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World-Class Oil Sampling
It is Possible

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When it comes to achieving a world-class oil analysis program and realizing all the benefits of condition-based maintenance, there are several milestones that must first be met.

One of the most important milestones of an oil analysis program is the sampling of the oil. The way a sample is collected, the frequency, the accessories used and the procedures followed all dictate how informative the oil samples will be and, subsequently, dictates how beneficial the results will be.

The following questions should be answered when designing a sampling program:

- Where is the best location to draw an oil sample to ensure the correct information is collected?
- What are the best tools for drawing a sample from a specific location?
- Who will be responsible for pulling the sample and how consistent will the sample be each time it's drawn from the specific location?

Sampling Port Location

Troubleshooting problems using oil analysis is greatly assisted by the installation of several sampling ports in various locations to isolate individual components. Isolating using multiple sample ports, gives an analytical edge for both discovering potential component failure and analyzing the root cause. Sample ports are classified into two categories, primary and secondary.

Primary Sampling Ports

The Primary sampling port is the location where routine oil samples are taken. The oil fluid from this sample location is usually used for monitoring oil contamination, wear debris and the chemical and physical properties of the oil. Primary sampling locations vary from system to system, but are typically located on a single return line prior to entering the sump or reservoir.

Secondary Sampling Ports

Secondary sampling ports can be placed anywhere on the system to isolate upstream components. This is where contamination and wear debris contributed by individual components will be found.

Consider a lube oil pump that feeds three sets of bearings (Figure 1). The return for the three bearings combines into a single return line before entering the sump. The primary sample port is on the single return line after all three bearing lines join and before the oil enters the sump. The secondary sampling locations are immediately downstream of the pump (upstream of all three bearings) as well as downstream of all three bearings.

