Oil Analysis
Resource Guide

Fix The Weak Link

A Must Have Guide To

Proper Sampling Procedures

WHY PULL OIL SAMPLES

Oil analysis is a quick and easy way to gauge the health of equipment by looking at what's in the oil. Sampling and analyzing oil on a regular basis establishes a baseline for normal wear and can help indicate when abnormal wear or contamination is occurring. In addition, oil analysis can indicate if the oil is still fit for service. Is an oil change really necessary? A lot of money can be saved in extending oil change outs.

Oil that has been inside any rotating equipment for a period of time reflects the condition of the equipment. Because oil is in contact with internal components, any microscopic wear particles or contaminants found in the machine will also show up in the oil. These particles are so small they will remain suspended in the oil.

By identifying and measuring these particulates, you get an indication of the equipment wear rate and of any excessive contamination. Using oil analysis will identify component wear, lubricant conditions and overall component operating conditions.

"Management, operations, engineering, and financial personnel should adopt the concept that: Maintenance Doesn't Cost, It Pays."

- AISE Steel Technology Magazine

Why Is Oil Analysis Important?

- **Prevent equipment failure**
  - **Select testing that monitors equipment health and identifies potential catastrophic conditions**
- **Extend equipment life**
  - **Select testing that monitors oil contamination and equipment wear rates**
- **Extend lubricant life**
  - **Select tests that monitor lubricant serviceability**

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Why Is Proper Sampling Important?

Sampling is the most important part of any lube analysis program and the quality of your samples is vital to the success of your program. All of the sophisticated oil analysis tools, techniques and diagnostic processes are meaningless if the oil sample fails to effectively represent the actual condition of the oil in service.

Pulling A Representative Sample

Proper oil sampling is critical to an effective oil analysis program. Without a representative sample, your oil analysis program will fail. There are two primary goals in obtaining a representative oil sample.

The first goal is to ensure that the location you are pulling from will be representative of the oil in the system. This information relates to such criteria as cleanliness and dryness of the oil, depletion of additives, and the presence of wear particles being generated by the machine.

The second goal is to minimize contamination. It is important to make sure that the sample does not become contaminated during the sampling process. This can distort and disturb the data, making it difficult to distinguish what was originally in the oil from what came into the oil during the sampling process.

Why Is It Important To Pull A Representative Sample?

1. **To ensure there is as much information per milliliter of oil as possible.**
2. **To minimize contamination.**

Proper sampling procedures build the foundation of an effective oil analysis program. Without good sampling procedures, time and money are wasted, and incorrect conclusions might be reached based on faulty data.

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What Equipment to Include in Sample Program

All too often, maintenance programs focus on sampling more equipment rather than sampling at the optimum frequency. When optimizing sampling frequencies, the best way to start is to decide which machines should be sampled. It's better to be committed on the most critical assets than to perform ineffective oil analysis on all of them.

When you start implementing an oil analysis program, you need to decide which equipment in the plant to sample. This can be a daunting task but it cannot be overlooked. Supervisors and management need to take the time to identify the targeted equipment, write detailed procedures, establish routes, and sampling schedules.

Equipment critical to plant operations should be identified first. This equipment often does not have a backup unit to replace it when it is not in service. In addition, major repairs and overhaul of critical equipment often require a complete plant shutdown, substantial manpower and subsequent loss of production activities.

Critical equipment in plants typically have these common characteristics:

- They require very high capital investment and are expensive to maintain and repair.
- They are engineered for long service lives when operated within design specifications and in a predictable environment.
- Many are quite large and are made up of several individual components.
- Downtime is quite expensive since production is usually halted when unexpected problems or a system failure is experienced.

How To Select Equipment For Sampling

- **Establish criticality**
  - What will happen if this equipment fails?
- **Repair cost**
  - What will it cost if this equipment fails?
- **Maintenance history**
  - Has this equipment been prone to failure in the past?
- **Safety concerns**
  - Will a safety hazard result from equipment failure?
- **Current practices**
  - Are we spending too much on maintaining this equipment?
- **Current performance**
  - Are we getting the most out of this equipment?

