The Ultra Clean Vacuum Device

the Wave of the Future in Precision Oil Sampling

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Summary: Oil sampling procedures, only headaches?

Whenever we mention to our customers the necessity to perform effective Predictive Maintenance procedures, everybody agrees on that. It's part of the evolved routine duties to make sure that your assets are constantly maintained under control, in order to avoid major failures involving hazards or production's losses. But when it comes to the practice, to really confirm in the field which is the actual status of you critical systems, and your conditions' monitoring choice (for that particular area) are oil analysis, all the problems, related with difficult approaches show up. Basically we get to prepare the lines where our interventions are forecasted/provided with special, hassle free sampling ports. The situations for technicians involved with such surveys are always a very complicated task; every time we get to comply with new, increasingly difficult situations. Safety restrictions are not the last of them. The oil is running (or at least we imagine that) in our machines, totally confined inside the circuits, at a given temperature and pressure. To "capture" the proper amount of such fluid in the right way (the basic condition to make sure that the sample is telling me "the truth" about the whole story) I need to create a "gap" or a media to let it flow outside of. On the other hand I want to be ready at the proper time, with a bottle or something specially adapted to collect that specimen, and I do not want to create interferences (cross-contamination) of any kinds in this critical moment. Airborne dust, humidity in the atmosphere, eventual paper tissues' debris, try immediately to join together, enormously attracted by the sample bottle left unattended, with the mouth wide opened!

Sometimes a mosquito too, may decide to put an end to her life, jumping in the freshly collected oil. What a mess, for someone that is challenging to provide "a picture" of the inner status of a certain machine, for an effective Predictive maintenance approach.

1. Introduction

Until today the only way to minimize the risk of dirt entering the bottle is the "clean oil sampling" method [1].

It involves the use of zip-lock sandwich bags and sampling hardware such as vacuum pumps and probe devices. The technician needs a clean bottle and before going out into the plant with the sample bottles, has to place the capped bottles into very thin zip-lock sandwich bag, one per bag. The bottles are zipped in the bag while the operator is in an indoor environment (clean air) in order to avoid the risk of particles entering the bags. Sampling hardware such as vacuum pumps and probe devices should be placed in the large bag as well. On the plant near the sampling port, without opening the bag, the worker has to twist the bottle cap off and let the cap fall to the side within the bag. The mouth of the bottle is treaded into the cavity of the sampling device. The technician uses the plastic tube to puncture the bag. At this point he has to suck the right amount of oil into the bottle with the proper probe device and then locks the bottle with the cap (all these actions should happen inside the bag!).

This procedure effectively permits samples to be obtained without exposing the fluid or the bottle to the atmosphere or surface contamination.

It's a complicate method, a good technique of sampling needs a lot of practice, a fresh-worker has to spent a lot of time with an uncomfortable way to work.

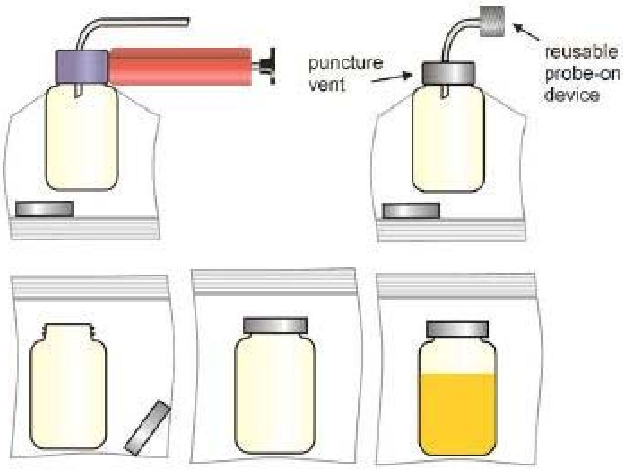

Figure 1: "Clean Oil Sampling" method.

