken into four major categories.

1) Incoming inspection of dies and tooling
2) Handling of dies and tooling
3) Inspection of dies and tooling after use
4) External features of dies and tooling

Incoming Inspection

It is not good manufacturing practice to put a bad die in the press and waste valuable press time, labor, billet, etc. Of course this probably doesn’t happen, at least not very often. But what are you currently monitoring to maximize your presses’ productivity? Could you be monitoring more? Listed below are many of the checks extruders have implemented to achieve the highest quality product at the most productive rate.

1) Proper tooling identification. Die, suffix, backer, bolster and feeder plate numbers are important. If the wrong number is on the die, it could be set up and run incorrectly, causing major problems. Also, date and vendor ID are a good idea.

2) Check for metal chips or shavings from manufacturing. These tiny metal shavings will hide in the relief area or bearing area of the die and show up in the extruded product or possibly create die lines.

3) Check die and related tooling for proper Rockwell. Even though most die makers thoroughly inspect for this, it’s not impossible to vary by a few Rockwell C points.

4) Tool diameter, thickness and step dimensions. It’s better to be safe than sorry. Checking tool dimensions will prevent tools from being stuck in die rings, or being loose, allowing for misalignment and/or aluminum seepage into undesired space, butt shear from hitting the tooling face, etc.
5) **Pinout of die openings.** This will tell you how much tool deflection you are getting on your tooling, which is extremely useful for future dies. It will give accurate information for zeroing in on minimum weight per foot, allowing for maximum poundage from each die.

6) **Support tooling clearance.** Check for interference of backers, bolsters, sub-bolsters and platen opening. It is better to grind in some clearance which will decrease the possibility of plugging and/or possibly breaking the assembly.

7) **Proper support on backer, bolster.** Make certain that the backer and bolster have the proper support to eliminate as much tool deflection as possible, and minimize the chance of tool breakage.

8) **Proper exit clearance.** Check the step behind the bearing for proper clearance. There should be a minimum step on critical tongues, screwbosses, etc. Too much clearance can cause a die to cave and run incorrectly. Approximately 0.040" (0.10mm) is considered normal.

9) **Proper die support.** On tongues it is desired to have maximum support for best results. Zero degrees of back taper is usually desired on areas with small or long tongues and screw bosses.

10) **Proper die support.** On tongues it is desired to have maximum support for best results. Zero degrees of back taper is usually desired on areas with small or long tongues and screw bosses.

11) **Bearing finish.** Check die bearings for:
   - Wire EDM lines
   - Scratches from files, gage pins, or emery paper
   - EDM pits
   - Nicks from handling, shipping
   - Burrs on exit side of bearing from orbital EDM or milling relief

It would be better to catch one of these items and correct it prior to sampling or attempting to run the order. How many times have you pulled a die because of die lines?

12) **Bearing flatness, squareness.** Not enough can be said for the importance of square and flat bearings. A precision square needs to be used to confirm that the bearings on both the die and mandrel are flat and square.

13) **Bearing transitions.** Proper placement and smoothness of bearing transitions are critical as this is another area which can cause die lines. Improper placement of transitions will also cause the die to produce a product that is not dimensionally correct.

14) **Maximum port/spreader/feeder plate openings.** These items if made too close to the container opening will cause poor metal finish. Contamination will enter the ports from the skin of the billet and be extruded into the profile. Poor metal quality will also result if the profiles are too close to the container size on a solid die.

15) **Proper die alignment and handling features.** Inspect dowel pins, keyways, bolster pins, etc., for proper position and sizes.

**Handling of Tooling**

Dies and tooling are the heart of your finished product. Bad dies, bad extrusions. It's that simple. Dies should be treated like jewelry, not blacksmith anvils. This slight exaggeration was not meant to insult the die handlers but to stress a point. Too often dies are not treated with enough care and are damaged due to carelessness. Make every attempt to keep dies off the floor as dirt in the tools will result in poor metal finishes. Care must be taken when removing assemblies from the die rings. A die separator would be recommended rather than a big hammer, even if the hammer is aluminum. Too many tongues, screwbosses, etc., have been lost to the blow of a hammer. Careless banging of tooling together can damage bearing surfaces and mating surfaces.

