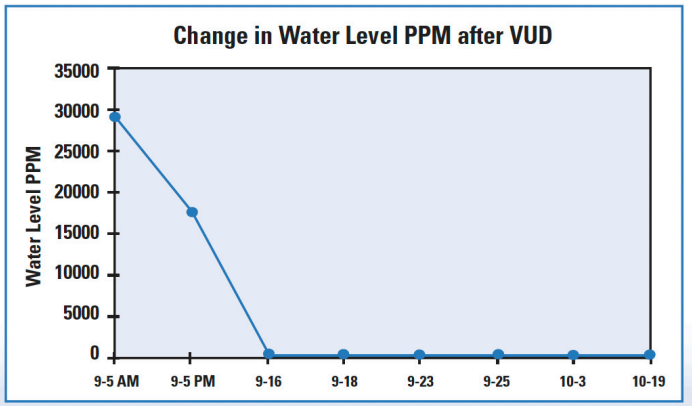
Donaldson
HY-PRO™

Improving Rolling-Mill Lube-Oil Performance & Useful Life

The Problem

Manufacturers of steel-mill equipment and components (i.e. Danieli, Morgoil®) commonly specify fluid brands and trade names that are qualified and recommended for use with them. That's because steel mills encounter very high amounts of water and particulates in lube applications. For example, a mill might have a single tank for oil return and supply, or there might be a twin tank setup where the return tank is a settling tank connected to a supply tank. Free water is regularly drained from these tanks—in fact, it is common practice to drain hundreds of gallons of water per day or shift, depending on the condition of the bearing seals and chocks.

Specified oils, such as Morgoil, are formulated for excellent demulsibility, or the ability to shed water in the presence of gross free water. Their demulsibility is a function of quality base stock and the oil's ability to remain chemically stable. One blender defines the maximum suitable water level as 500 ppm (0.05%) to ensure optimum lubrication, viscosity and useful oil life. In the field, it's not unusual to encounter rolling-mill oils that look like chocolate milk or mud (cloudy), with water levels from 3000 ppm (0.3%) up to 150,000 ppm (15%). Once the oil begins losing demulsibility and the "emulsified" water increases, the oil may be replaced based on analysis data, or left in the system until the mill experiences bearing failures ($30,000 each). Depending on the amount of water in the oil, the viscosity will change. In an extreme case, oil-analysis reports revealed that ISO 460 oil viscosity with 7000 ppm was 445 cSt and with 133,000 ppm had dropped to 330 cSt.



When viscosity drops, the lubricating film is compromised, yielding thin film—which, of course, can lead to greater risk of particulate contamination damage and metal-to-metal contact between bearing and bearing housing. As the lubricating film becomes thinner between the rolling surface and the housing, there is an increase in heat that can vaporize the water and cause further damage to the bearings and oil. The combination of high "emulsified" water and high particulate levels creates a perfect storm for bearing failure and reduced oil life.

The Solution

Achieving and maintaining ISO cleanliness codes below recommended maximums can improve reliability, minimize component damage and extend useful oil life. The same can be said for controlling water contamination.

A suitable target ISO cleanliness code is 18/16/14, yet typical ISO codes found in steel mills can range between 24/23/20 and 21/20/18. System filtration is usually done via cleanable strainer baskets featuring large perforated holes or pleated cartridge elements with wire mesh media, unless the cleanliness has been addressed by adding finer side-loop filtration.

In addition to the increases in emulsified water caused by oxidative oil degradation, the particles and free water can combine loosely to increase the amount of water in the oil that will not readily demulsify. The free water can act as a powerful solvent looking for molecular partners, and can form loose bonds with the suspended particles. The suspended particles can invite more water into the oil in which they are suspended.

An emulsion is a bond that can be chemically strong and unbroken by settling. Although centrifuges have traditionally been used to remove free water, they do little to treat the emulsified and dissolved water that causes damage in bearings and shortens fluid life. Centrifuges also require frequent maintenance, and are often neglected due to other heavy demands on maintenance personnel.

Vacuum dehydration, including high-efficiency particulate filtration, must be applied to properly address the whole water issue of dissolved, emulsified and free water. Removing water and particles with vacuum dehydration will improve demulsibility and fluid cleanliness of the oil for improved bearing lubrication, increased bearing life and longer oil life. Other benefits include less roll-stand leakage, decreased oil consumption, elimination of the need for decanting and reduced environmental impact.