1.1. Back ground – *Surgery Inspiration*

In 1949 Joseph Kleiner developed an innovative device using a simple idea that would subsequently change the way lab technicians would draw blood samples from the human body. His apparatus used the basic ability of test tube depressurization to trap a vacuum in a vial or test tube for receiving the specimen. During use, a needle is inserted in the tube stopper to break the vacuum allowing atmospheric pressure to effortlessly draw the blood from the patients arm or finger into the test tube. This new sampling device was especially beneficial because it made the process nearly impervious to the invasion of external contamination.

In today's ultramodern global economy, oil is the lifeblood of machinery operation and health. Lubricants are no less important to machine functionality and operating state as blood is the human body. As is the case in sampling blood, aliquots of oil that are subject to laboratory analysis must be suitably representative of their source, meaning they should be free of contamination entering during the sampling process including impurities original in the sample bottle. With the sampling of blood, Kleiner's Vacutainer System has proved to be the most effective method of gathering a true representation of the blood in addition to enhanced simplicity. This same sampling concept, more than 60 years later, has now been implemented in the field of oil analysis with the introduction of the Ultra Clean Vacuum Device (UCVD) developed by Mecoil Diagnosi Meccaniche S.R.L. in Florence, Italy.

Figure 2: Oil sampling with a Vacutainer System.

There are many procedural factors to consider when attempting to extract a representative oil sample. The most important of which are these four: (1) sampling location, (2) sampling procedure, (3) sampling device or hardware, and of course, (4) the receptor or bottle. Although the selection of the sampling location is typically dependent on the machine's design and oil analysis objectives, the other three factors can be modified and improved.

Today, with the extensive use of particle counting plus advanced wear debris analysis techniques, the importance of getting a quality sample without inadvertently contaminating the sample cannot be understated. Sadly, user organizations commonly fail to follow proper sampling procedures which often lead to data errors and false positives on particle counts. There are three reasons this happens, (1) the bottle cap is removed too soon and left off too long, exposing the bottle to airborne contamination, (2) the technician touches exposed surfaces with his/her hands (inside of bottle cap, bottle mouth, etc.) and, (3) the transfer tube between the sampling port and the bottle is originally contaminated (transferring this contaminant to the oil). Additionally, the lube tech that is responsible for sampling can be unreliable in ensuring a consistent method is followed. This is due largely to the grueling and complicated sampling procedure that is typically required. The objective of the UCVD development has focused on eliminating or mitigating these common challenges.

2. Why it is called a UCVD?

Figure 3: Main structural features of the UCVD.

The UCVD is truly an unconventional oil sampling device. In doing so it solves problems and enhances the quality and precision of the oil analysis that will be performed. Let's look closer at why this name was selected:

- **Ultra**: definition- "Going beyond the usual limit."[1] This particular word has been used to emphasize that the UCVD makes a radical improvement in both method and effectiveness of oil sampling. After the next three letters of this acronym are explained, the reasoning for use of the term "ultra" will make more sense.
- **Clean**: This word pertains to two separate aspects to the sampling procedure. The first relates to the cleanliness of the process and surroundings; given that this bottle is never opened and the drawing of the oil is automatic and effortless, the likelihood of the lube tech coming into contact with the oil or the oil spilling is virtually a non-issue. The second relates to the interior cleanliness of the bottle; the bottle can be supplied certified "super clean", i.e., fewer than 10 particles > 10 microns per ml. However, the achieved cleanliness of the bottle is not due to a washing procedures but rather a result of the induced vacuum which purges nearly all particles together with atmospheric humidity.
- **Vacuum**: The fundamental and most unique feature of the UCVD is clearly the vacuum. This bottle, along with its lid and sealing elements, is uniquely designed to not collapse or leak under vacuum (~0.95 bar) and, of course, to hold this state for an extended period of time. The UCVD is provided with sufficient vacuum to inject at least 80% of its capacity in fluid. This should not be viewed as a physical limitation. It is essential that oil samples contain about 20% of ullage to allow for agitation before testing.

