Lubrication of Extrusion Press Tooling

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Why Lubricate Press Tools?

Hot aluminum and many of its alloys tend to stick to hot steel and its alloys; for this reason, lubrication of press tools is standard operating procedure when deforming hot aluminum. Once the process of aluminum build-up on tool steels begins, it continues until the build up eventually slows or stops the machine process. This eventual build up of aluminum can be avoided in one of two ways:

A. **Lubricate as Needed** - Before or after sticking of metal to the tool steels has begun, apply a high temperature wax, grease, oil, or other parting compound to the point of build- up with a swab or similar tool so as to penetrate the metal-to-metal contact point and separate the build up from the tool steel. This process is often creates smoke, flames, and soot. In addition, if lubrication is not applied at the proper time, build-up will lead to sticking that eventually causes machine wear, premature misalignment, and eventual downtime. Further, this process often leads to excessive use of chemicals which cause blisters, streaks and other defects to the profile.

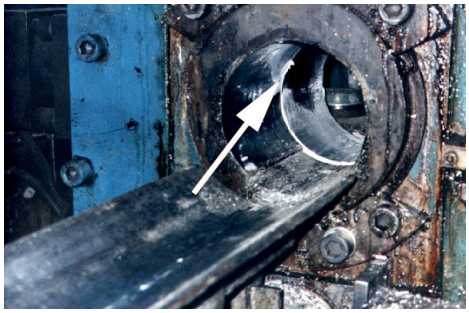

Figure 1**: Left unlubricated, tools build up metal that eventually leads to problems.**

B. **Lubricate as Preventative Measure** - Prior to metal build up occurring, automatically apply a high-temperature water-based solution to the points of aluminum/steel contact at regular intervals (i.e. with every billet, with every other billet, etc.). Using the proper chemicals, applied with well-engineered spray equipment, this process goes virtually unnoticed while at the same time reducing or eliminating metal build up and thus allowing for uninterrupted press operation.

It is not hard to see that in today's world of quality directives and automation implementation that the latter is the best solution, as long as the cost of use and implementation does not exceed the potential benefits. Accordingly, we will now discuss a variety of items relating to the implementation of manual and automatic lubrication of press tools.

Manual Lubrication of Press Tools

Manual lubrication methods are primarily used where automatic lubrication is not possible. They are most often used where automation is not possible due to space, budgetary, or process constraints. In fact, there are certain tools, such as the die ring, container ring, and related die components cannot reasonably be lubricated automatically. Manual methods, when compared to automatic alternatives are often slow, inconsistent, and potentially unsafe. For this reason, the trend is now (and will likely continue to be) toward the use of automatic applicators for dispensing liquids, powders and solid waxes.

Automatic Lubrication of Press Tools

Automatic press tool lubrication can be used to improve extrusion press efficiency, safety, and repeatability. Specifically, the use of automatic lubrication for butt shear blades, log shear

tools, fixed dummy blocks, and billet scalpers, is now in common use; other areas such as piercing mandrels are under consideration.

Automatic lubrication was initially not well received, because the early equipment and chemical designs were not always suited for the rough environment associated with an extrusion factory. Additionally, extrusion presses are expected to be clean and the early systems were messy to operate. The technology has been updated to a point that has been time-tested to be effective and usable within this rugged working environment and within the cost parameters of this very competitive industry. Implementation of automatic lubrication requires proper system design, installation, operation, and maintenance, so as to insure long-term success.

Advantages of Automatic Lubrication

The advantages of automatic lubrication of press tools as an integral part of the aluminum extrusion process are now recognized by aluminum extruders and equipment suppliers to the industry. This is because it is not possible to leave these tools unlubricated when the tools or machine become worn and/or misaligned. Used properly, automatic lubrication will:

1. Significantly **reduce press downtime** due to hang-ups, sometimes by a factor of ten (10) or more, when compared to less predictable manual methods.
2. Provide **better cuts** for improved billet-to-billet contact, potentially reducing air entrapment (See Figure 2).
3. **Eliminate manual** lubrication by press operators, allowing them to focus their attention on other parts of the process. Also, this is one more step towards the full elimination of operator intervention into the hazardous extrusion press working environment.
4. **Clean up the smoke and soot** associated with graphite and oil chemicals used with manual methods, providing a cleaner and safer production environment.
5. Make the lubrication process **predictable**, adjustable and able to be monitored for a more quality-oriented process and a method for continuous improvement.

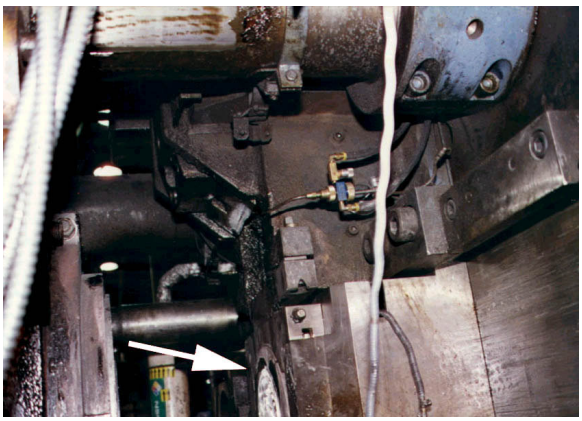

Figure 2: Proper Lubrication of the butt shear results in a clean and complete removal of the butt from the die.