**Inspection of Tooling After Use**
After the tools are used to extrude the required product and have been run through caustic, a careful inspection of all components is recommended. Putting a damaged tool in production is obviously not a desirable practice. Here are a few areas to check for:

**All Dies:**

After each extrusion run, all dies should be inspected for the following conditions:

1) **Wash-out on bearing surface.** Washed out bearings can cause poor metal finish. Polishing the wash-out from the bearing will eventually cause an overweight condition. It might be time to consider ordering a backup die for stock or future orders.

2) **Cracks on tongues and critical areas.** Breakage is on the horizon. This can waste valuable press production time.

3) **Weight per foot.** Monitoring this factor will prevent you from giving extra metal to your customers.

**Hollow Dies:**

Hollow dies should be inspected after each run for the following conditions:

1) **Check for cracked webs, armpits or weld chambers on the housing.** Some hairline cracks are normal, but excessive cracks will lead to complete tool failure.

2) **Flatness of housing face, die face.** A caved entry is a sign of tool fatigue and replacement might be considered. This can cause die and mandrel bearings to be misaligned resulting in poor metal quality.

3) **Rockwell hardness of tool components.** Low Rockwell hardness of dies can cause poor metal quality and tool failure. Recommended Rockwell C is usually 47-49. Sometimes tools can be re-heat-treated to avoid premature failure.

4) **Tapered sealing area on die and spider assemblies.** Check for nicks on the outside taper which could damage the die ring.

**Solid Dies:**

Solid dies should be inspected after each run for the following conditions:

1) **Flatness of die, backer.** If the die or backer isn't flat, more than likely the metal isn't hitting the bearing surface correctly and you are losing control of the metal flow. It also is allowing the die to deflect too much which contributes to poor production and bad material. Caved tooling could be a sign of improper or cracked support tooling (backers, bolsters).

2) **Cracked corners on die openings.** This could result in burrs or die lines on the extruded product. This also could be a sign of poor or cracked support tooling.

3) **Cracked backers.** Cracks in backers will cause metal to run poorly and can result in premature failure of dies.

**Bolsters and Support Tooling:**

Support tooling should be inspected on a regular basis rather than only when a profile runs poorly. Check for the following conditions:

1) **Flatness.** Bolsters and sub-bolsters which are not flat will cause problems when extruding. This will allow for the die to deflect too much. It is also extremely important when running wide profiles or profiles with critical tongue conditions. Many times bolsters, etc., can be reground flat and even re-hardened if necessary.

2) **All surfaces clean and free of aluminum build up.**

3) **Rockwell.** Periodically check the Rockwell to insure the tool isn't being annealed over time being exposed to temperature changes. The ideal Rockwell is between 42 and 46 RC.
4) **Inspect for cracks.** Small cracks in the corners eventually become big cracks, which could cause the whole tool stack to fail, including the die and backer. Replacement should be considered soon.

5) **Nitrogen Inlets.** N\textsubscript{2} couplings and inlets must be kept clean to allow free flowing of liquid or gas nitrogen. Also, this prevents dirt from passing through to the metal.

6) **Nicks.** Check for nicks caused by handling the tooling. It's easy to bang these large tools into other pieces of steel or tooling. Nicks will keep other tooling from sitting flat and could cause damage.

7) **Lift holes.** Make sure threaded lift holes are free from foreign materials which could prevent the eye-bolt from being threaded in completely. This decreases the chance for accidentally dropping the bolster, thus damaging the tool and even possibly injuring someone.

### Platen Pressure Ring:
As true with other support tooling the platen pressure ring needs to be inspected periodically. Check the following items:

1) **Flatness.** Check for an impression approximately the size of the bolster or sub-bolster. This means the ring is wearing and needs to be considered for replacement.

2) **Clean.** Free from aluminum build-up.

3) **Cracks.** If the pressure ring is cracked you can be assured the whole tool stack is deflecting which will eventually cause other tooling components to fail.

### Die Rings:
The ring which contains the die assemblies also needs to be regularly maintained:

1) **Sealing areas on tapered die rings.** The tapered area on die rings which hold spider assemblies must be kept free of nicks and aluminum build-up. It is also important to monitor the sealing area for impressions from the assembly. This could be an indication that the spider assembly is improperly sized. This will also allow unwanted aluminum to build up between the ring and assembly.

2) **Sealing areas on step die rings.** Again check for metal build up. Inspect for chips of the ring missing which could allow aluminum to squeeze between the ring and die components resulting in difficulty to disassemble. Check the step dimension to insure that the die doesn't protrude too far, allowing the butt shear to hit the die. This could also cause the die to leave an impression on the container liner which could cause flashing.

3) **Lift holes.** Make sure threaded lift holes are free from foreign materials which could prevent the eye-bolt from being threaded in completely. This decreases the chance of dropping the assembly, damaging the tools and even possibly injuring someone.

4) **Keyways.** Worn keys can cause misalignment of the die and backer assembly. This could result in clearances not being correct and plugging of the tool. Replace the keyways periodically for maximum reliability.

5) **Nitrogen hookups.** If gas or liquid N\textsubscript{2} is introduced through the die ring make sure hookups and inlets are in proper working condition, clear and free from buildup. Check sealing area for damage or wear.

### Die Carriers, Die Slides:
Over the course of multiple die changes the die slide is prone to wear and tear. Proper inspection and upkeep will help keep the dies in their proper position during the extrusion process, and keep the die and ring from being damaged by the shear. Routinely check for the following items:

1) **ID of horseshoe.** Check for proper fit to die rings.

2) **Build up of grease, dirt, or aluminum.** This will cause improper alignment of tooling.

3) **Horseshoe bolts.** Assure tightness of these bolts periodically.
Other steps to take for optimizing press and tooling performance

Organization of dies and support tooling with easy access will help prevent the wrong support tool from being used. Location numbers can even be used to organize the tools.

Once the die, whether it be a hollow or a solid, is cleaned, inspected and ready for storage, it is recommended that the internal areas of the die be coated for protection from rust, dirt, etc. These areas would be die bearings, pockets, ports, etc. On some complex profiles some extruders even leave the die full of aluminum if the die performed well on the last run. One of the more popular coatings is an aluminum spray which doesn't affect the metal on the next run.

A good high temperature anti-seize compound should be applied to all bolts used in the die assemblies. Anti-seize also should be used on replaceable parts such as pincores and mandrels which fit into pockets. This will help during the replacement process.

If you have more than one press in which a die assembly can be used, it is important that care is taken when making tool stack setups. Make sure the proper bolster, sub-bolster, spacer rings, etc., are used to make up the proper tool stack. It's easy to miss the proper thickness and plug the first billet, creating unwanted downtime. Also check for proper clearances all the way through the tool stack.

Press alignment plays an important role in the production and quality of metal. There are various means of checking press alignment, and it should be checked and corrected weekly.

Developing a re-nitriding program will help maximize die life and press productivity. Through such a program one should be able to accurately predict the amount of billets to run of a certain section, rather than waiting for a die line or something to show up on the metal. Excessive tool wear and bearing washout can be reduced through proper monitoring.

On hard pushing dies the practice of using a short, and sometimes hotter billet is recommended to start the die on the first billet. This will reduce the risk of damaging the die.

Insuring that dies and support tooling are preheated properly is of critical importance. Cold bolsters and other support tooling can crack during use, and can also draw too much heat out of the die assembly.

Summary

Although some of the items covered in this article might seem a little elementary, it is important to make sure as much prevention is considered with extrusion tooling as possible. Anytime a problem or potential problem is detected before trying to extrude, you can save valuable press time, and even prevent major tool failure.

