PRESSWORKING LUBRICANTS AND APPLICATIONS

The selection of the proper pressworking lubricant for a specific application is determined by several major factors. These include the condition of purchased material, type of tooling, severity of the pressworking operation, desired application technique, cleaning and finishing requirements, disposal cost and worker acceptance. Current United States federal law requires the lubricant supplier to furnish a complete safety data sheet to the user. This data must be available to all employees that may be exposed to the material.

Guidelines for Choosing Pressworking Lubricants

Presswork operations are becoming more highly integrated. For example, some dies incorporate an assembly station and tapping operations. Here, the lubricant must serve multiple needs while being compatible with subsequent operations. [1] [2]

Pressworking lubricants fall into four categories: fluids, pastes, soaps and dry films. Fluids are the most widely used pressworking lubricants. The two major classes of fluids used are solutions and emulsions.

Solutions

A solution is a fluid in which all of the ingredients are mutually soluble. Solutions utilize either oil or water as a base. A typical oil based solution for difficult operations may consist of a mineral oil base, a wetting agent, a rust inhibitor and an extreme pressure agent. Mineral oil solutions provide good fluid integrity and are generally safe from biological attack. Oil based solutions can be recycled and clarified.

Water based solutions may contain surfactants, soluble esters, soluble rust preventives, and in some cases, extreme pressure agents. These solutions differ greatly from oil-based lubricants. One advantage is that the evaporation of water helps cool tooling used in severe operations. These solutions can be recycled, provided water and other constituents are added as needed to maintain the correct composition.

[1] J. Ivaska, Jr., "Lubricants--A Productive Tool in the Metal Stamping Process, SME Technical Paper TE77-499 © December, 1977.

[2] J. Ivaska, Jr. "Lubricant Implications for Integrated Pressworkers, "SME Technical Paper MF87-003, © July, l987.

Emulsions

An emulsion is a fluid system where one immiscible fluid is suspended in another. The mixture with formed droplets is an emulsion.

In pressworking lubricants, the continuous phase generally is water containing suspended oil or a synthetic solution. The water can contain several additives such as extreme pressure agents, fats or polymers depending upon the severity of the work. Stable emulsions require proper composition as well as mixing devices and correct application techniques.

Synthetic Solutions

These solutions combine excellent high temperature properties and good boundary lubrication. The main ingredients for these types of synthetics are synthesized hydrocarbons (polyalphaolefins) and polybutane derivatives.

Synthetic solutions are much like oil based solutions in their physical characteristics, but have a higher degree of resistance to oxidation. The polyglycols, polyesters and dibasic acid esters have superior high temperature stability. Synthetic solutions are more costly than oil based solutions.

Pastes, Coatings and Suspensions

For severe pressworking operations, high film strength lubricants are sometimes needed. Pastes, suspensions and conversion coatings are often used.

Pastes can be made in several ways. They can be formulated with oil or be water based and may contain pigments. The pigments used in pastes are much like the pigments in paints. They are fine particles of insoluble solids. Some commonly used pigments are talc, china clay and lithopone. Some pigmented pastes are available as emulsion compounds composed of fats and fatty oils and in some cases, mineral oil-pigment, emulsifier, soap and water.

Pastes can be used as supplied or diluted with water or oil for easier handling and application. For more severe work, pigments dispersed an oil base which may also contain extreme pressure agents are available. These compounds may be diluted with mineral oil.

Non-pigmented pastes are available in several forms. Emulsion drawing compounds are pastes composed of fats, fatty oils and their fatty acids sometimes containing free mineral oil, various emulsifiers and water. These products are diluted with water before use. Fats, fatty oils and fatty acids can be used straight, but usually are mixed with mineral oil for use. Mineral oil and greases can be used straight when necessary.

Dry-Processed Coatings

These coatings find increasing use because of their economy, cleanliness and ease of handling. The coating may consist of dry soap films, wax or wax-fatty compositions. The coatings are applied by hot dipping, spraying the material hot, or by a cold application in a solvent vehicle. In the latter method, the vehicle evaporates, leaving a dry coating. For high production, roller coating is preferred for sheet and coil stock.

Phosphate coatings are chemical immersion coatings that provide a measure of lubricity. Graphite coatings are useful under high-temperature and heavy unit loading conditions where no other lubricant will serve the required purpose. Graphite has the disadvantage of difficult removal and used for drawing only when necessary.

Suspensions

These lubricants consist of fine particles of various solid lubricants dispersed throughout a carrier fluid. Usually the lubricant is insoluble in the carrier or vehicle fluid.

