ADVANCES IN OIL MIST LUBRICATION FOR ELECTRIC MOTORS

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ABSTRACT
Oil mist lubrication is a proven, environmentally clean and cost effective method for the lubrication of electric motor bearings in process industries. The application of oil mist lubrication has grown dramatically in many parts of the world because of the benefits delivered by its use. Since the late 1980's many advances have been made in both the technology of oil mist system design and methods for applying oil mist to rotating equipment. Technology for closed-loop, environmentally clean oil mist systems in addition to the latest in central mist generator design is reviewed. Advanced oil mist system components are described and new applications for use of oil mist on process equipment such as electric motors are discussed

INDEX TERMS
Oil mist, closed-loop oil mist systems, advanced oil mist components

INTRODUCTION
An oil mist system is a centralized system that is an efficient and cost effective method of providing lubrication to several different classes of rotating equipment in widely dispersed physical locations within the same facility. The system uses the energy of a compressed gas to produce and convey an oil mist through a piping manifold for distribution and injection into the bearing cavities of rotating machines. This equipment may be under operating, standby or storage conditions. Several considerations affect the design of such a system, including the classification of hazardous areas in which the equipment may be applied, the nature of the bearing elements to be lubricated, and the environmental restrictions or limitations which may be placed upon emissions.

This proven method is a cost-effective means to reduce the bearing failures of process equipment in excess of 90% over traditional grease and oil sump methods of lubrication. The reduction of bearing failures attributed to oil mist lubrication allows for expensive maintenance resources to be utilized in more time and cost effective ways.

THEORY OF OPERATION
The oil mist system employs an expanding gas, usually instrument air, to atomize lubricating oil into tiny particles of 1 to 3 microns in size. These particles are then conveyed continuously by the air through an appropriately designed low-pressure piping distribution system to multiple points of usage. Droplets of this size are are not large enough to carry particulates that would be detrimental to bearing surfaces, so only fresh clean oil is applied to the equipment being lubricated. Turbulence is introduced into the flow near each point of application where the airborne oil particles coalesce into larger particles. These particles then flow into the bearing cavity to wet the interacting surfaces of a bearing and other internal surfaces with a light coating of oil. This small amount of oil is sufficient to lubricate operating anti-friction bearings as well as provide a needed film on internal components for corrosion protection.

The basic oil mist lubrication system consists of the following: (see Figure 1)

- Bulk (oil) Supply Tank (BST)
- Oil Mist Generator (OMG)
- