How to rest easy knowing your stock is lubed

Stock lubrication process monitoring and data

Introduction

It is safe to say that most manufacturers are interested in curtailing waste, increasing profit margins, and having the ability to manufacture parts more quickly as these actions provide an edge over their competition. In today's manufacturing environment, there has been much hype around terms such as "Industry 4.0", "M2M" (machine to machine) and "IIOT" (industrial internet of things). These buzzwords are centered on a single concept and typically can be summarized with one term: Data.

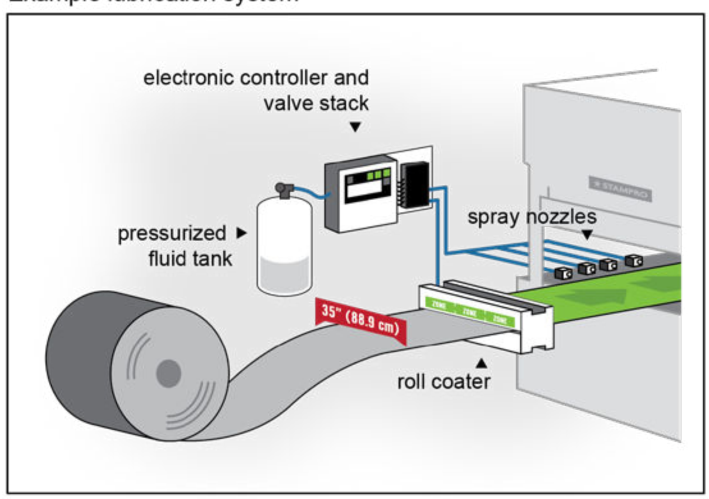
Having accurate data is not only essential for identifying wasteful and unproductive areas, but also for implementing a successful manufacturing change. While obtaining good data is crucial, one of the lesser known secrets is that obtaining, storing, analyzing, and understanding it can come with a price tag. The size of this price tag can vary, but it usually tends to increase with more complex solutions. Sensors that convert a real world entity into a digital value can be quite expensive and manufacturers must be able to put a value on the data delivered by these devices to know if the added expense is worth it.

For over 25 years, Unist has been providing manufacturers within the metal stamping and forming industry solutions that accurately and reliably apply lubricants to stock material. While lubrication in the stamping or forming of metals is often an afterthought, it is nonetheless an absolutely critical component of the overall process. Our broad experience has taught us some of the essential features that contribute to a high level of performance from a stock lubrication system.

The next several paragraphs explore a typical lubrication system for this industry, and break down some of the key components required to make the system work well. Areas in the system that could fail and cause an issue related to a lack of lubrication are highlighted. Various monitoring techniques that help mitigate these problems will also be discussed. What we've discovered is that the closer to the point of fluid application, the more expensive the monitoring technology, and metal formers must evaluate what the added protection is worth when deciding how much data they wish to collect from the process.

The lubrication system we use as an example is one that is installed on a coil fed stamping press. The stock material is about 35 inches wide (89cm), and the lubricator consists of a roll coater placed on the infeed side of the press. The roll lubricator has three top and three bottom zones, each zone covering approximately a 12" (31cm) area. The lubrication system also has four supplementary spray nozzles at critical die features. The roll lubricator and nozzles are connected to a solenoid valve stack that is in turn supplied by a pressurized fluid tank. The valves are controlled with an electronic controller.

Example lubrication system



In such a lubrication system, there are several utilities and system functions that must work properly for the correct amount of lubricant to be delivered to the material. Various parameters related to that utility or function can be monitored to indicate proper performance. There are three basic ways to monitor any of these parameters. The first, and most basic, is a manual check where a human verifies that a parameter is good. The second, slightly more sophisticated option, utilizes a sensor that tells the automation if a certain parameter is either in a go or no-go state.

The final way is to directly measure the parameter with a measuring device that provides an instantaneous measurement.

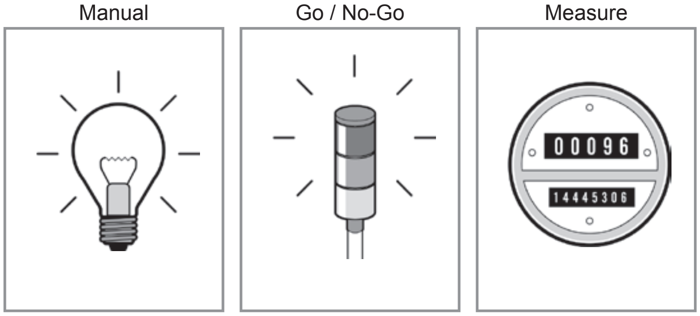
Power Monitoring

At its most basic level, the lubrication system requires electrical power to function. For the system to control the valves, run various jobs, and react to the line, it must receive power. But how does the production line know that the lubricant controller is powered up and ready to go before it runs? The manual option is to have an operator verify that the controller has power.

A second, and better, option would be to install the lubrication system with an alarm interlock relay connected from the lubricant controller to an input on the press controls, so the press will not run without this input signal present. Installing this interlock so the relay from the lubricant controller provides a closed circuit when powered up provides broken wire, or fail-safe, operation. Wiring such a circuit is relatively easy and cost effective to implement.

Power Monitoring

Manual | Go / No-Go | Measure



Check it's on (Not sufficient) | **Alarm Interlock** (Sufficient, easy to implement) | **Current/Power Meter** (Data not worth the expense)

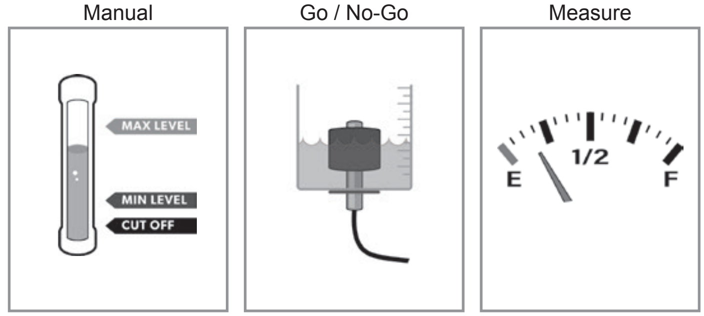
A third option would be to measure input power or electrical current to the controller system. With this third option, the manufacturer would know exactly how much electrical current the lubricator was drawing for each part stamped (knowing this information may or may not be beneficial).

Fluid Supply Monitoring

How does one ensure that fluid is present in the lubricator before stamping a part? A simple sight gauge in the fluid reservoir provides a quick way for an operator to verify that the tank is full. This is effective when consistently performed, but relies on humans to ensure it gets done. A better option is the use of a float switch inside the tank which is wired in a fail-safe manner. This switch can communicate to the lubricant controller that there is adequate fluid in the tank and that it is okay to start running. If the fluid level is low, the previously mentioned alarm interlock circuit, which is normally closed, will open – preventing the press from running until the fluid level condition is satisfied. It is possible that, over time, a float switch in the fluid tank could degrade, become stuck, or have some other malfunction.
For these reasons, a well-designed fluid supply system should incorporate a visual sight gauge that can be inspected by operators or maintenance as part of a daily preventative maintenance routine. The additions of a float switch and sight gauge to a supply tank come at a minimal cost, but provide a high level of protection. One could take the fluid monitoring one step further by introducing a fluid level transducer. This transducer would communicate exactly how much fluid was in the tank with each

Fluid Level Monitoring

Manual | Go / No-Go | Measure

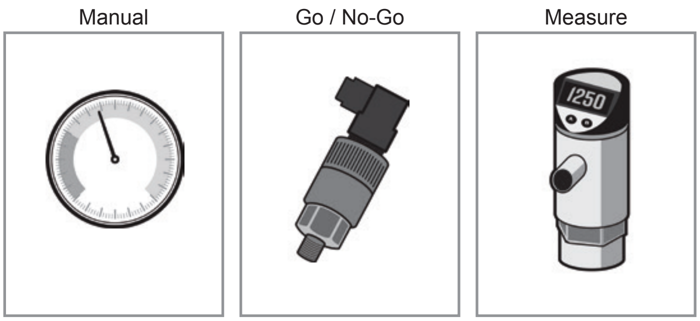


Sight Gauge (Good to have, not sufficient alone) | **Level Switch** (Sufficient, easy to implement) | **Level Transducer** (Data not worth the expense)

part made. However, since the actual volume of fluid in the tank does not impact the performance of the lubrication system, the transducer option may be superfluous; making the low level switch a better value.