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WHAT FREQUENCY SHOULD I PULL SAMPLES?

Many people regard drawing oil samples as an “as time allows” activity and fail to reap the benefits this technology has to offer. It should be taken seriously and be performed with the utmost care and diligence. It is not enough to simply fill a bottle with oil from the system; you must perform this task properly to accurately trend the data you receive back from the lab.

There is no universal formula for determining oil sampling frequency, but most experts consider monthly sampling to be optimum for critical machinery. However, when making this decision, it is important to consider the objectives of the oil analysis program. If the only objective is to perform condition-based oil changes, the sampling frequency should be determined relative to the lubricant’s expected service life, which is defined by the OEM recommended oil change frequencies.

In most situations, this is not the only objective, or even the most important one. The real value of oil analysis is its ability to serve as a proactive condition-monitoring tool, allowing for the detection and quantification of particle contamination, moisture, foreign lubricants or fluids and assessing overall lubricant condition.

In addition to the criticality of the asset, one must consider how the machine would be effected by an unacceptable amount of contamination and the likelihood of a contamination or other abnormal condition. If oil analysis is used as a predictive condition-monitoring tool, the biggest consideration is the likely time period between detection and failure. Obviously, the sampling frequency must be shorter than this period to be successful.

Ideal Sampling Frequency

- **Equipment Criticality**
  - Extremely Critical - Weekly
  - Critical - Monthly
  - Non-Critical - Quarterly
- **Equipment History**
  - Equipment prone to failure should be sampled more often
- **Equipment Vulnerability**
  - Equipment with a risk of oil contamination should be sampled more often
  - Load variations, high temperatures, operational factors need to be considered
- **New Oil**
  - Sample bulk oil shipments and equipment directly after oil change to ensure proper lube is in use.

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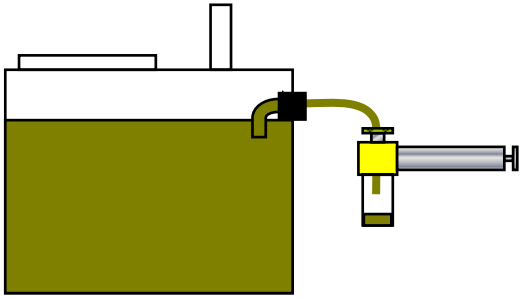
LOCATING IDEAL SAMPLE POINT

Routine oil analysis sometimes requires the use of specialized hardware permanently installed in the machine or component from which an oil sample can be extracted. It is extremely important to install the sample valve in an ideal location.

The best location for extracting an oil sample from a sump or reservoir is as close to the return line, gear set, or bearing as possible. You also need to make sure there is enough room surrounding the termination point of the hardware you have chosen to use. Maintaining a distance of two inches from any static or dynamic surface within the component puts you on the right path to a quality sample. Hardware that extends too far into the machine risks contacting machine surfaces and causing damage.

Hardware that terminates on or close to the surface of the machine or component risks collecting contaminants that can skew the data and result in unreliable analysis.



Points to Remember:

- **Sample should be good representation of the oil in the system**
- **Sampling location and method must be consistent**
- **Never sample on a "dead leg"**
- **Take samples while equipment is running**
- **Your sample location should lend itself to a "clean sample"**

A sampling location should be identified to allow for trouble-free, repetitive and representative sampling of the health of the equipment and the health of the lubricant. This sampling method should allow the equipment to be tested under its typical operating condition while maintaining a safe sampling method for the technician.

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Who Should Pull the Samples

Establishing effective, user-friendly oil sampling procedures helps to build an oil analysis program that creates value through better maintenance decisions. One aspect of a reputable, self-sufficient oil analysis program that is often overlooked is training. The person taking the sample is just as important as the person interpreting the results, but insufficient training often leads to the sample taker being the weakest link in the predictive maintenance chain.

Trained technicians that understand how important quality oil sampling procedures are will be key in maintaining a program.

Oil analysis is a science, and the tests are only as accurate as the sample they are performed on. Improper oil sampling can lead to a false positive, which results in shutting down equipment unnecessarily. Even worse, it can lead to a false negative, which can lead to an unidentified equipment failure.