Gary Dion
Minimizing the Occurrence of Flared Billets in Aluminum Extrusion Presses

A common problem of aluminum extrusion is flared or mushroomed billets --- in which the aluminum spreads out between container and die instead of passing through the extrusion die. Flared billets result in lost production time and also scrap. Occurrence of more than one or two flares per month is considered excessive.

Mr. Domenico Bertoli of SEPAL, a well known extrusion expert, has recommended steps which can be taken to reduce the occurrence of flared billets:

1. The sealing surface between container and die/die ring must be clean and smooth. The butt shear blade must be in good condition and designed for a smooth, clean cut. Clearance must be adjusted properly, typically 0.020 inches (0.5 mm) for smaller presses, up to 0.125 inches (3.2mm) on larger presses\(^\text{15}\). Proper release agents sprayed automatically on the shear blade will also help\(^\text{16}\).

2. It is also important to maintain the correct specific sealing pressure on the surface between container and die/die ring. Specific pressure is defined as the sealing force divided by the contact surface area. The minimum value desired\(^\text{17}\) is 2.5 kg/mm\(^2\), which converts to 3,550 pounds per square inch.

To compute the specific sealing pressure:

- **Calculate the sealing force.** For each sealing cylinder, the effective area is the area of the bore minus the area of the rod\(^\text{18}\). Multiply this net area by the sealing pressure and by the number of sealing cylinders (typically two, occasionally 4). The result is the sealing force.

- **Calculate the area of the contact surface.** This area is the difference between two circles. The smaller circle is the container inside diameter, which is usually about 0.375 inches (9mm) larger than the nominal billet diameter. The larger circle varies with containers but should be the outside diameter (OD) of the container liner, assuming that the liner extends slightly outside the container forging as it should. Subtract the smaller area from the larger to determine the contact area.

- **Divide the force by the area.** Divide the sealing force by the sealing area to determine the sealing specific pressure.

If the specific sealing pressure is too low, indicating poor sealing, there are two ways to increase it:

1. **Increase sealing pressure.** This is subject to the capabilities of the hydraulic system and the pressure ratings of the hydraulic cylinders and piping. Do not exceed capacity of cylinders.

2. **Reduce the contact area.** Since the inside diameter of the container liner should not be changed, the outside diameter may be reduced. First calculate the desired outside diameter,

\(^{15}\) Follow press manufacturer’s recommendations.


\(^{17}\) Mr. Alan Castle of Service Aluminium recommends values up to twice this value, but cautions that the contact area between liner and die must bear additional force during the early part of extrusion, when the friction force is added to the sealing pressure. He cautions to be sure that the contact area is not reduced so much that it will cause the die to deflect or unduly; he especially advises that the liner not contact the die ring, which is usually unsupported and so may deflect too much under this force.

\(^{18}\) For presses with platen-mounted sealing cylinders. A few presses such as “front-loading” presses, have direct-acting cylinders, mounted on the main cylinder, in which case the rod area is not deducted.
based on the area needed to give the correct specific pressure. Then at that diameter introduce a slight (7°) bevel at that point to limit the contact surface. (See illustration.)

**Sample Calculations:**

Sealing force: assume 2 cylinders, 9” bore x 6” rod, 2500 psi

Area = \( \frac{\pi d^2}{4} \)

Total area = \( \frac{\pi 9^2}{4} = (3.14159)(81)/4 = 63.62 \text{ in}^2 \)

Minus rod area = \( \frac{\pi 6^2}{4} = (3.14159)(36)/4 = 28.27 \text{ in}^2 \)

Effective area = \( (63.62 - 28.27) \times 2 \text{ rods} = 35.35 \text{ in}^2 \times 2 \)

Force = \( 2500 \text{ psi} \times 70.70 \text{ in}^2 = 176,750 \text{ pounds} \)

Contact area: container ID 8.375”, liner OD = 12.5”

Total area = \( \frac{\pi 12.5^2}{4} = (3.14159)(156.25)/4 = 122.72 \text{ in}^2 \)

Minus ID area = \( \pi (8.375)^2/4 = (3.14159)(70.14)/4 = 55.09 \text{ in}^2 \)