A critical requirement of the fluid supply tank in our example is that it be a pressurized fluid source. Pressure is what drives the fluid through the valves to the roller applicators or to the nozzles. A typical pressure tank needs to be vented in order to be refilled. This begs the question: How does the line know the air pressure was turned back on after a tank refill? Additionally, how do operators ensure there is adequate pressure in the tank or even that the pressure is the same at which the system was calibrated? One option is a pressure gauge installed on the fluid supply, which signals to the operator that pressure is sufficient.
Another option for monitoring fluid pressure is a pressure switch which would also signal satisfactory tank pressure. The optimal way of ensuring adequate tank pressure is the use of a pressure transducer at the valve stack. This transducer signals to the controller that pressure is present and, additionally, that the pressure is in the correct range for accurate dispensing.
If either of these conditions aren't true, the lubricant controller

Fluid Pressure Monitoring



Visual Pressure Gauge Check (Good to have, not sufficient alone)

Pressure Switch (OK, but could do better)

Pressure Transducer (Data worth the expense)

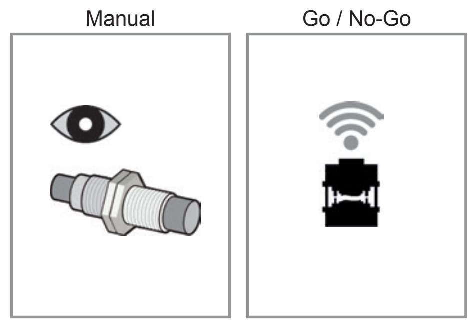
will rely on the alarm interlock relay to prevent the press from running. Consistent fluid pressure is absolutely essential to providing consistent lubrication. The flow rate of fluid to the rollers and nozzles is directly related to the pressure in the fluid tank, and knowing the exact pressure when each part was made could be quite valuable as it directly relates to the amount of lubricant applied to the stock material.

Control Signal Monitoring

The lubrication controller in our example requires a control signal that turns on and off at a rate that is proportional to the speed of the stamping line. This input signal could be a rotation sensor on the lubrication roller that provides an input with each full revolution, or it could be a limit switch that is triggered each time the press strokes. Whatever this signal is, it should communicate to the lubricant controller how fast the stock is moving and, in turn, when and how often to dispense lubricant to the applicator rolls or nozzles. This is called the cycle input signal and it is important to know that it is working properly. How does the lubrication controller know when it should be receiving cycle input signals? What if the limit switch or rotation sensor fails? How will the press controller know not to run because there will be no lubrication?

The simplest option would be an operator visually inspecting the signal as the line starts up, ensuring that the input signal is in working order. A better solution would be to install a second control signal wired to the press controller (the first being the alarm interlock relay) that is referred to as the “press is running” signal. This signal is used by the lubricant controller so that it knows the press is in run mode and, while the press is running, it should continually receive cycle inputs. If no cycle inputs are received within a specified period of time while the press is running, the alarm interlock relay will open to stop the press. A common way to implement this on a press line is for the “press is running” signal to be activated when the press clutch is engaged. The circuit and wiring between the lubricant controller and the press controller should be configured so

Cycle Input Monitoring



Visual Sensor or Switch Check (Not sufficient alone)

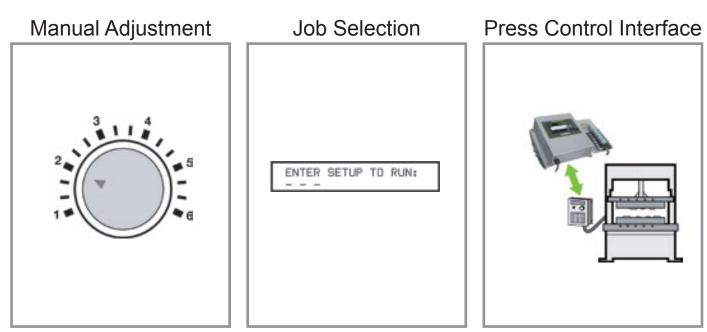
Line Running Signal (Best solution)

that it provides fail-safe operation: the circuit is closed when the press is not running, and the circuit is open when the press is running. Implementing this could take some programming effort and electrician time, however, the insurance it provides is well worth the cost.