Warm and hot forging of steel and other metals is frequently lubricated by graphite in water, or less commonly mineral oil. The structure of graphite, its stability at temperatures over 1000 degrees F (540 degrees C) and positive side effects of air and water vapor on its lubricity favor the application of graphite with a carrier as a very cost effective high temperature lubricant.

Solid Lubricants

Solid lubricants are used in pressworking, particularly where operations encounter high unit pressures on high temperatures brought on by deformation of metal. The two major types of solid lubrication are soaps and soap combinations or graphite and molybdenum disulfide, either alone or in combination.

Soap Lubricants

There are four types of soap lubricants. The first class is dry powders, which usually are sodium or other metallic type soaps. They are generally furnished in powder form for use in tube bending and wire drawing.

The second class is dried film compounds. These are usually soluble soaps, often mixed with soluble solids. A few examples are those containing borax, waxes, wetting agents and other chemical ingredients. These dry films are used for drawing and can be applied by spraying or dipping with a 10 to 20% hot solution. The film is dried prior to the forming or drawing operation.

The third class is sodium or potassium soluble soaps. These are diluted up to 10% with water.

Metallic soaps such as aluminum stearate, calcium stearate can be used alone or in combination with molybdenum disulfide (MoS_2) and/or graphite. This combination, which makes up the fourth class, is used for wire drawing and warm forming.

Advantages of Water-based Pressworking Lubricants

There are many benefits derived from the use of water based lubricant solutions where possible. When compared to mineral oil based lubricants, the advantages include lower initial cost, compatibility with secondary operations, and elimination or reduction of cleaning.

In some instances, portions of the production process require modification to permit the use of water-based lubricants. For example, if the lubricant is recycled, additional clarification and contamination control equipment may have to be installed in order to maintain lubricant stability and product quality.

Material Considerations

When specifying material for use with water based lubricant solutions, the stamping material should be clean, dry and as free as possible from mill oil and rust preventives.

Paper clad and plastic film protected material finishes can be formed with water-based solutions without damage to the protective coverings by simply applying the lubricant with roller coaters or spray units.

Tests should be conducted to determine if the water based solution would not react with materials such as galvanized steel and aluminum resulting in corrosion or staining. The proper dilution strength should be carefully noted. Operating with the proper concentration can be the difference between success and failure. Surface tests should also be performed on coated stocks.

Stamping Material Properties

The four most common categories of material surfaces are normal surfaces, active surfaces, inactive surfaces and coated surfaces. [3]

Normal surfaces have a natural affinity to retain lubricant readily. Generally, a special wetting agent is not needed. Bare mild steel is the most common normal surface. Normal surfaces are easy to lubricate provided dirt or contamination is not present.

An active material surface is one in which the strength of the bond between the lubricant and metal atomic structure is great. Because the attractive energy is high, surface chemical reactions are encouraged. The surface attraction is also a function of the lubricant's composition. This explains why chemically active additives, wetting agents and extreme pressure agents are so effective.

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[3] E. Nachtman, "A Review of Surface-Lubricants Inter-reactions During Metal Forming", SME Technical Paper MS77-338, © July, l977

An inactive surface is one in which the strength of the bond between the lubricant, including additives and the metal atomic structure is low. Typical inactive surfaces are stainless steel, aluminum and nickel. To be effective, the lubricant must have a high film strength, which provides a mechanical barrier between the tool and part, preventing a metal-to-metal contact.

The most common coated stock is galvanized steel. Material pick-up can occur when forming galvanized material. Special water-soluble lubricants are available which can keep the galvanized metal particles from building up on the tooling. Dry film and water-based solutions find successful use on galvanized stock.

Corrosion of Zinc Coatings

The term white rust describes the destruction of the surface of galvanized steel or zinc by oxygen or other chemical elements. This reaction accelerates in the presence of moisture.

The rate of attack relates to temperature, pH and composition of moisture and the concentration of dissolved gases within the moisture. The rate of surface breakdown increases with the amount of dissolved oxygen and carbon dioxide. The corrosion cycle starts with the formation of zinc oxide, which in turn converts to zinc hydroxide and then to basic zinc carbonate in the presence of carbon dioxide.

It is essential that parts are drained of as much water based lubricant as possible. Parts in process should be used rapidly in order to avoid stagnation of any residual fluid. Conditions of high relative humidity and temperature aggravate the condition.

Tooling Compatibility

Progressive dies and transfer press operations require that the lubricant being used provide correct lubrication for every operation, and be compatible with the materials used to build them. Some lubricants may attack the self-lubricating graphite composition plugs pressed into guide bushings and wear plates. Damage to pads and seals made of rubber and elastomer products are a consideration.