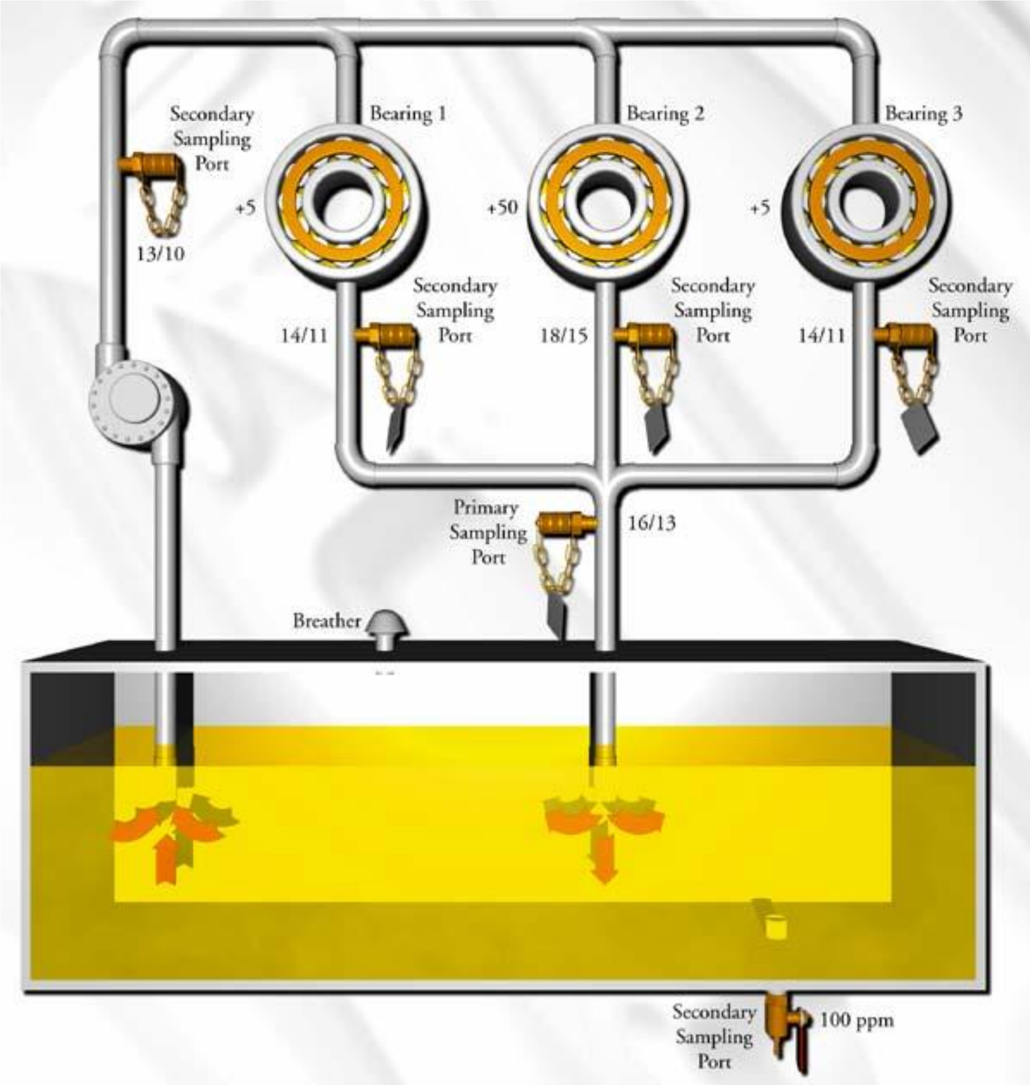


Figure 1

As an example, when performing an onsite particle count from a sample from a ferrous metal count on the primary sample port, a particle count corresponding to an ISO Code of 16/13 is reported (32% of which are ferrous particles). This level has exceeded the target of 14/11 and reflects a problem in the system. It also shows the contamination level of the oil returning to the sump is quite high even though the concentration may be somewhat diluted.

The sample drawn from the primary sample port informs us that something has changed in the system, but not what has changed. This is when secondary sample ports are used. They pinpoint the precise location of the problem. The particle counts on the secondary sample ports indicate the cleanliness level of ISO 13/10 downstream of the pump. Therefore, the oil being delivered to the bearings is fairly clean suggesting that the pump is not the cause of the wear. The secondary sample collected and tested after Bearing 1 shows an ISO 14/11. Bearing 2 reported ISO Codes of 18/15 with 25% ferrous and Bearing 3 reported an ISO Code of 14/11. The tests indicates Bearing 2 is showing wear because the oil delivered to the bearings was fairly clean and below the target level of ISO 14/11.

Exception testing of the oil sampled from Bearing 2, such as analytical ferrography, is used to determine what is causing wear.

Sampling multiple points on equipment takes most of the guesswork out of pinpointing troubled components. Use this method of oil sampling to schedule downtime and avoid maintenance to

components that do not require replacement.
Secondary sample ports can also be used to monitor the general performance of filters. The primary port will show what's going into the filter while the secondary ports show what is coming out. This procedure enables a filter change based on condition, long before the differentiated pressure indicator shows a filter is in bypass.

The Right Tools for the Job

Drop-Tube Sampling
Drop-tube vacuum sampling is a simple, low cost way to draw a sample for oil analysis. However, 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 (Figure 1). 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 fluid flushing volume, difficulties in getting a consistent sample form 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. However, as previously mentioned, for circulating systems the preferred location is on the return line, not the reservoir. 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 sample tubes that can be installed on the bottom or the side of the sump (Figure 2). These inward pilot tubes can be manipulated to ensure that the sample is drawn from 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.

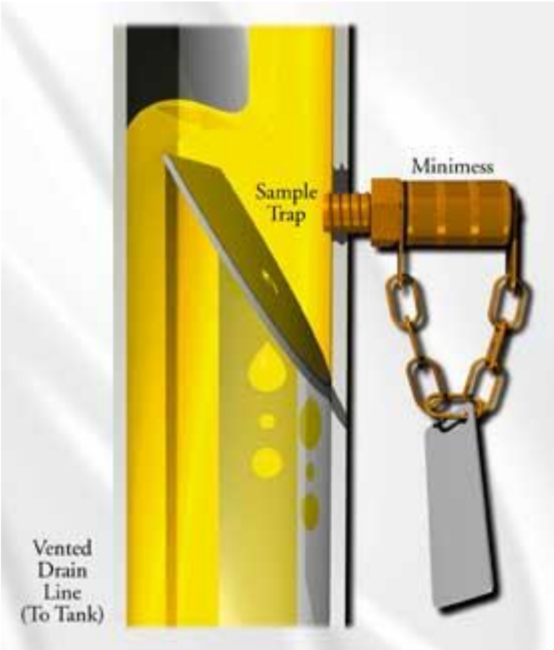
Figure 2

Minimess Sample Valves

There are several commercially available sample valves offering different features from which to choose.

Perhaps the most effective choice, typically used on larger systems, is the minimess sample valve. These special sample ports are similar to a check valve, i.e., the valve is normally closed until the sample port adapter is threaded (or pushed) on. High quality sample ports have a dust cap with 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 fluid to flow. These valves can be used on systems from zero psi (assuming the line is flooded) to 5000 psi.