Job Changeover

A fluid application system installed on a stamping line will likely need to lubricate the stock material for a multitude of jobs, oftentimes with different fluid output levels for each of these. The flexibility to change a line over from one part to the next is important, and being able to do so quickly is a must. How can a press line ensure that the lubricator settings have been set for the parameters of a new job? On simpler lubrication systems, the adjustment of settings is performed manually with regulators, metering screws, or pump stroke control knobs. An operator

Job Changeover



(Not sufficient)

(OK, but could do better)

(Best implementation)

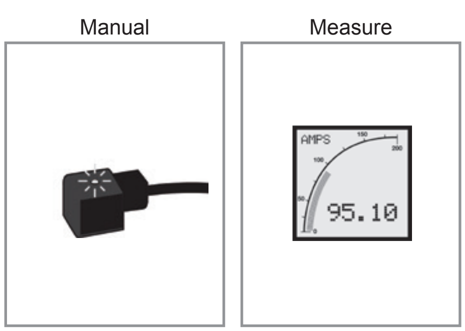
must remember to change the settings with each new job they run. The lubrication system in our example utilizes a programmable controller, meaning it remembers settings for individual jobs. Operators can select the correct job from the programmed list and resume operation of the press line. The ideal scenario is for the lubrication controller to utilize a press control interface, one where the press controls send the lubrication controller the correct job number to run. Changeover of the lubrication job and the corresponding fluid output parameters, happens without any operator involvement. A full press control interface might also allow operators to view and acknowledge alarm messages and make small output adjustments from the press controller.

Dispensing Monitoring

During operation, the lubricant controller receives cycle inputs and, according to the settings in the controller, opens and closes valves to dispense lubricant in the desired quantities. In the example system, solenoid valves are used to control fluid flow. When a solenoid valve is told to open, how can the lubricant controller know that it actually turned on?

Once again, the simplest option is reliant on operators: they can watch lighted DIN connectors on valves to ensure they light up with each cycle. Another more efficient way to verify the electronic portion of the solenoid valve is working properly is to monitor the electrical current through the solenoid. Detection of a short circuit, open circuit, incorrect solenoid coil, or faulty connector is achievable with well-designed control circuitry. Lubricant controllers can implement this technology into the valve drivers so that gross malfunctions in the operation of the solenoid valve are visible. This technology is fairly common and can be added with only a minimal increase in cost.

Solenoid Valve Monitoring



DIN Connector LED Visual Check (Useful, not sufficient alone)

Solenoid Current (Data worth the expense)

Now that the correct amount of electrical current was delivered to the solenoid valve, how can an operator know that the valve actually opened and fluid was dispensed? A visual inspection by the operator is one way, but another option is to use a flow switch. A flow switch would detect that fluid actually flowed from the valve when opened, but it does not tell how much. Alternatively, a flow meter could be used that can report the actual flow rate of the fluid from the valve. With this information, the volume of fluid that has been dispensed can be calculated. Flow switches can provide reliable indication of flow, although are typically limited by a minimum effective volume of flow and might not work for every application.

Fluid Flow Monitoring

Flow Visual Check (Useful to have)

Fluid Flow Switch (Useful to have)

Flow meter (Valuable data but expensive)

Commercially available flow transducers can provide an indication of flow at low flow rates, however they typically come with a large price tag. In a lubrication scenario where the flow of lubricant to the points of use can be staggered, a flow transducer is a great option as one can be used for multiple points of application. However, in a lubrication system where flow must simultaneously travel to multiple points of use, such as several nozzles, a transducer must be used at each point. This greatly increases the cost of implementation, but also provides precise data about how much fluid was dispensed at each point. If the process warrants, a flow meter can be an effective way to ensure fluid is delivered to the dispensing apparatus. Another useful benefit of flow transducers is that the total volume of fluid consumed by the process can be tracked.