Effective area = \( 122.72 - 55.09 = 67.63 \text{ in}^2 \)

Specific pressure: Force/area = \( 176,750/67.63 \text{ in}^2 = 2613 \text{ psi} \) (too low)

To calculate a suitable sealing area:

Assume no change in sealing force = 176,750 pounds

Desired area = \( 176,750 \div 3550 \text{ psi} = 49.79 \text{ in}^2 \)

Plus area of liner ID = \( 55.09 + 49.79 = 104.88 \text{ in}^2 \)

Using Area = \( \frac{\pi d^2}{4} = 104.88 \text{ in}^2 \)

\[ d^2 = 104.88 \times 4/\pi = 133.54 \]

\[ d = 11.56 \text{ inches} \]

Therefore, mark the face of the container liner at 11.56” and bevel the face outside that point. (See Illustration)
REVISED CONTACT AREA
BETWEEN DIE AND CONTAINER LINER
ABSTRACT – Dummy block lubrication has changed significantly over the years with the inception and evolution of the fixed dummy block and hot log shear, and the elimination of the popular acetylene sooters. More recently, the transition to short stroke front-loading presses, hot log saws, and the complete guarding of the extrusion press has further impacted dummy block lubrication. These changes are driven by the need to automate and speed up the process, and this further exacerbates the importance of proper lubrication. Two technologies have come to the forefront to lubricate either the back side of the billet or the dummy block directly. They are: Boron Nitride-based ceramic powders, which are electrostatically applied; and organic liquid polymer-based solutions, which are air atomized. Both have advantages and disadvantages. Further, both technologies have evolved over many years in order to improve reliability and reduce overuse of lubricant and the subsequent overspray. This article will explore the evolution and development of both technologies with a look to the future and what is still to come.

INTRODUCTION

Lubricants and parting compounds are used to separate the dummy block from the billet end in direct horizontal extrusion. Historically, billets were precut prior to the extrusion process, and billet paint was manually applied to each and every billet sometime prior to being loaded into the furnace (see Figure 1). Breaking the bundle before loading into the furnace was generally a manual operation, and so painting of billets was easily completed as a part of this process. This method is still valid today where billets are precut, independent of the extrusion process.

Times have changed. Billets are now primarily cut or sheared to length at the press, directly before or after heating. This process requires that each billet is automatically lubricated as the complete process is now automatic. The acetylene sooter was the first technology used to complete this process; however, this practice was soon recognized to be an unacceptable safety/fire hazard (see Figure 2). This process was also unreliable and caused dusting that could cause electrical shorting issues in motors and controllers. Often, additional manual or automatic dummy block lubrication was required and was completed using grease, wax, or liquid polymer-based products.

The extrusion industry eventually transitioned to electrostatically-charged and sprayed Boron Nitride-based powders (subsequently referred to as BN powders). The primary benefit was that the BN powders virtually eliminated the need for any additional lubrication on the dummy block. BN powders also eliminated the fire hazard, as these products are not combustible or burnable. Reliability issues and dusting
issues continued. However BN powders are not conductive and so the electrical issues were eliminated. With proper dust containment and collection and the many other best practices discussed in this article, it is possible to successfully utilize BN powder.

For many, the dusting and reliability issues involved with BN powders simply could not be resolved. Some tried using water-based BN dispersions, however these were hard to repeatably dispense for a variety of reasons. An old technology was reborn; water-based organic polymer solutions (subsequently referred to as WBOP) quickly became a viable alternative to BN powder technology.

Both technologies, BN powder and WBOP, are now in widespread use worldwide. With proper dispensing system design, installation, and maintenance, either technology is a viable option with a long list of successful installations. On the other hand, there are many substandard, unreliable installations of both types. With some installations, it is merely a matter of system obsolescence where the equipment needs complete replacing with new components or updated design options. With others, it is merely a matter of including best available technology with best in use practices. The purpose of this paper is to present the best practices with either technology, and let the end user determine which technology is best suited to their individual application.

What Do They Have in Common?