There are several companies that offer excellent training in lubrication fundamentals and practices and most will be willing to come to your site if you have enough people to fill a class. Do not forget to include supervisors and managers. They need to be onboard and be aware of what is required and the benefits that can be achieved by implementing an oil analysis program.

Oil analysis is an ever-changing technology and to reap its benefits, one must continually receive quality training. Training options may include:

- **Classes and/or certifications**
- **Trade shows and conferences are another way to help personnel stay on top of recent advances in their field**
- **Department budget should reflect these educational opportunities from year-to-year.**

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How Will Samples Be Collected

The way a sample is collected, the accessories used and procedures followed dictate how informative the oil sample will be and how beneficial the analysis will be. That is why it is of great importance that the sample be taken correctly. If the oil sample taken is not representative of the oil in the machine then the results of the oil sample will not accurately reflect the condition of that component. The result will be an incorrect diagnosis based on incorrect analysis because of a poorly taken sample.

Which sampling method is best?

That really depends on the system being sampled. For gearboxes and other bath lubricated systems, a minimess-type sampling valve with a pitot tube is the usually the best option. This apparatus uses a fixed tube which can be cut to length and positioned in a desirable location in the sump. This is similar to the "drop tube" method but it eliminates the most common problems associated with drop tube sampling which are inconsistent placement of the sampling tubing, the excessive sampling pathway volume, and overall difficulty or time requirement to collect the sample. The use of a minimess and pitot tube minimizes the sampling pathway and ensures a consistent extraction point.

Drop tube sampling refers to the use of a flexible tube which is inserted into the sump by hand. This method may produce valid results, but to do so you must be very careful and you must be aware of the potential problems. While the minimess is certainly the preferred method, drop tube sampling is an acceptable alternative. Most other sampling methods, such as drain port sampling, will not yield useful results and should be eliminated from your sampling program.

For hydraulic systems the primary sample point should be on a pressurized portion of the system upstream of system filters. All pressurized systems offer easy, consistent sampling if they are properly fitted with sampling hardware. The same

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type of minimess sampling port can be utilized although no pitot is required, and if the sample bottle cap is vented there is no need for a vacuum pump.

To address safety concerns, it is desirable to use a low pressure portion of the system such as the pump case drain or a bypass circuit. These locations offer easy sampling, safe pressures, and consistent data about the pumps and the fluid cleanliness.

For other circulating systems it is reasonable to sample from the pressurized portion of the system (after the pump and before the filter), but it may be better to sample from return lines. By sampling from the return line, you can get highly concentrated wear debris information making the oil analysis a very sensitive predictive condition monitoring tool.

Samples should be taken from turbulent or "live" zones within the oil system. Pulling a sample from the drain valve is not an accurate representation of the condition of the machine. Wear particles, contaminants and water settle to the bottom of the sump, thus making this sample full of historical data and difficult to trend as you continue to sample from this location.

What is the proper procedure for each method?

For drop tube sampling there are quite a few common mistakes, but a well thought out and documented procedure will ensure the best results. Always use a new piece of sample tubing. In any sampling procedure, always begin by flushing the sampling pathway with approximately 3 times the volume of the pathway.

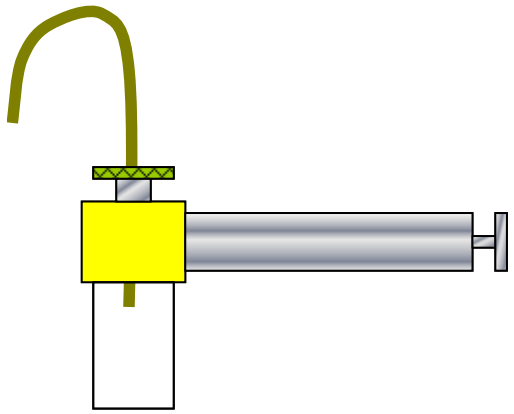
Technicians often choose to use a dedicated waste oil bottle for flushing that is larger than the sample collection containers so they can typically complete a sampling route without having to empty the waste bottle. The proper length of tubing should be predetermined so that you can effectively insert the tube end in the middle of the reservoir without touching anything. In general, the tube end should be at least two inches from the bottom of the sump, two inches from the

sides, two inches below the oil level and at least two inches from any moving parts. This can be difficult to accomplish without three hands, but if you use a “one-handed” pump it is easier.

