# The 100 Failure Modes of Lubrication & Lubrication Programs

Lubrication strategies are essential to keeping plant machinery up and running. Terry Harris, a Certified Maintenance and Reliability Professional, has outlined the various failure modes of lubrication programs described in this white paper. By taking predictive maintenance measures, you can greatly improve the lifespan and performance of your machines.

Just because a machine is running as it should today, doesn't mean it will in the future. Taking care to properly service and maintain these assets, even when they seem to be performing fine, can extend their lifespan by 3 to 8 times, making proactive strategies an integral part of plant maintenance.

The key to preventing failures is knowing how they occur in the first place. By being able to identify failure modes, maintenance professionals can develop Reliability Centered Maintenance plans aimed at addressing the issues that can arise with selected components.

**Why Equipment Fails**
It is important to note that lubricants do not automatically fail – they do so because of poor practices within the plant that strain them. So by being able to identify failure modes, and where and how they occur, RCM professionals can develop strategies that are aimed at predicting, preventing and eliminating them entirely.

**Types of Lubricant Failure Modes**
There are five major areas where lubricant failure modes can occur:

1) Temperature failure modes

2) Moisture failure modes

3) Foreign materials/particles

4) Viscosity failures

5) Contamination (ex: stored chemicals, glycol, etc. that can mix with the lubes)

By understanding the ways in which each of these areas can create lubrication failures, professionals can better enact RCM plans.

## Temperature Failure Modes

One of the biggest contributions to temperature failures can come from overloading. If a plant is constantly looking to expand operations, this could be putting too much strain on its machines. Other failures can come from simply using the oil or grease improperly. Putting too much grease or overfilling lube levels can create temperature failure modes, while using high viscosity lubrication or the wrong viscosity in a certain area can as well. Limited air movement due to location can also produce failures.

Temperature factors also play an important role, both inside and outside the machine. If the cooling levels are not right, whether inadequate, or nonexistent, lubrication runs a strong likelihood of failing. These are internal factors, but also thermal conditions in the plant can contribute to these failures. Sunlight and ambient atmosphere, such as excess heat generated within the plant, can contribute to plant failure.

There are other reasons for temperature failure modes, but at the end of the day the right RCM process needs to address the factors that directly affect the well being of lubrication. A lubricant has a lifespan of roughly 30 years, when kept at a temperature of 70 degrees Fahrenheit. For every 20 degree rise, this time is cut in half, meaning that higher temperatures result in faster oxidation, which ultimately contributes to component wear. If a lubricant is operating in 170 degree conditions, it needs to be replaced more than just once every year.

There are a number of actions one can take to prevent this kind of wear. By reducing temperature with coolant and changing it more often, failure modes become less common. Also, by getting a better understanding of viscosity and the role it plays in specific applications, there is a higher likelihood that failure modes can be prevented. Finally, consider synthetics as they can better withstand temperature failures.

## Moisture Failure Modes

Another area that can create lubricant failure modes is moisture. These issues can arise from different levels of moisture entering the lubricant, be it through conditions like humidity and rain, along with instances of human error such as improper seals and wash down practices. Leaks, improper lube and lube equipment storage methods, along with a lack of ventilation can all contribute to moisture failure modes.

When moisture gets into a lubricant, it can have devastating effects on its lifespan. Just 1 percent moisture in oil can reduce component life by up 50 percent, with similar results for other lubricants. For instance, if a professional can reduce the amount of moisture in a lubricant from 100 parts per million to 2 parts per million, it can extend the life span of the equipment by a factor of 10. This is a ratio that continues as the parts per million increases.

Additives also play a crucial role in extending the lifespan of lubricants as they can control oxidation, which, as stated before, can limit corrosion. However, additives will deplete over time, and so too will lubricant life spans, especially in combination with higher moisture levels. There are numerous types of additives that could be in a lubricating oil including: antifoam, dispersants, extreme pressure agents, detergents, anti-wear agents, rust inhibitors, oxidation inhibitors and corrosion inhibitors.

The key is being able to maintain strong additive levels. This means reducing moisture levels in new oil, while eliminating moisture in stored oils, equipment and from wash down procedures. Be sure to monitor moisture levels and replace the lube when necessary, while taking preventive measures, as well. For instance, using desiccant breathers on critical equipment and devices with dry air to remove particles can help cut down on destructive moisture.

The best way to ensure the longevity of machines is to take a proactive approach to their maintenance. Lubrication plays an essential role in making sure these tools are operating at their best, but because there are so many different components to these machines, there are a variety of different failure modes on account of lubrication and lubrication programs.

Taking proactive measures to ensure that the lube is performing its best can go a long way in extending the lifespan of a machine. In fact, a proper failure mode prevention program can make a machine last three to eight times longer. For this reason, it is important to take note of all of the failure modes of lubrication and lubrication programs.