The maintenance and operation of tooling when working with water based solutions requires special consideration. Most synthetics are alkaline in nature and act as detergent soaps. These solutions remove most conventional greases and machine oils. It may become necessary to protect the tooling and related die components with rust preventives, especially when the tooling is in storage for extended periods.

Tooling Interaction

Some lubricants attack the binding material of tungsten carbide. Electromotive forces (EMF) can be generated between the carbide surface and the machine tool with resulting erosion of the cobalt binder.

Roller Coating with Three Application Options

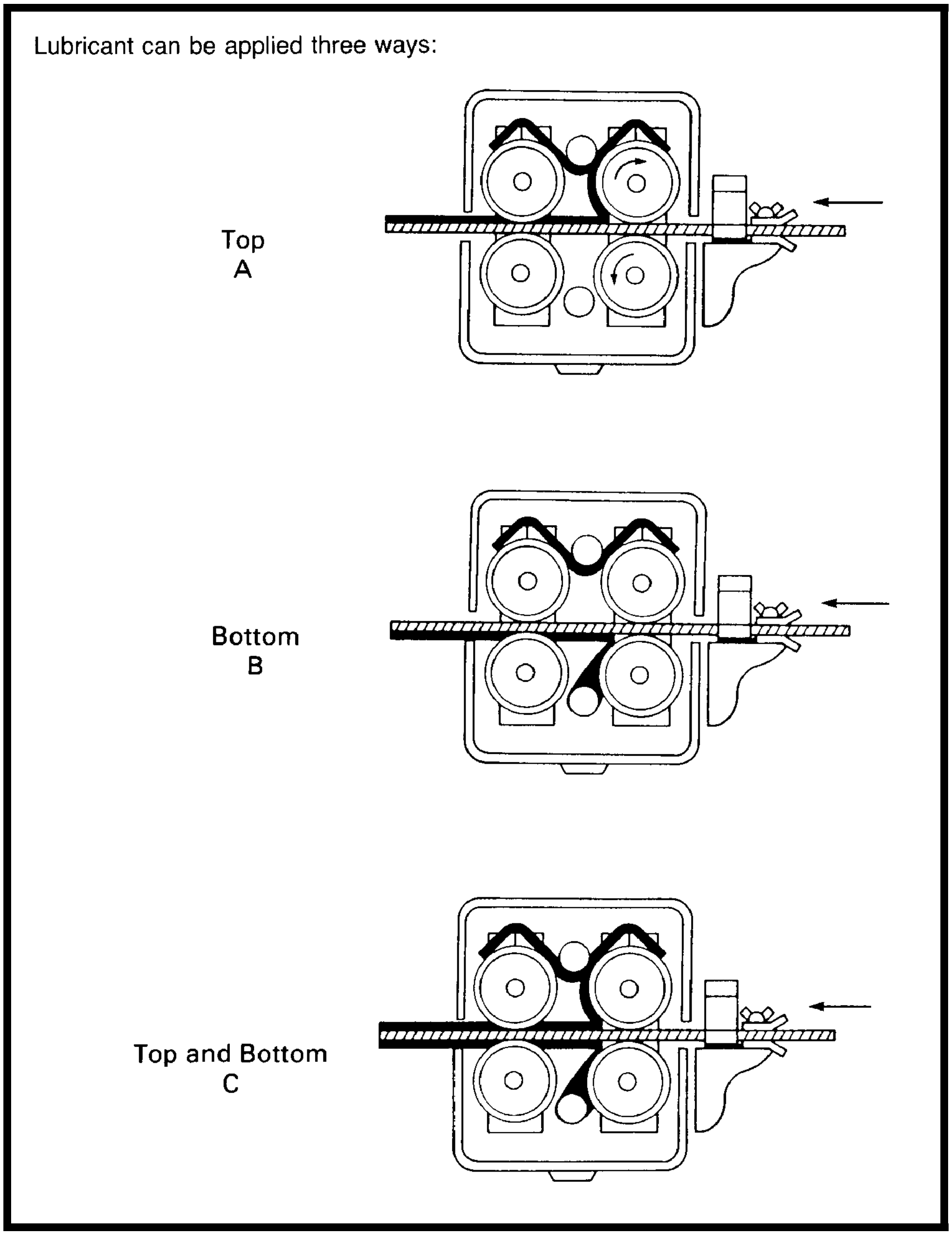

Figure 1. Roll coaters permit versatile lubricant application on the top, bottom or both the top and bottom of the stock. *Tower Oil and Technology Company*

Electrical current being present in the die from sensing probes and other electrical hardware can cause this same condition. In such cases, the coolant must not act as an electrolyte.

