Eliminating Lubricant Cross-Contamination With Manufacturing Improvement Principles

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With the growth in base oil types and additive combinations that we have seen in the past couple of decades, the possible combinations of final blended lubricants has grown exponentially. While this can allow lubrication programs to hone in on the most suitable lubricant for an application, it also means we can have 15 to 20 different lubricants to manage in one facility. It's no wonder that issues of cross-contamination of lubricants are prevalent in many plants today.

Obviously, using or adding a fluid that does not meet the performance properties specific to an application is an issue. However, even lubricants that begin with similar performance characteristics may not coexist well. Different base oils can react chemically with each other, mixing base oils can lead to additives not holding in solution and various additives can even combat each other. All these issues lead to significantly lower performance of the lubricants. While the significance of incompatibility can vary widely, we can see certain indications, such as increased foaming, hastened oxidation rates, altered viscosity and film strength, water demulsibility issues and additive floc.

When determining how to minimize cross-contamination issues in a lubrication program, we don't need to reinvent the wheel (or the process to make it). Instead, we can learn from concepts that have been proven over several decades and adopt and amend them to overcome typical challenges in our lubrication programs.

Manufacturing Process Improvements

In the manufacturing processes of the 21st century, the methods of the Toyota Production System (TPS) are well renowned for eliminating waste while also improving quality. The success this system has generated for Toyota over the last half century has led to as many as 43% of U.S. manufacturers following some form of lean manufacturing.

From the days of Henry Ford all the way to current Toyota suppliers that are adopting the TPS methods, there is strong evidence that when executed properly, lean principles can and do help companies achieve sustainable improvements.

One of the many fundamental tenets of TPS is the concept of poka-yoke [poka joke]. In simple terms, poka-yoke is a method or mechanism that either prevents, corrects, or quickly draws attention to human mistakes. In fact, the translation for the Japanese term is "avoid mistakes." One good example is the use of left-handed threads on flammable gas cylinders to prevent accidental use of oxygen or other oxidizing gases.

Cross-Contamination Issues and Resolutions

Before we delve into applying poka-yoke to help us avoid cross-contamination, let's cover the issues cross-contamination can wreak on our lubricants and the equipment we are trying to protect.

As Table 1 indicates, some of the key properties of a lubricant can be expected to be altered when mixing incompatible lubricants. These alterations to the lubricant properties may come from incompatibility from base stock to base stock, or from issues with the compatibility of the many different additives found in today's lubricants. The severity of the conditions can

Contaminant Type	Damage to Lubricant	Damage to machinery
Cross-Contamination of Lubricants	• Oxidation • Additive loss • Viscosity changes • Loss of demulsibility of water • Increase in air entrainment	• Varnish/Deposits • Potentially exacerbates all wear mechanisms due to loss of film strength and changes in additive concentration • Premature filter plugging

Table 1: Cross-contamination effects on lubricant and machinery

range widely, from a slight reduction of oil service life all the way to sudden catastrophic failure. It's also important to note that a decline in the performance of any one property of the lubricant tends to directly affect the performance of other properties. For example, an increase in air entrainment can cause the viscosity to rise, which can cause the temperature to rise, which tends to increase the rate of oxidation.

When working with mineral oils, compatibility issues are more common with the additives in solution. The interactions of the different lubricants often cause additive floc. As additives fall out of solution, we not only lose the performance properties these lubricants are designed to provide, but the floc tends to plug filters and even plug fluid passage ways in more severe cases.

The additive loss issues are certainly present in synthetic lubricants as well, plus it is more likely that the base oils will react negatively with each other. Special attention should be paid specifically to polyalkylene glycols (PAGs) and silicone base oils as they are incompatible with any other base oil stock.

With cross-contamination of lubricants, any and all of the main functions of a lubricant can be negatively affected. Friction and wear control are largely a function of the correct viscosity and/or anti-scuff additives. Mixing two incompatible lubricants of the same viscosity can still cause the anti-wear (AW) or extreme pressure (EP) additives to be reduced to floc. If we increase oxidation rates, the sludge and varnish byproduct build-up will reduce the ability to transfer heat. Dropping anti-corrosion or anti-foam additives from solution has obvious affects as well.

All these issues are true for both lubricating oils and greases. However, with greases, the compatibility concerns are greater because the thickener type is another component that adds to the complexity. When grease thickeners are incompatible, the likely result is a significant

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change in consistency. This change in consistency often causes the base oil to drop or bleed out at abnormal rates.

With all these negative effects that can all exacerbate each other, why does cross-contamination of lubricants happen frequently? The same reason most mistakes happen - we are human and therefore subject to many limitations. The cross-contamination causes can be categorized into two broad groups: intentionally selecting a different lubricant and inadvertently applying an opposing lubricant.

We may intentionally decide to change lubricants for consolidation purposes, to change vendors, or to attempt to improve the lubricant's performance properties. Changing lubricants can be challenging, largely because of how difficult most systems are to properly flush out the previous lubricant. Depending on how severe the compatibility issues between the new and old fluid, even small amounts of the old fluid may cause serious issues. Consulting the lubricant supplier in advance is key every time we decide to change lubricants in a system. Lubricant manufacturers go to great extents to properly blend and test their fluids, and have also performed a significant amount of compatibility tests. Rely on their expert knowledge and don't attempt to test for compatibility yourself.

At least when we have made a decision to change lubricants, we are on the alert for cross-contamination issues. But the more common cause of gross cross-contamination is the inadvertent application of opposing fluids. Operators may inadvertently top-up with the wrong oil because they don't recognize the significance of various lubricant types, there are limitations in the labeling methods, or it's a case of apathy. In any of these cases, the poka-yoke philosophy guides us to make it easier to perform the job correctly rather than do it incorrectly.