The technology is proven to have benefits, with the simplest and most cost effective application being lubrication of the butt discard shear and log shear cutting blades. Thus, we can now detail chemicals and equipment that have been engineered specifically for application to press tools, how they are implemented, and the potential pitfalls in their use.

Liquids for Non-ferrous Extrusion

A variety of chemistries have been used for manual and automatic spray lubrication of tools, such as graphite/water suspensions, boron nitride suspensions, fatty oil mixtures, water carried soaps, inorganic solutions, organic polymer dispersions, and other specialty blends. Simple graphite and boron nitride dispersion chemistries have shown to perform most effectively in this area; however, these dispersions have proven hard to apply consistently and safely. Water carried soaps and inorganic solutions have proven to be most easily applied, yet performance characteristics can be limited. Organic polymer dispersions and other proprietary blends seem to provide a good balance of performance and applicability.

The following list details the ideal characteristics for a universal fluid for all applications in aluminum extrusion:

1. **Non-flammable** - Any fluid to be sprayed around an extrusion press must be non-flammable and such that the remaining lubricant cannot be easily ignited. The Flash Point and Auto Ignition Temperature found on a Material Safety Data Sheet (MSDS) should be "not applicable" or "not burnable" and the National Fire Protection Association (NFPA) fire rating should be zero (0).
2. **Not Detrimental to Extrusions** - The litmus test for lubricants used in and around the extrusion process is to spray the product into a die and on the dummy block for several billets and follow the product through extrusion, fabrication, and finishing. A product that is detrimental to the extrusion process cannot be considered a viable alternative.
3. **Lubricating at High Temperatures** - As the primary function is to provide tool lubrication and release properties, the fluid must keep the hot aluminum from sticking to the tool steel at the pressures and temperatures associated with the extrusion process. Manual spray methods are used to help simulate automatic methods as a test procedure to insure the success of automatic methods (See Figure 3).

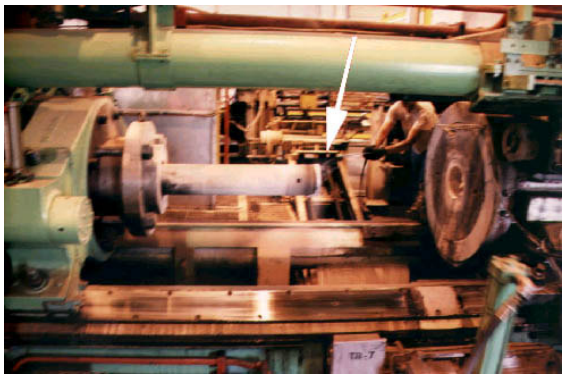

Figure 3: Manual spray wands are used for testing and production application of spray fluids.

4. **Good Wetting Properties on Hot Tool Steel** - Water carried fluids have a tendency to bounce off hot surfaces; the water carried fluid must therefore stick to the tool steel and allow for evaporation of the water as a method to provide momentary surface cooling. Once the water has evaporated from the spray applied fluid, the remaining lubricant must be able to spread out onto the hot surface to form a light, uniform film over the area onto which it is sprayed. This allows for the fluid to reach surfaces that cannot be directly sprayed.
5. **Water Miscible** - A well-designed water-miscible lubricant can be easily blended with tap water to form a light-viscosity solution, which can then be spray atomized. Once mixed with water it must be stable so as not to separate and it must be resistant to biodegradation from bacterial contamination, which is often found in tap water. Equipment designs are simpler and application is more predictable with water-miscible chemistries. If the product is unstable in water, yet mixable with water, equipment designs are available for continuous mixing.
6. **Safe to be Sprayed** - Many chemicals cannot be sprayed as they will cause bodily harm if inhaled or absorbed through the skin. Be sure these types of chemicals are not atomized in the working environment.
7. **Overspray Easily Cleaned Up** - Overspray will occur when atomizing a fluid to a remote location; therefore, be sure that the remaining overspray is easily removed with warm water or a light duty industrial cleaning solution.

Lubricants have been developed that meet all of these parameters if the surface to be coated is normally below 400°F; however, the technology in the area of high temperature coatings applied to surfaces which exceed 400°F is still under development. The butt and log shear blades are normally well below 400°F at the time of application and thus this is an area which is in common use and very successful. Dummy blocks, billet scalpers, and piercing mandrels are much hotter and the fluids used in this area must be specifically designed for extremes in temperature.

Equipment Designs for Liquid Dispensing

Application success is dependent on the fluid technology combined with proper application method. The equipment must be rugged, yet user and maintenance friendly. The following is a list of components required for a complete spray application system, along with some suggestions for success:

Component	Important Details
Fluid Reservoir	• Use stainless steel or coated metals to provide flexibility in fluid compatibility. • Automate or filling and mixing. • Test for correct fluid composition and dilution. • Clean out on scheduled basis.
Spray Metering, Atomization and Pattern Definition	• Protect fluid metering from high heat areas. • Shape the spray according to the tool to be coated.
System Actuation, Control and Supply Lines	• Include flow controls and gages for adjustment and monitoring. • Filter liquid to no less than 80-mesh particle size.
Spray Mounting Assemblies	• Protect spray devices from press and billet movement. • Observe press cycle and operation prior to installation. • Provide flexibility for ease of operation and maintenance.