On pressurized systems ranging over 2000 psi, consider safety. For example, handheld pressure reducing valves can be used with sample ports and adapters to reduce pressures of 5000 psi to less than 50 psi. They also come in several styles that are easy to install. Another benefit to these types of sampling valves is that they retain a very small volume of static oil (dead volume). This results in less oil needed for flushing prior to taking a sample.



Trap Pipe Adapters
Trap pipes are excellent for pulling a sample from a vertical, non-flooded line of pipe coming from a bearing housing or gearbox (Figure 3). Typically, vertical, non-flooded lines of pipe cause the oil to spiral down the inside wall of the pipe, depending on the velocity of the oil flow. The Trap Pipe essentially temporarily traps a portion of the oil flow, regardless of velocity and allows the user to draw a data rich oil sample in a representative location.

Oil Sample Bottles
Most oil analysis labs will supply sample bottles. It is important to be aware of the cleanliness of the sample bottle supplied by the lab or oil supplier.

Choose a low cost bottle with a consistent cleanliness. Most bottles available fall into the "clean" category. "Clean" bottles have less than 100 particles greater than 10 microns/ml. "Super clean" bottles have less than 10 particles greater than 10 microns/ml. "Ultra clean" bottles are also available (Refer to ISO 3722 for bottle cleanliness guidelines). "Ultra clean" bottles are usually glass bottles that have been thoroughly washed and dried in a "clean room" environment. These bottles might cost more than the oil analysis and once the bottle is opened in a typical work environment, it is no longer "ultra clean."

Ask suppliers about the cleanliness level of their bottles as well as how often, and under what circumstances, the cleanliness of their bottles is verified. Beware of the "sanitized" or "sterilized" lab bottles. Sterilized means that there is no bacteria living in the bottle, however, there may still be high concentrations of particle contamination inside the bottle.

Though bottle cleanliness is very important, the cleanliness of a bottle will only affect results at higher oil cleanliness levels. For example, if the cleanliness code is an ISO 19/16, there are between 2500 and 5000 particles greater than 5 microns/ml in the sample. At this level of contamination, typically the bottle cleanliness will not interfere with the particle count or ISO Code. On the other hand, if the cleanliness code is an ISO 12/9 that means there are between 20 and 40 particles greater than 5 microns/ml in the sample. A bottle that falls under the "clean" category will have a disturbing effect on results because the contamination in the bottle can add up to 100 particles greater than 10 microns/ml.

There are several bottle types available at reasonable rates. The most popular bottle is a clear 4 oz. PET (polyethylene terephthalate). This clear bottle allows the analyst to use sensory evaluation on the sample. This bottle is compatible with most industrial lubricants and is readily available.

Opaque 4 oz. HDPE (high-density polyethylene) bottles are also fairly inexpensive and offer excellent compatibility with a variety of liquids. The downside to this type of bottle is that they are opaque (not clear) and not conducive to a visual evaluation of the sample.

Glass bottles are excellent with respect to cleanliness, visual inspection and fluid compatibility. The negative side to glass is the high cost and the lack of durability in the plant environment. (Be skeptical of inexpensive glass bottles and question their actual cleanliness.)

Sample Port Identification
A savvy successful oil analysis program incorporates the practice of labeling sampling ports with corrosion resistant tags. These tags should display the information needed by the technician to obtain a proper sample.

You may want to include items such as:

- sample port I.D.
- machine I.D.
- lubricant I.D.
- target cleanliness level

Bar coding identification tags are another good way to label the port.

Summary

The measures outlined in this article will ensure that the life of your program does not depend on one person alone. Try to be consistent with your program. Procedures and guidelines for the program should be set up and monitored. These should include the frequency of the sampling on a given piece of equipment, the amount of oil to flush prior to pulling the sample, the method by which the oil sample is attained, the tools used to get the sample, how the bottle is to be labeled and what information it will contain, which tests are done for a specific machine on a regular basis and which tests are done on exception, and anything else that will add to the integrity of the sample being analyzed.

World-class programs do not happen overnight. The success of a program is indicative of the people and companies who strive towards specific goals. It takes resources, conviction and knowledge to implement an oil analysis program of world-class caliber. Approaching oil sampling with knowledge and creativity will allow a program to reap the available benefits.

Jason P. Kopschinsky, Schematic Approach Inc., "World-Class Oil Sampling - It is Possible". *Practicing Oil Analysis* Magazine. July 2000

Issue Number: 200007
Practicing Oil Analysis
Best Practices