For sampling from pressurized systems, the extraction is simpler because a vacuum pump is not required, and if tubing is necessary, only a short length need be used. If the sample is to be obtained from a high pressure location in the system, additional steps such as the use of a pressure regulator may be required for safety.

As with the drop tube method, begin by flushing the sample valve and tubing with 3 times the pathway volume to a waste oil container before collecting the sample to be analyzed. Another hardware requirement for pressurized sampling is a vented sample bottle cap. If such a cap is not available, you can attach the sample bottle to a standard vacuum pump to allow the bottle to vent.

While there are several acceptable sampling methods for each machine, there is usually one best way. The best sampling methods will typically require some work up front in that you will usually have to install sampling hardware, but the end result will be well worth it. Using fixed hardware installed in the correct location, will provide consistent, valid data with which you can make good decisions about machine and lubricant condition. With the sample location selected and the proper hardware installed, all that is left is to document a detailed, step-wise procedure that will ensure the sample will be taken correctly no matter who takes it.



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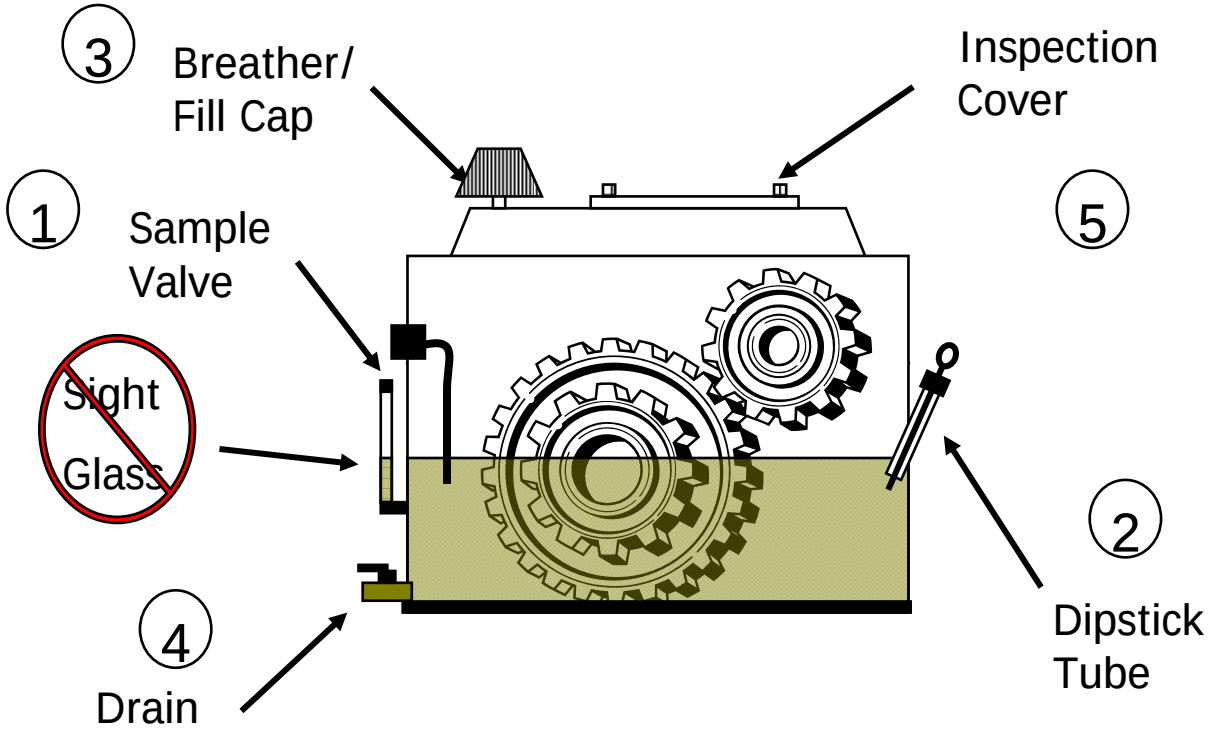
IDEAL SAMPLE POINTS BY EQUIPMENT