Originally, the UCVD had one major concern: could it draw oil at very high viscosities, and if it could, at what flow rate? What were its limitations? We are pleased to state from our recent tests of the UCVD that there are acceptable to practical viscosity constraints. For example, with an ISO VG 320 oil at room temperature (approx. 600 cSt), the UCVD was 80% full in 85 seconds and 90% full in less than three minutes (completely hands free). If the sample was at operating temperature, a more typical scenario, the fluid can be drawn much quicker. Even fluids as viscous as honey have been drawn using a UCVD with some extra time. The bottle can also be re-vacuumed, if desired, using a standard hand vacuum device.

In the graph below, the effectiveness of the vacuum is seen at various viscosities and the chart shows the time it takes to reach 80% capacity with different viscosity levels at 40°C.

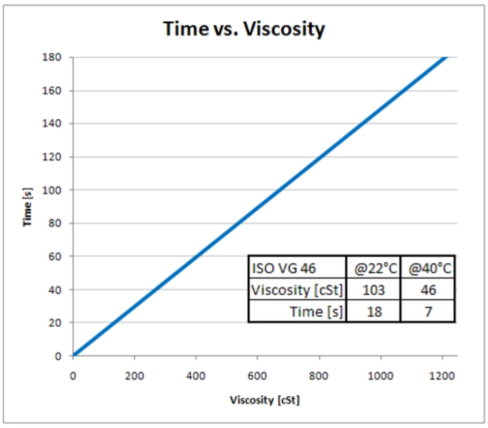

Figure 4: Time vs. Viscosity for Fluid

ISO VG cSt	Time @40°C s
10	<2
22	3
32	5
46	7
68	10
100	15
150	22
220	33
320	48
460	69

Figure 5: Fill time to 80% for Various ISO VG at 40°C

- **Device**: You may be wondering why this is called a device, when it's simply a bottle. Well, it's because it is more than just a bottle. This device is like a tool that is straight forward to use and, with a turn of a switch (valve), can perform a surprisingly rather complicated procedure. Previously the only practical way to extract a fluid sample from a drop-tube sampling port was with the use of a vacuum sampler or a syringe. Although these have been standard and common place tools to use, they can pose issues. These issues, whether it is contamination related or just inconvenience, are easily avoided by using the UCVD instead.

The following discusses several common issues associated with drop-tube sampling along with the corresponding UCVD solution:

Issue: Lube techs often have trouble making compatible connections between the thread sizes used on the vacuum sampler and those used on various types of bottles, forcing them to use thread adaptors.

Solution: The UCVD works completely on its own without any additional equipment, i.e., there is no required threaded connection. However, if you wish to use the UCVD bottle with a vacuum sampler, the thread sizes are compatible.

Issue: One of the well-known problems of using the vacuum sampler relates to the cavity the bottle must thread into. This cavity is often dirty from repeated use. This dirt can then transfer to the bottle. Also, in the dusty machinery work environment, it can be difficult preventing contamination from entering the interior of the bottle while the lid or vacuum sampler is removed.

Solution: Opening the UCVD is not required during sampling; therefore the chance of any contamination is avoided.

Issue: When using a vacuum sampler it can be a challenge to avoid allowing the transfer tube from accidentally dipping into the oil in bottle. When this happens the tubing gets coated with oil on the outside. Later when removing the tube the oil transfers to the oil-ring seal that grips the tube during sampling. The next tube that is inserted subsequently picks up this oil causing fluid cross-contamination (i.e., the slight mixing of two different samples). In addition, it is necessity for the technician to be present in order to hold the vacuum sampler and bottle upright. Otherwise, the oil sample may come in contact with the vacuum sampler itself.

Solution: The UCVD during sampling is completely hands free. It can be left sitting in any position. This also allows the technician to extract several oil samples from different lube points at the same time. (picture shown is a temporary edit).

Figure 6: Illustrates the various positions for the UCVD during extraction.

Issue: Lube techs must be careful with the amount of force applied to the vacuum sampler, which is always dependent on the level of viscosity and length of the hose. If the vacuum sampler does not come with a pressure release valve and the induced vacuum is too high, this can result in accidentally causing the oil to rise into the sampler. Similar headaches can occur when using the syringe, the high viscosity fluids can make using them very difficult and challenging to use. Contamination from the silicon grease on the syringe's sealant ring can occur as well.