First and foremost, both technologies are used to separate the billet and dummy block at the end of the extrusion cycle. With proper use, there is an immediate financial payback, as a lack of lubrication will lead to sticking and pull-back, which results in lost press time and potential damage or premature wear to dummy blocks and other press components under a worst-case scenario. Ideally, the dummy block is clean from any aluminum build-up (see Figure 3). Over-use will result in excess lube cost, and likely lead to a variety of problems associated with mess and overspray. Dysfunctional equipment or improper maintenance planning will affect press productivity and likely add to a variety of operational inefficiencies.

On a technical level, BN powder and WBOP are both air-assisted spraying technologies. With proper use, there is only a light coating applied, with little or no overspray (see Figure 4). They can be used on each billet or with less regularity on the dummy block. Each is a short burst of spray at an exact time. The spray cycle is completed in a hot work zone that is not accessible without shutting down the extrusion press. In short, the spray cycle must be quick, efficient, repeatable, and reliable. Generally speaking, the BN powder and WBOP spray technologies have been retrofitted as ancillary equipment. One would assume that for this reason, both are often overlooked in basic press training and maintenance. Yet a lack of lubrication has an immediate and detrimental affect on press productivity.

By comparison, many extruders utilize the same or similar technology in painting profiles. On a paint line, operators and supervisors are likely trained in the intricacies of system design and operation. On a paint line, each operator and supervisor is trained in the importance of system maintenance and monitoring.
On a paint line, dust and fume collection is integrated as a part of the original equipment design. So is it possible to implement these same concepts to billet lubrication? It is absolutely necessary!

There are a number of best practices that both spray technologies have in common:

⇒ Prepare a simple and quick lock and tag process. Main air supplies must be plumbed, so as to allow for isolated de-energizing systems for service or repair.

⇒ Safeguard spray nozzles. Electrostatic guns and atomizing air nozzles both have intrinsic safety hazards, such that they should be isolated from access by untrained personnel and be protected from other moving machinery (see Figure 5).

⇒ Clean air source. Both systems utilize air to atomize product and perform other functions. Contamination will cause system malfunction and premature wear.

⇒ Spray nozzle in close proximity to billet/block. Product coating efficiency is best when the nozzle is in close proximity to the billet/block. This will also minimize overspray.

⇒ Shorten all hose connections. This is true with virtually any pneumatic or hydraulic piece of equipment.

⇒ Establish lube transfer and fill policies and procedures. This includes establishing equipment that is appropriately marked and maintained.

⇒ Maintain basic replace/rebuild inventory. Keep a stock of parts that will replace worn out parts, as required by the manufacturer.

⇒ Establish preventive/predictive maintenance. Basic daily observation of equipment in operation by a qualified individual is a great starting point. Additional procedures are defined by the manufacturer, and may have to keep in mind the specifics of your installation.

⇒ Locate controls and reservoir (hopper for powder) outside press guarding. This will allow for system filling and basic monitoring, adjustment, and maintenance/repair without shutting down the furnace, loader, or press.

⇒ Enclose and contain overspray. Enclosing the area where spray is completed is very much installation-specific, in order to properly deal with movement issues specific to your application. Keep in mind that containment is in addition to dust or fume collection. This added protection is for your employees and your equipment.

⇒ Determine system settings off-line. Then, insure those settings are maintained and monitored in the production environment.

⇒ Include a manual override for testing. This can be used to test and operate equipment for maintenance and repair purposes.

⇒ Clean-up overspray and mess regularly. Powder can be vacuumed and the WBOP’s can be washed.

Figure 5. Spray nozzle clear of machinery.
Many of these same principles apply to virtually every piece of equipment in your extrusion facility, or any production/industrial environment for that matter. We can now look at some best practices that are a little more specific to each method.

**BN Powder Best Practices**

Dispensing an electrostatically charged powder to a billet end is presently completed using equipment that is typically designed for a continuous spray cycle; most equipment on the market is most commonly used for painting and coating of metal parts. There are also a very limited number of producers of this type of equipment and at the time of this article there were no designs specific to the aluminum extrusion process. There are, however, a number of suppliers that have taken these standard designs and created installation and operationally-friendly assemblies that are specific to the aluminum extrusion process.