Figure 4: Remote mounting of nozzles away from the heat allows for easy adjustment and repair.

Proper installation, combined with complete operator training, is then the most important factor in the potential ongoing success of press tool spray lubrication systems.

Results with Automatic Spray Coating of Press Tools

Today, a variety of pre-designed and pre-assembled packages are available for a variety of applications; the three most common applications are butt shear blades, log shearing knives, and dummy blocks. Butt and log shear systems can be economical, simple to install and maintain, and easily cost justified in most applications. Dummy block spray systems, on the other hand, are more complex and

expensive in nature due to the requirement for limiting their effect on dead cycle time. Specific applications will now be discussed.

Butt Shear Lubrication - Spray lubrication of the butt shear blade can virtually eliminate sticking butts, improve cut quality, lower shear pressures, and reduce cut deflection. Some extruders lubricate only the die side, others coat the container side, and many hit both sides according to user expectation, shear blade design, alloy pushed, discard butt lengths and extrusion product mix. In all cases, spray is applied to both sides of the blade to insure even lubrication. One extruder observed that the use of automatic lubrication on a blunt shear eliminated abnormal guide and cylinder wear that previously caused complete press shut down twice yearly.

Log Shear Lubrication - Lubrication at the cutting tool interface and log contact points will instantly reduce billet hang-up and build up in the shear, while also providing improved cut quality. With most installations, the atomizing nozzles are mounted to the platen on the exit side of the shear and remotely spray the upper sides of the tool where the fluid can then drain down to the lower cutting edges. Spraying from the exit side allows for nozzle adjustment and repair out of the hot zone; further, the atomized spray from the exit side is against the air flow out of the log oven (i.e. hot to cold) which minimizes overspray (See Figure 4). A detailed investigation of one specific installation proved to virtually eliminate press downtime related to “stuck logs” when combined with an improvement in shear tooling alignment; chips created in the cut and smearing of the log end were also significantly reduced.

Dummy Block Lubrication – Fixed dummy blocks have proven to be the most challenging tools to spray lubricate automatically. The technology to date has required a spray nozzle to be moved in front of the dummy block, spray the face and land, and move back out of the way of the press cycle. In addition, due to the necessity for uniform dummy block wear, a rotating nozzle (rather than a fixed nozzle) is used to apply the fluid. Ongoing developments (See Figure 5) continue to improve system reliability, however the most successful systems in operation still require ongoing maintenance and operator intervention.

Figure 5: Rotating nozzles are driven with an air driven gear motor for improved system reliability.

Many new presses and log shears built today have automatic lubrication systems already installed. This is a clear sign that there are benefits to automatic lubrication of these vital press functions.

Potential Pitfalls

Automatic spray lubrication, as with most automation, has several inherent problems associated with its use. The best designed equipment and chemicals for this process **must be monitored and maintained** properly so as to provide optimal results.

With the fluids, it is important to see to **proper dilution** and mixing of the concentrate with good quality water. In addition, the reservoir must not be allowed to run dry, as this will put air into the fluid line, which causes inconsistent spray patterns and volumes.

With the equipment, filters and seals must be **changed and cleaned on a scheduled basis** prior to becoming deteriorated and causing a long list of other problems. Nozzle extensions must be put back into position after being moved, in order to assure proper spray direction. Fluid volumes and spray patterns may **require some adjustment** accordingly.

Improper system operation and maintenance can cause a variety of concerns that include, but are not limited to, the following:

- Overspray on equipment.
- Clogging of nozzles.
- Smoke and mist.

Investing the time, effort and training can make all the difference in assuring successful implementation of spray equipment into the extrusion process. A successful installation will quickly offer the benefits highlighted throughout this article.

Powders for Billet and Block Lubrication

A newly developed method to lubricate extrusion press tools is the use of powders that are electrostatically applied. The primary application for this technology is for application to the dummy block or billet end (hot or cold) in order to insure proper parting and reduce the associated build up on the land of the dummy block.

The advantage of this new technology is as follows:

1. No Smoke or Fire Hazard
2. Applicable to Hot and Cold Steel and Aluminum
3. Highly Effective in Small Quantities

Unfortunately these products have also shown to be expensive to use, messy as the dust is easily transported, and the powders can agglomerate as they are hygroscopic. For this reason, the technology continues in its development.

Conclusion

Manual and automatic lubrication of press tools is well documented to provide improvements in cut and quality, while at the same time reducing or eliminating metal hang-up and sticking if performed on a regular basis. The technology is at a point where the combination of application-specific chemicals, used in combination with the proper applicator system, can be expected to operate continuously and predictably to provide these results. As with all forms of automation, automatic spray lubrication requires scheduled maintenance and adjustment so as to optimize expected results.

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