Solution: The amount of vacuum applied to the UCVD almost always draws the fluid to at least 80% of its maximum capacity, or about 100 ml. When the bottle reaches about 80% full, the tube can then be pulled out of the sampling port to allow the rest of the fluid still in the tube to enter the bottle, thus leaving the tube void of the fluid.

Issue: Lastly, the syringes and vacuum samplers can be expensive to always replace or a hassle to clean or fix. Silicon seals on the syringes often cause compatibility problems as well. If there is a limited number of vacuum samplers and several different technicians, the pump needs to be continually accounted for and returned to its proper place.

Solution: It is always desired to reduce the work required to get a job done, this is obvious. And the sampling hardware should have a primary purpose of extracting the sample without disturbing the sample's quality in the process. The UCVD has shown to be the solution to minimize this job while improving the quality of the sample in the process.

We expect the above explanation on the meaning of the "Ultra Clean Vacuum Device," to have greatly clarified the value gained from the latest technology in precision oil sampling . We also expect that all of these benefits will not be entirely recognized until you take the leap to use the UCVD in practice and get familiar with its exceptional features. But this won't take long because the UCVD is extremely simple to use and its benefits for, very apparent.

PETG (Crystal clear, glass appearance)
100 ml capacity
85°C max operation temperature
950 mbar of vacuum applied
Feasible with **any viscosity** range

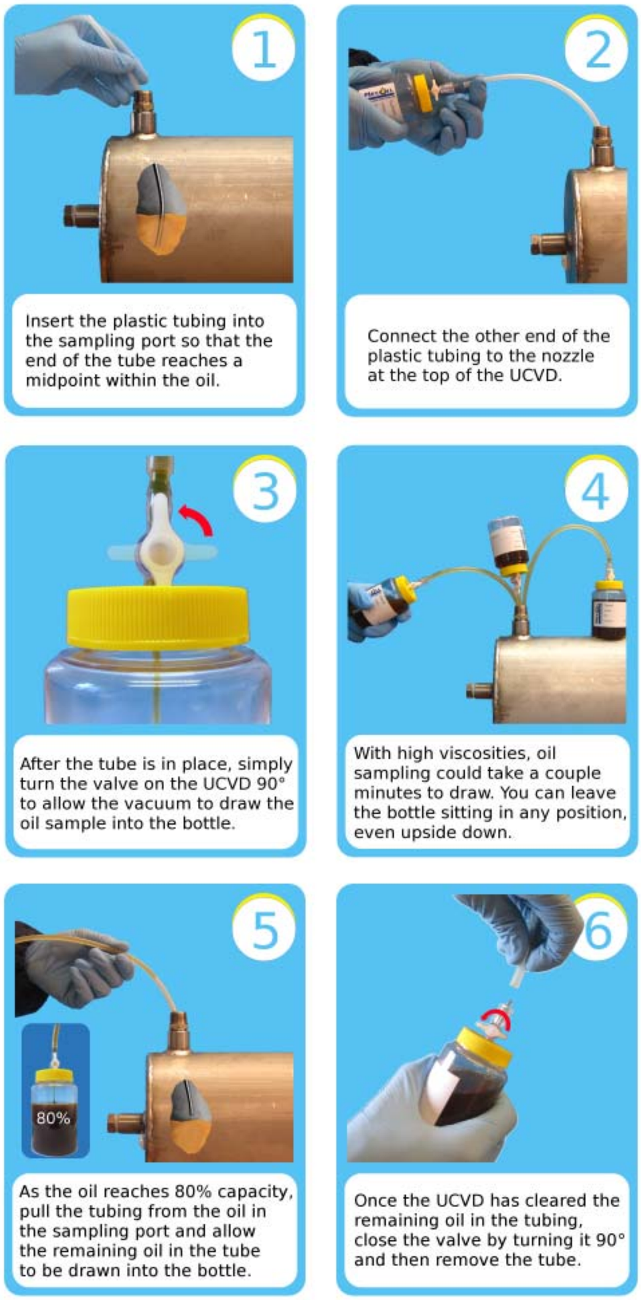

Figure 7: UCVD Drop-Tube Procedure

As stated, it comes pre-certified super clean and due to its particular design, despite the fact that it is not visually complex, it can effectively hold this vacuum over an extended period of time. Furthermore, the device can comes supplied with a single use hose to increase its ability to providing a true representative sample. The full procedure of how the UCVD is illustrated in Figure 7.

