Lubricant Sampling Design and Implementation

Introduction

The promise of enhanced reliability and increased foresight in the way we conduct maintenance practices on capital equipment has always been a selling feature of oil analysis and condition monitoring. Unfortunately the steps taken to reach the goals mandated by our lube oil program often overlook a key element vital to its success. Lubricant sampling and extraction is perhaps the most important and highly variable step taken prior to the analysis of a sample and it is also the easiest to make consistent. Before we decide the appropriate way to extract the sample from our equipment for analysis, we first need to determine the desired end result. At this, we can work backwards to ensure the outcome can actually be achieved. We determine the end result first by examining the mandate of our lube oil program. We then can make decisions on the location of where we should be extracting our sample, what tools to use and what procedure to follow.

The Goal of Our Program A common mistake made by many companies beginning a lube oil program is that lubricant sampling is not considered an important part of the program. The methods and procedures we use for sampling will determine the amount of useful data we can acquire from our sample. The goals of our lube oil program will determine the amount of useful data we need to acquire in order to perform the proper analysis to make significant judgments on the maintenance of our lubricants and equipment. At the outset of our program, we need to determine whether our program will aid us in decision-making regarding the condition of our equipment by way of the lubricant, (condition based maintenance) or simply the condition of the lubricant alone. These are two very different goals of a lube oil program and each requires a specific approach to be successful.

Historically, many programs work toward condition based maintenance, but often they do not start there. So it is important that we begin our program with an ultimate goal in place. A common misconception in the evolution of a lube oil program is that the transition between lubricant monitoring and machine condition based maintenance is the difference between the types of testing that are done on the sample. This is not necessarily true. Of course the type of test run on a sample will provide specific information either on the condition of the lubricant or on the condition of the equipment it came out of. The difference is the location the lubricant was extracted from the equipment, the method that was used to obtain the sample and the tools that were used.

For example, samples taken from hydraulic reservoirs will offer little significant data on the condition of the equipment. Reservoir samples, however, can provide excellent data on the homogenous properties of the lubricant such as acid number, remaining useful life, viscosity and additive properties. Samples taken at the reservoir or sump are typically referred to a Primary Samples.

Primary Samples: If the intent of your lube oil program is only to monitor the health of the lubricant, a primary sample is all you will need. It is very easy and inexpensive to draw a sample for these types of tests. Often in lubricated pieces of equipment, a primary sample is the only type that can be installed. For example a bearing housing or small gearbox will only have one primary sample port. Secondary Samples:

Secondary samples a taken at specific strategic locations throughout the system. On a hydraulic system, you may have a primary sample port on a main return line and secondary sample ports downstream of major components such as pumps, motors, coolers, valves and filters. Secondary samples support what may be found in a primary sample and help to determine the cause. For example, if a particle count is done on a primary sample and the result exceeds a target level, it is difficult to determine the source of the contamination. It may have been ingressed through the breather, or lack thereof, introduced through contaminated oil during an oil top-up or generated internally by excessive wear. By testing secondary samples after the pump, motor and filter we can compare the ISO particle counts to that of the Primary Sample port to determine the cause. If all the particle counts are similar, we can conclude that there is no excessive wear being generated by the pump or motor. We can conclude that if the particle count after the filter is the same as all the other particle counts, the filter is no longer capable of removing contaminants from our lubricant. Changing or upgrading our filter should reduce our contamination level throughout the system. Without the use of secondary sample ports, we never would have determined that we needed to change the filter.

Methods: There are several methods used for drawing oil samples from equipment. Of course, some are more effective than others; the idea is to make the method in which you sample oil consistent among those sampling. We want to make sure that each time a sample is drawn, the end result is the same regardless of the technician drawing the sample. Written procedures and specific training are vital to the success of your program.

Drop-tube Sampling: Drop-tube sampling is an effective, low cost way to draw a sample with a vacuum pump for the analysis of chemical and physical properties of the oil. When using this method of sampling, there are many points to consider. For instance, in order to draw a sample, the machine must be opened and therefore the oil is exposed to the environment. Opening a machine potentially allows significant amounts of airborne contamination to enter the oil and cause damage.

The key to an effective oil analysis program is the ability to draw an oil sample from a specific location while the machine is in operation and under normal load. However, using the drop tube method on a gearbox while it's running poses several concerns. For one, the plastic tubing may be pulled into the gearbox. This presents specific safety concerns for the person taking the sample. Other problems associated with drop-tube sampling include large required flushing volume, difficulties in getting a consistent sample from the same location, and problems with sampling high-viscosity fluids. In summary, this method of oil sampling should be avoided when possible.

Drain Port Sampling: The ideal location for drawing an oil sample from a sump or reservoir is to get it as close to the return line, gear set or bearing as possible. Another rule-of-thumb is to sample at 50% of the oil level. Sumps and reservoirs were designed to hold a large volume of oil, to dissipate heat and to allow air to rise and contaminants to settle. Therefore, the most concentrated contamination is on the bottom of the sump or reservoir and the cleanest oil towards the top. Avoid using the drain plug for sampling if it sits on the bottom of the sump, even if you flush high volumes of oil before drawing a sample. If the drain port is the only way to obtain a sample from the gearbox, there are commercially available pitot tubes that can be installed on the bottom or the side of the sump. These inward pitot tubes can be manipulated to ensure that the sample is drawn in the most appropriate location of the sump or reservoir, and that the sample is taken from the exact same location inside your system each time. This method is a more consistent and representative way of sampling oil than drop-tube sampling.

Minimess Valve Sampling: When it comes to sample valves, there are several commercially available valves. Some valves are far superior to others. When selecting a valve, consider all the options. Sampling with valves as opposed to static sampling adds integrity and success to a program.

Perhaps the most effective option, which is typically used on larger, pressurized systems, is a minimess style of sample valve. These kinds of sample ports are check style, i.e., the valve is normally closed until the sample port adapter is threaded on. Sample ports come equipped with a dust cap that also has an o-ring for second stage leak protection. The adapter has a hose barb on one side that accepts standard 1/4” O.D. plastic tubing. As the adapter is threaded onto the sample port it unseats the check ball in the valve and allows you to draw a sample. These valves can be used on systems from zero psi (assuming the line is flooded) to 5000 psi.

On pressurized systems of 2000 to 5000 psi, consider safety as a factor. There are sample valves available that offer superior quality and safety when taking an oil sample. For example, hand held pressure reducing valves can be used in conjunction with the sample ports and adapters to reduce pressures of 5000 psi to less than 50 psi. They also come in several adapter styles that allow for ease when installing them on your system components. Another benefit to these types of sampling valves is that they hold a very small volume of static oil. This results in less oil flushing prior to taking a sample.

Conclusion:

Although there are several methods and tools available for sampling lubricants, the key is to ensure that the method and procedure used is consistent among those performing the task. Written procedures need to be enforced and streamlined. Sampling methods need to be easy and effective and be able to follow the mandate set out for the lube oil program. We must also make sure that we employ the use of Primary and Secondary sampling ports to gain vital perspective on the condition of our equipment and lubricant to make key decisions on equipment and lubricant maintenance.