1. Use inorganic blends only. Never use an organic powder, as this could result in some type of explosion hazard.

2. Use a tubular collection hose just past the spray point (see Figure 7). This simple, yet effective design has been analyzed using FEM, and confirmed with prototype models in a collaborative study at the University of Michigan[1].

3. Utilize dust collection network to also include powder transfer area and keep dust exposures below permissible exposure limits. Optionally, use dust mask when transferring powder. Be sure to follow best safety practices for mask handling, storage, training, and testing.

4. Dust vacuum needs to include shake-down of filter. This is a process that shakes the main HEPA filter after each vacuum cycle, so that powder does not collect or clog this micro filter.

5. Do not reuse collected powder. If you are collecting too much, then concentrate on getting the dispensing equipment in proper operating condition.

6. Eliminate water and any humidity in service air. Water causes the powder to agglomerate (clump), and also dissipates an electrostatic charge on powder. A localized air purification system specific to the application equipment is strongly recommended. An in-line desiccant can be used for monitoring air quality. Some substitute pure Nitrogen in place of air, as it is often readily available.

7. Install powder hose to the electrostatic spray gun, so as to travel “downhill.” If not, then the powder will collect inconsistently in loops in the hose.

8. Transfer powder in small volumes using a scoop or other engineered method. Auguring with a dump station is a more automated and reliable/meterable option.
9. Insure charge transfer from gun to billet/block. The billet/block must be the closest grounded and conductive component to the gun tip. Isolate grounded and conductive components in the area.

10. Disassemble and clean the powder injector, powder hose, and electrostatic gun weekly.

WBOP Best Practices

Spray equipment designed for spraying liquids for use specific to aluminum extrusion, on the other hand, has been available for many years. Designs have been progressively improved. The most popular design utilizes an air pilot-operated atomizer, in combination with a rotating spray nozzle assembly with four spray tubes. This same design is scaleable in order to easily fit most any billet size; it can also be fitted to spray the face and land of the dummy block (see Figure 8).

Figure 8. Rotating spray assembly sprays the dummy block.

WBPO best practices are as follows:

1. Use splash protective clothing and eye wear when transferring fluids. A full face shield is strongly recommended and is easily made available in the transfer area.

2. Implement proper cross-ventilation or install fume collection.

3. Automate diluting of lubricant concentrates using positive displacement proportioning equipment. Where applicable, water purification and condition controls may also be required.

4. Include an air blowout or air purge of spray tips that are in the heat-affected zone.

5. Include monitoring/troubleshooting hardware. Pressure gauges should be available as monitors throughout the process.

6. Utilize mesh filtration of liquid. This avoids clogging of spray nozzles and tips.

7. Do not use pressurized reservoirs. Pressure vessel safety standards and certifications limit design options for filling, mixing, and repair.

8. Use stainless steel construction where practical and reasonable. Do not use aluminum or galvanized steel.

9. Be sure liquid has metal inhibitors for steel and brass.

Moving Forward with Lubrication Best Practices

These technologies, both chemical composition and application method, will continue to improve. Using well-designed application equipment and a quality lubricant will not ensure reliability; it is the implementation of best practices in using these systems. Reliability is further enhanced with proper installation, operator training, system monitoring, and maintenance. This concept can be applied to billet lubrication, hydraulic lubrication, way lubrication, saw lubrication, shear lubrication, and many other applications. Lubrication best practices for reliability require time and financial commitment on behalf of the extruder. The results are possible and measurable.
CONCLUSION

BN powder and WBOP techniques have both been used successfully for separating dummy blocks and billets as a part of the direct horizontal aluminum extrusion process. Both spray technologies have many basic principles in common, where best practices can be established and followed. Best practices specific to each method are also possible. Implementing these policies and procedures will pay off with improved safety and productivity.

REFERENCE