3. Is this the right choice?

It cannot be disregarded that the UCVD may have some disadvantages, but few of them can be really considered significant, in the routine usage. First, it is to be noted that this device has been particularly developed as an improved alternative to the vacuum sampler and syringe methods. To extract a sample with these approaches, the fluid often needs to be exposed at atmospheric pressure, usually just a fill port or dip-stick port. Therefore, the UCVD is not designed to apply for very high pressure sampling ports like those found in hydraulic systems. Although these bottles can still be used to draw the fluid into, the function of its vacuum is irrelevant. Second, while the UCVD can be used to sample various types of fuels such as diesel, biodiesel and kerosene, there is a compatibility issue when sampling gasoline due to its high content in aromatic hydrocarbons. However, for the extracting of an oil sample that contains in part a dilution of gasoline, then the UCVD is still applicable. And third, this device is designed to draw the standard sample amount of 100ml of fluid, so if there is a need to provide a higher volume sample, multiple UCVDs will be necessary.

The application of this basic property like vacuum, first implemented in blood sampling, is clearly a cost effective and "simple to manage" method that should be utilized. The UCVD has made a statement to be a preferred alternative for the unpractical and outdated practices of today. Not only can your lube tech, or you if that be the case, appreciate a simple and hassle-free procedure but the results received from your respective oil analysis laboratory will be more accurate and, most importantly, contain less false-positives. So, if you are interested in getting the most out of your oil analysis and save some time in the process, the UCVD is the next step.

List of References

[1] **Jim Fitch**: Clean Oil Sampling - How to Sample Oil Without Opening the Bottle, Machinery Lubrication, July 1998

[2] **ISO 4021:1992** Hydraulic fluid power -- Particulate contamination analysis -- Extraction of fluid samples from lines of an operating system

[3] **J. Kopschinsky**: Oil Sampling do's and don'ts – Machinery Lubrication, March 2010

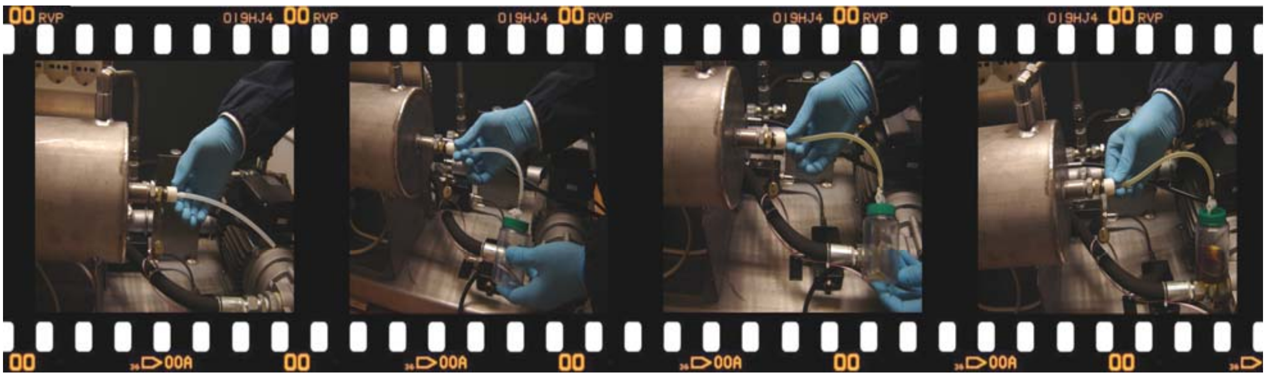

Figure 8: UCVD – Quick Connection "video clip".