In their chemical structure, high-demulsibility oils are relatively stable and not looking for molecular partners. The hydrogen in water, however, is actively seeking partners (H-O-H)—it is the *friendliest molecule the oil encounters*. Likewise, many suspended particles in the oil are looking for molecular partners, so they will join with the water.

The particulate contamination in the oil is the catalyst that intensifies the entrainment of the water in the oil along with the increase in emulsified water that is caused by continuing degradation of the oil, which is accelerated by the increase of emulsified water. The rising levels of water not only lead to an increase in the rate of oxidation, they also contribute to the formation of various acids that form as the oil molecules breakdown. The acids attack and degrade the seals, hoses, pumps and metal surfaces.

When there is a high percentage of water in the oil (free, emulsified, and dissolved), the immediate concern is for controlling the free and emulsified water and particulate contamination as these do the most damage to bearings. A parallel target should be minimization of the ingress of the free water through leaky seals and chocks to reduce regular decanting of free water and lube oil losses that occur as oil is carried down the drain while draining water.

Water in rolling-mill oil is inevitable; defining success is important in the battle to extend the life of bearings through proper lubrication—and to also extend oil life. Striving to achieve and maintain low levels of water and particulate in the oil, both quantifiable goals, will increase reliability and ultimately improve bottom-line profitability.

Proper care of the oil can help an operation both justify the use of premium products and move beyond the acceptance of high levels of water and particulate as the norm. That's more important than ever, since increasing oil prices have put the cost of replacing lube-system oil in the range of $100,000 to $300,000, depending on the system volume and type of oil used.

The Results

Proper oil condition can be the difference between uptime and unplanned downtime. It's an enormous issue for steel mill operations. Consider the following: In a recent application, a Donaldson Hy-Pro Vacuum Dehydrator (VUD) was installed on an 8000-gal. rolling-mill lube reservoir to prevent the type of frequent bearing failures that were costing the operations $30,000 per occurrence. The VUD had an immediate impact, reducing water levels from 29,000 ppm (2.9%) to 17,735 ppm (1.7735%) during the first day. Within two weeks, the water level of the system had stabilized at 383 ppm (.0383%). Since the water has been reduced to acceptable levels, the mill has not had a bearing failure.

Prior to the installation of the VUD, the mill was decanting water every shift. The VUD was installed on the decanting line and the daily practice of decanting the reservoir was ceased, decreasing oil consumption by 25,200 gallons (~$201,600 annually). The mill is no longer topping off lube reservoirs, oil consumption is limited to roll-stand changes and roll-stand labyrinth seals are no longer leaking. The oil lost during decanting would accumulate in a sealed retention pond from which it had to be periodically skimmed/reclaimed. Subsequent to the installation of the VUD, pond oil, recovery efforts and costs decreased significantly.

In another successful application, Donaldson Hy-Pro installed a Vac-U-Dry V20 model vacuum dehydrator with high efficiency glass media elements on a 12,000-gal. single tank Morgoil® system where the water concentration was over 7000 ppm (0.7%) emulsified. The oil was dark and had the appearance of chocolate milk. The mill was regularly draining free water from the reservoir that contained residual oil. The Vac-U-Dry was connected to the reservoir drain line and the free water was no longer drained. Within two months of this installation, the water concentration had dropped from 7000 ppm (0.7%) to < 30 ppm (0.003%). Mill personnel have mentioned that when viewing the oil in the lube window in the bearing supply line, "it actually looks like oil again."

This specific mill is no longer draining free water, thereby saving valuable maintenance man hours and not losing oil (which is common in the decanting process). Oil-analysis indicates that the oil is no longer operating under alert conditions for water concentration. Particle counts also show fluid cleanliness trending toward acceptable levels.

Today's advanced vacuum dehydrators are designed for 24/7 unattended operation with automatic water drainage and large particulate filter elements to improve oil cleanliness while removing all forms of water in oil (free, emulsified and dissolved). Maintenance intervals for vacuum dehydrators are much longer than those of other technologies, thus easing the burden on maintenance personnel. In addition to addressing the contamination issues, it is also important to combat sources of water and particulate contamination if possible. Achieving optimum oil health requires the removal of water and particles as the particles are a catalyst for increasing the amount of entrained water that leads to increased oxidation, the formation of acids and low viscosity. Donaldson Hy-Pro equipment has been used in the reclamation of rolling-mill lube-oil where oil that once had been condemned was reclaimed to extend its useful life.

Want to find out more? Get in touch.

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