Application Techniques

There are many ways to apply lubricants for pressworking operations. Among the best methods are recirculating systems, roller coaters and airless sprays.

Roller Coating

This method of application is one of the most efficient methods of applying lubricant. The preferred position is between the die and the feeding mechanism. Placing the coater before the coil feed can cause the lubricant to work off the metal surface and often results in slippage in the feeder.

Roller coaters range in complexity from homemade units using paint application rollers to the system illustrated in Figure 1. With this type of roller coater, either one or both sides of the material can be lubricated. The stock is coated with lubricant as it passes through the applicator rollers. Any excessive lubricant is then squeezed off by wiper rollers and returned to the recirculating reservoir where it is filtered and available for re-application.

Airless Sprayers

An airless spray is a mechanical method of producing a finely divided spray of lubricant. Pressure is applied by means of an intensifier and then carried via a high-pressure hose to a tiny orifice in the nozzle, where the lubricant is expelled as a fine spray.

A typical airless set-up consist of an air-powered intensifier assembly, a check valve, a lubricant reservoir of the required size, the necessary number of nozzles needed for the operation and valves to activate the nozzles at the correct time.

The spray pattern can be either round or fan shaped. Airless spray systems are excellent for spot lubrication within the die, or lubricating the stock before it enters the die.

A modern airless spray system produces very little mist that results in overspray problems. It can be precisely directed at a target area in the die and timed to operate in conjunction with the equipment cycle.

Figure 2 illustrates an airless sprayer with two nozzles applying lubricant to both the top and bottom side of the strip. A felt pad on each side of the strip is used to spread the lubricant evenly onto both sides of the material. The pads are retained by two simple plywood fixtures clamped with simple coil spring retaining devices.

An option to spraying the lubricant onto the strip as shown in Figure 2 is to apply it directly to the felt pads. This will further reduce any mist problems and increase the efficiency of lubricant application.

Dual Nozzle Lube Spraying Device with Felt Pads

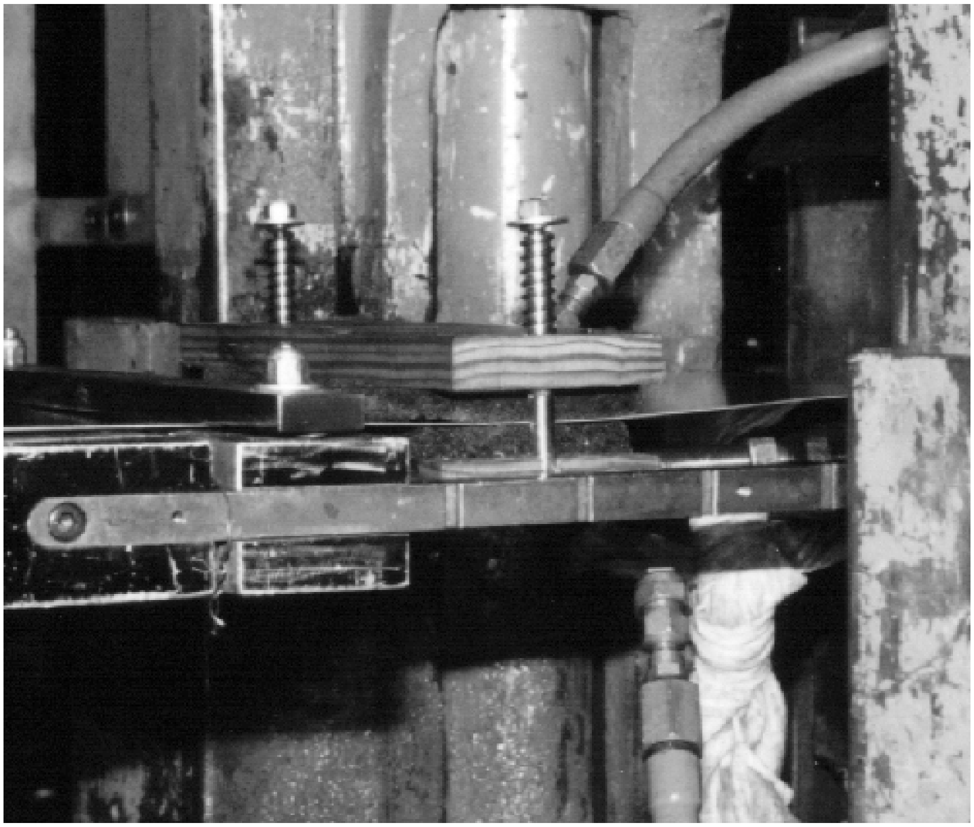

Figure 2. An airless sprayer with two nozzles applying lubricant to both the top and bottom side of the strip. A felt pad on each side of the strip is used to spread the lubricant evenly onto both sides of the material. *Smith & Associates*

Drip Applicators

The use of drip application methods is difficult to control. Typical drip lubricators is generally mounted after the stock or roll feeder. The drip system is regulated by a petcock that is adjusted for the flow desired.