TOP 5 SAMPLE POINTS FOR GEARBOXES

Gearboxes



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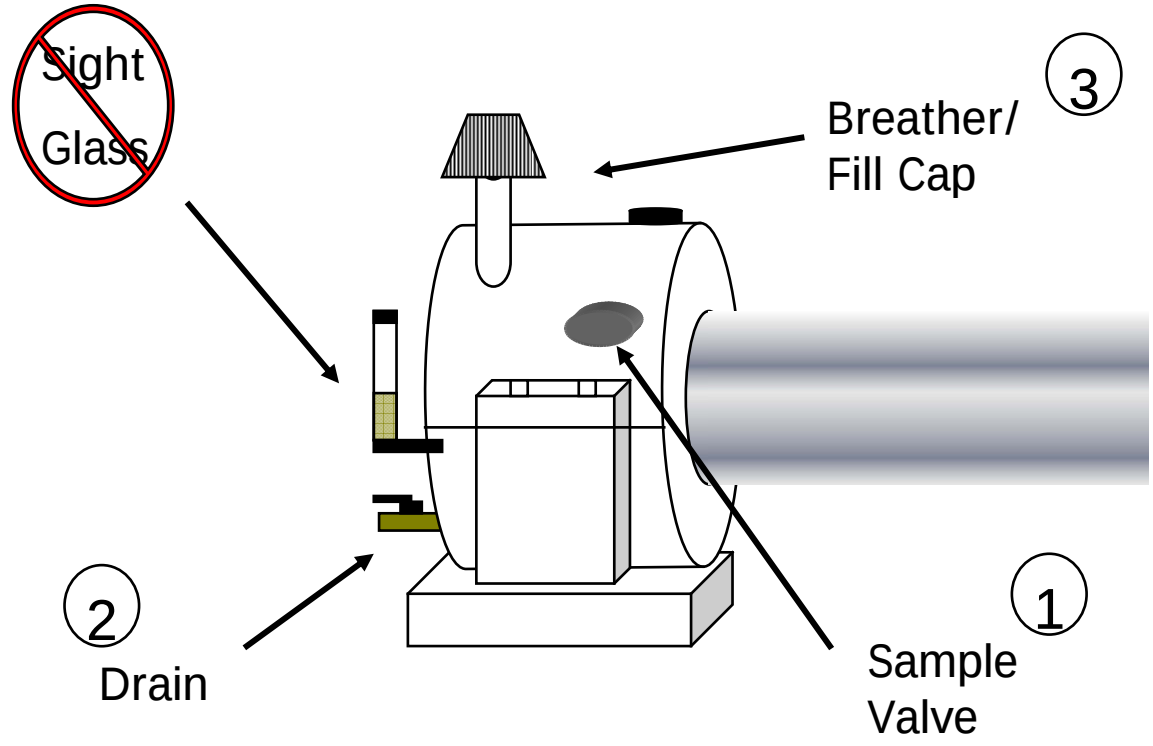
IDEAL SAMPLE POINTS BY EQUIPMENT