**Foreign Materials/Particles**
Foreign materials and particles can be a major source of failure mode. There are only about 5 microns of film between a loaded bearing or gear, but foreign particles can be as large as 40 microns. This means that when these particles get into machine lube, they can grind and scratch the bearings and gears of the machine.

Contaminates can get into lubrication for a number of reasons. Poor storage methods can contribute, while,depending on the facility, particles that are simply floating around in the plant can get into the lube.

Also, the way new lube is handled can allow foreign materials to enter. New oil can come already contaminated and if the filtration is not adequate, particles from new grease can lead to lubrication failure modes. Further, lubrication related failures can arise if lube filtration is improperly handled or the grease can become contaminated simply out of long term machine wear and tear.

The ISO code for cleanliness has a method of measuring the amount of foreign particles in lube, and the effects that these materials can have on a machine. The code has three numbers separated by a '/' with each number representing the amount and size of particles. The first number in the code is the amount of 4 micron particles, the next number is 6 micron particles and the third is for 14 micron particles.

Take a 21/19/15 on the ISO code. A 21 means that there are between 10,000 and 20,000 particles at 4 microns in size, the 19 means there are between 2,500 and 5,000 particles at 6 microns and between 160 and 320 microns at 14 microns, all within a one milliliter sample. By reducing these figures with cleaner oil, the life of a gear box can be extended. For instance, by reducing a 21/18/16 to a 19/12/9 the life span of a gearbox can increase by 2.5 times. Depending on the level of reduction, these life extensions can get up to seven or eight times.

In order to achieve these strong ISO codes, it is vital to eliminate particles from lubricants, filter new oils, keep lubes clean before and during the use of equipment and purchase grease products that have been produced with filtered oil or make the switch to synthetics.

**Viscosity**
Viscosity failure modes can occur for a variety of reasons. Fluctuations in temperature can lead to changes in viscosity, while oxidation, contamination, moisture and chemicals can each contribute to changes as well. Further, not enough or no additives will contribute to changes in viscosity along with other lube procedures.

Viscosity is what determines how the lube will flow through a machine. Different machines call for different viscosity levels. It is important to understand the operating temperature of the machines, as it can change between standby and when it's running. Failure to achieve the right viscosity as it relates to machine operation can lead to leaks and other forms of failure. It is important to understand that greases can fluctuate in viscosity as well.

As previously mentioned, contamination that leads to changes in viscosity can arise due to ambient conditions such as temperature, humidity and free floating particles in the plant in which it is used. Other contributions to contamination can be: improper practices in lube storage, application, transportation, equipment, procedures and leaking coils. In addition contamination from the vendor must also be considered. To address these issues it is important to have well a constructed lube storage facility that can control temperature and other factors for proper receiving, storage and distribution of lubricants. Also, make sure to always check for contaminants, filter new oils, use oil safe containers, install labyrinth seals on critical equipment, and obtain the proper training on eliminating contaminants.

Keep in mind that synthetic lubes outperform mineral oil based lubricants in almost every situation. This is because they are much more stable when it comes to temperature, oxidation and volatility, while having longer life spans. They also have less foaming characteristics and changes of hydrolysis.

**Operational Failures**
Operational failures are largely a result of bad maintenance. Improper oil levels and incorrect oil addition along with sudden volume loss can lead to operational failures, Using the wrong oil or additives, foaming, particles, moisture along with under or over greasing and improper wash down practices contribute to operational failures as well.

These failure modes arise largely from improper maintenance and operations, meaning that a strong knowledge of how machines work and how to apply lube is the best defense against them.

**Program Failures**
Lubrication excellence programs are essential to preventing lubrication failures and extending the life of machines. Many of these failures covered here can be a product of a lack of knowledge, best practice and maintenance, all of which can be prevented with a strong program.

Program failure modes can arise from an incomplete or non existent program or a lack of documentation. Ordering, receiving and storing also needs to be an integral part of any program, along with an RCM decision process. Also, filtration systems that are both on and offline are essential, as is proper equipment for draining oil. Be sure to maintain proper additive packages and better analysis programs.

Ultrasonic lubrication equipment can also play an important role in monitoring lube levels and possible failures.

These are not all the program failures, but generally speaking, a sound training program and documented procedures provide workers with the knowledge they need to make sure that machines will be able to last. Lubrication Excellence training can teach workers about the correct methods to eliminate failure modes, which, if properly addressed, can extended equipment life by 3 to 8 times.

At the end of the day, proper lubrication maintenance and failure prevention is about taking a proactive approach, so by equipping workers with the proper tools and knowledge, plants can significantly extend the life of their machines.

For more detail, view this link.

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