Usually there is no provision made for automatic drip applicator shut off when the press stops. This results in wasted lubricant, messy parts and housekeeping problems. If a large stock width requires lubricated, a drip lubricator is an especially unwise choice.

Lower consumption of lubricant and increased productivity that can be achieved by eliminating costly drip or manual application can often pay back the cost of automatic application equipment in a short time. Inlaying out a new press line, it may be advantageous to install a fully automatic coil feeder, stock straightener and stock lubricator to obtain the maximum productivity from the press and tooling.

Cleaning and Secondary Operation Requirements [4]

The cleaning and finishing processes used often limits the choice of a pressworking lubricant. For example, low temperature cleaning lines generally are not capable of removing heavy oils, and extreme pressure agents. For low temperature cleaning, specially formulated water soluble lubricants are recommended.

Hot alkaline wash systems can clean heavy residual oils and other difficult to remove drawing compounds. The waste disposal costs for alkaline systems can be quite high if skimmers and clarification equipment are not used to lengthen the life of the cleaner.

Other considerations for compatibility with secondary operations include suitability for use with finishing methods such as painting or powder coating. In addition, compatibility with assembly or joining is important.

The use of some types of water extendable pressworking lubricants such as emulsions and chemical solutions may allow welding without smoke and weld integrity problems. Painting can be performed without prior cleaning in some cases. Heat-treating annealing and stress relieving operations may be affected by the choice of lubricant.

Lubricant Clarification Recycling and Disposal

Recycling pressworking lubricants reduces the amount of new lubricant required and disposal costs. Successfully recycling pressworking lubricants depends largely on controlling the contaminants that affect its useful life. If the lubricant is oil based, some of the chemical components of the lubricant may, precipitate on surfaces wetted by the fluid. If solid lubricants are used in suspension, these too deposit.

The stability of emulsions and soluble oils decreases with time and amount of reuse. In the case of water-based solutions, changes in pH may cause precipitation. These changes determine the choice of the recycling equipment and disposal requirements.

The contaminates in lubricants can include particles from the stock that break loose during the pressworking operation. Some typical contaminants are mill scale, aluminum oxide and particulate material from zinc coatings.

In addition, contaminants other than those directly resulting from the process may be present. These may include cleaning fluids, oil absorbent from the floor, and lubricants from the pressworking equipment.

[4] J. Ivaska, Jr., "How Metal Forming Lubricants Affect the Finishing Process", SME Technical Paper FC83-690, © l983.

Clarification Equipment

If lubricants are to be recycled, appropriate clarification equipment is required. A simple gravity-settling tank will remove of the debris that is heavier than the lubricant. Gravity setting systems, because of their low cost and simplicity, are often used as the first stage in a total system that might include cyclone separators, filtration devices and/or a centrifuge. This approach reduces the operating cost of the more sophisticated equipment and the productivity of the system is frequently improved.

Skimming can easily do removal of tramp oil from the surface of a gravity-setting tank. High volume recycling systems often incorporate cyclone or centrifuge separators. However, simple filtration is usually employed for low volume work.

Gravity, pressure and vacuum filters are often used for final clarification of pressworking lubricants prior to reuse. The equipment can be as simple as the use of old-fashioned dairy cans and milk filters, to sophisticated suction filters. In all systems, the filter media must be changed periodically and disposed of properly.

Limitations on Recyclability

Pressworking lubricants containing water are apt to be affected by any number of the microbes, which are present in the environment. The lubricant constituents are the food that feeds these microbes. When growth occurs by attacking a constituent, the lubricant may be changed. The lubricant no longer functions as intended.

The use of an effective biocide together with proper clarification and filtration are good procedures to follow. Water based solutions usually require the addition of water to make up for evaporation. Impurities in the water should be avoided to help insure long lubricant life. Other constituents may also require replenishment. Most water-based solutions can be tested and controlled with the aid of a chemical titration kit developed by the manufacturer of the particular solution.

Clarification, maintaining a correct balance of lubricant constituents and avoiding microbe growth all promote the recyclability life of the lubricant. These measures also help avoid irritation of the operator's skin, which can lead to dermatitis problems.

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