TOP 3 SAMPLE POINTS FOR BEARINGS

Bearings



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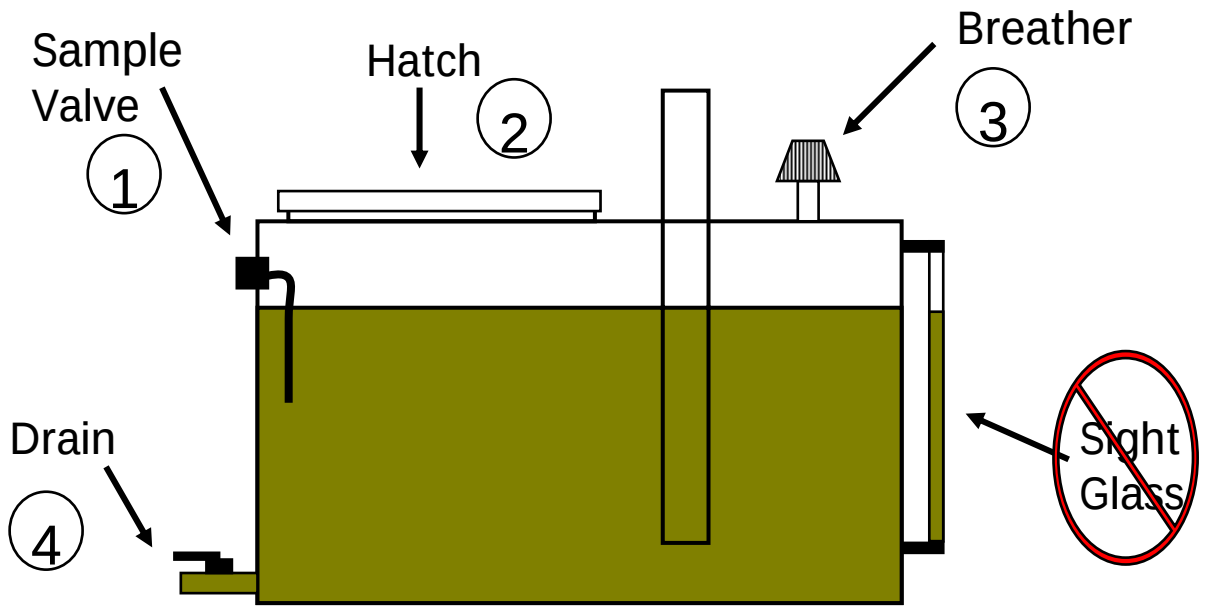
IDEAL SAMPLE POINTS BY EQUIPMENT

Top 4 Sample Points for Reservoirs

Reservoirs



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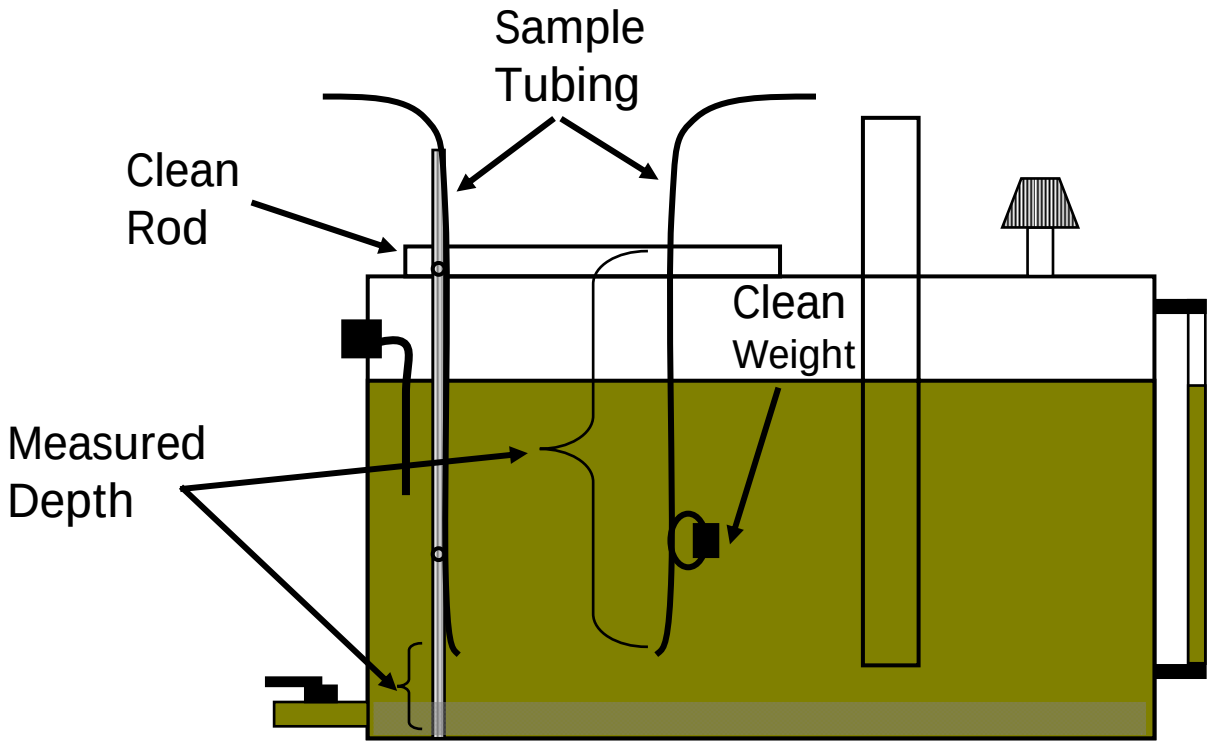
How To Use Tubing Sampling