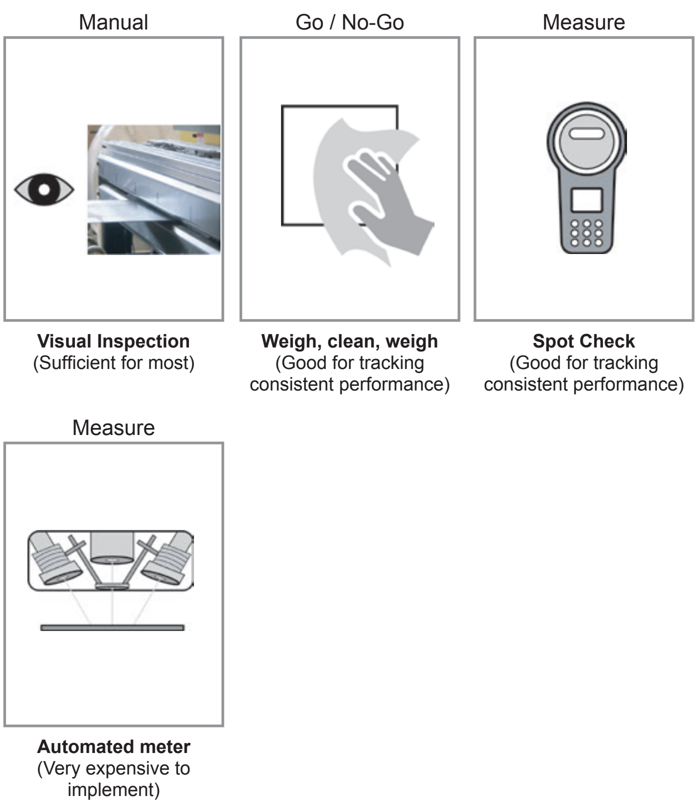
Application Monitoring

Finally, if the correct volume of fluid has been delivered to the roller or nozzle, how can one ensure that the roller or nozzle has deposited the intended amount of lubricant onto the stock material? To gauge this, there are several methods. The simplest option is a quick wipe of the fingers across the stock to see how much fluid is there or additionally, to visually look for signs of over-application such as drips or pooling of excess fluid.

A second method involves periodically taking parts out of the process, weighing them, removing all fluid, and re-weighing them to calculate the amount of lubricant on the part.

A third method would be to use an instrument to spot check and measure the actual film thickness of lubricant on the part. Finally, an instrument could be placed in line with the process between the lubricator and the press to gather data about the lubricant film thickness across the entire area of the stock material.

Application Monitoring



Technologies such as laser induced fluorescence spectroscopy and infrared spectroscopy can measure the physical characteristic of lubricant film thickness, however they come at a significant cost. A traversing system that can measure the top and bottom of the material feeding into a stamping press could quickly exceed several times the cost of the example lubrication system.

The data would be elegant, allowing users to know exactly how much lubricant was on each part when it was stamped. This information could be correlated with dimensional tolerances and a model could be developed that controlled press tonnage, clamp pressure, and other parameters in real time. This would allow for optimal results, but at the end of the day, such a sophisticated solution must be able to produce bottom line benefits due to some improved operational efficiency.

Conclusion

Proper lubricant application to stamped and formed material is a vital component of a well running process. Consistent coverage across the width of the material, top and bottom, ensures that the benefits of lubrication are realized by improving part quality and lengthening tool life. Controlled application prevents fluid pooling, drips, and overspray that would eventually lead to a messy (and oftentimes unsafe) condition. Applying the proper amount of fluid exactly where needed is the goal of our stock lubrication system. The guidelines for monitoring the system presented above will help to ensure the stamping line always runs with the proper amount of lubrication.

A well-controlled and monitored lubrication system can also help manufacturers keep track of their costs. With some of the advanced monitoring techniques, metal stampers can calculate and track their lubricant costs per part. It's good data like this that helps drive informed decisions about improving efficiency. Part quality and tool life data can also be correlated with lubricant usage and system performance to further optimize the stamping line. As we discovered, the closer we approach measuring the real life parameters that impact the lubrication system, the more expensive the solution. Metal formers may elect to implement sophisticated measuring devices for applications producing extremely high cost components or high volumes of low margin parts. Others may opt for the easiest and simplest option of relying on human interaction to verify the end result.

Whatever is the best solution for your operation, Unist can supply a lubrication system that is robust, reliable, and provides the peace of mind that comes with knowing that the proper amount of lubrication is being applied.