Error Proofing Lubricant Applications

Now let's talk about modifications that will help dramatically reduce the possibility of lubricant cross-contamination. Once the lubricant has been selected, the next step for ensuring we get the right lubricant to the right place is to know (consistently and without question) which lubricant is the correct one. In lubricant application terms, we refer to this as tagging. But where do lubricant tags belong? The most obvious choice is on the equipment, specifically at the fill port. That will tell us what belongs in the equipment. We also need to consider the sources from which we draw on to get the oil (or grease) into its destination. After all, what good is it to know your blood is Type A, if the nurse can't tell whether the blood in the bag is Type A, Type B, or Type O? The solution is to tag all critical control points (CCPs). By this, we mean the fill port, transfer containers, off-line filtration systems, and of course, the storage reservoirs. This should include ALL containers that will hold any lubricant, including 'waste' containers that should specifically be marked with 'DO NOT USE.'

One piece of information that should be included in all lubricant tagging is the viscosity.

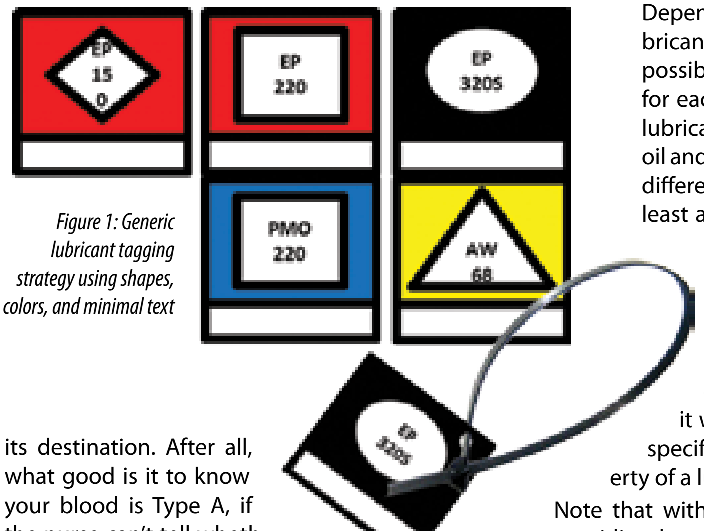

Figure 1: Generic lubricant tagging strategy using shapes, colors, and minimal text

Now that we understand where to place lubricant identification tags (everywhere the lubricant can be), what should these tags look like and what information should they include? The objective is to make it obvious which lubricant a particular component holds without making the tag difficult to read with small font size or overly-complicated information. We can include some obvious differentiators by using shapes and/or colors on the tags. This also helps to minimize the verbiage needed. We can then color-coordinate our transfer containers, off-line filtration systems and possibly our storage systems with our lubricant identification scheme.

Both colors and shapes (see Figure 1) can be used as indicators of major categories. For example, we may use orange for any PAO base oil, blue for a mineral oil and green to indicate a food grade lubricant. We might use a triangle to indicate an AW oil, or a diamond to indicate R&O turbine oil. Once we decide how to assign the colors and shapes, we will likely need just a little more information to hone in on the exact lubricant. For this, the tag should allow some space for any additional details, such as PMO oil, fire-resistant fluid only, etc. Depending on the quantity of lubricants you utilize, it may not be possible to have a different color for each. Using the same color for lubricants that have the same base oil and additive blend but a slightly different viscosity is one way to at least avoid the chemical reactions caused by more significant differences in lubricants.

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Note that with the lubricant tagging system, avoiding brand specifics is preferable. After all, a complete system can encompass many points and labels, so why set yourself up to relabel all these points if you change your lubricant vendor again?

Once we have all CCPs outfitted with proper labeling, we can take the error-proofing strategy to the next level. In the first level, we have clear identification of which lubricant should be used and where each lubricant resides. Now we go from making the right choice obvious to also making the right choice the easiest. We do this through some simple equipment modifications. As proper contamination control practices dictate, we should be using quick connect fittings to both top-off systems and for periodic decontamination. Not only are these quick connect fittings best practices for particle and moisture control, they allow us an additional method to avoid cross-contamination. Take advantage of the various sizes and types of fittings by outfitting your storage tanks, transfer carts and equipment fill ports with a scheme that minimizes cross-contamination. For example, we can use an ISO B 1-inch connection on our drum of hydraulic oil, the same ISO B 1-inch on the filter cart dedicated to transferring clean oil to the reservoir and then the hydraulic fill port uses a multi-port adapter (as seen in Figure 2) that has a 1-inch ISO B connection. Then for our gear oil, we may use a 1-inch ISO A connection, for the turbine oil, a 1/2-inch flush face connection, and so on. The same philosophy applies to grease points; we can use regular zerks for grease with a lithium thickener and then button head fittings to indicate an incompatible polyurea grease. Figure 3 provides grease zerk examples.

Figure 2: Adapter kits like these allow the use of quick connects with various sizes and styles; always matching fill port tagging with lubricant tagging scheme

Figure 3: Utilizing a variety of grease zerks will allow us to reduce errors in our re-greasing tasks

Summary

In outfitting the CCPs with connections that only join similar fluids, we have made it much easier to dispense the correct fluid than to dispense the incorrect fluid. By proper labeling and by applying the labels to all relevant CCPs, we make the right choice obvious. When we make the best path the easiest and most obvious, we dramatically reduce the probability of mistakes. This may not earn you the Shingo Prize for operational excellence, but you can feel confident that the issues caused by cross-contamination of lubricants will be dramatically diminished under your watch.

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