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SAMPLING PROCEDURES CHECKLIST

How To Sample

Sample Pump Method

- ☐ Cut new sample tube to desired length
  - o Sample tube length should be the same each time sampled, consider recording length for each component
- ☐ Insert sample tube into silver disk on top of pump so that the tube protrudes from bottom of pump approximately ½ inch
- ☐ Tighten silver disk to secure tubing
- ☐ Remove sample bottle cap and secure the bottle to the sample pump
- ☐ Insert sample tube into desired sample location so that tip of tubing is in the middle phase of the oil
- ☐ Pull a vacuum on the pump by pulling the pump handle 1 to 3 times
- ☐ Allow the sample bottle to fill (you will not need to continue to pull handle to maintain sample flow)
- ☐ Hold pump upright while taking sample
- ☐ When the sample bottle is ¾ full, loosen the sample bottle to release the vacuum and stop the sample flow
- ☐ Remove the sample bottle and re-cap the sample immediately
- ☐ Remove the used sample tubing from the pump and discard and do not re-use
- ☐ Wipe the sample pump with a clean cloth to remove any oil

Drain Valve / Ball Valve Method

- ☐ Open valve and allow oil to flow until any water or sediment is flushed from the valve and pure oil begins to flow
- ☐ Remove cap from sample bottle and fill bottle to ¾ capacity
- ☐ Replace cap immediately
- ☐ Close valve and replace cap or plug

When To Sample

- ☐ While equipment is at full operating temperatures
- ☐ During operation if possible
- ☐ Directly after shut down

Where To Sample

- ☐ Sample should be good representation of the oil in the system
- ☐ Sampling location and method must be consistent
- ☐ Never sample on a “dead leg”
- ☐ Take samples while equipment is running
- ☐ Your sample location should lend itself to a “clean sample”

Shipping Samples to the Lab

- ☐ Wipe sample bottles to remove residual oil
- ☐ Fill in date and any oil change information on pre-printed sample labels
- ☐ Affix label to bottle and place in sample mailer or sturdy box
- ☐ Ship to lab using preferred carrier

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Sampling Best Practices

- ✓ Alert production that you are in the area
- ✓ Wear rubber gloves & other proper safety attire
- ✓ Keep all sample points capped until ready to use
- ✓ Flush a sample point before sampling
- ✓ Clean a sample point before sampling
- ✓ Never close a valve in the middle of a sample
- ✓ Always use clean tubing for each sample
- ✓ Use a proper sample bottle
- ✓ Cap sample bottle immediately
- ✓ Make sure bottle caps are tight
- ✓ Properly label a sample bottle
- ✓ Ship samples the same day they are collected

About TestOil

TESTOIL is a full service oil testing laboratory owned by Insight Services. Since 1988 the laboratory has been providing fast and reliable oil analysis results across all industries throughout the Americas.

The firm's comprehensive range of oil analysis services assists reliability engineers with condition monitoring and identification of machine wear.

TESTOIL employs a sophisticated diagnostic technology that assists their Machine Condition Analysts in making equipment and lubrication condition assessments.

Fix The Weak Link Today!

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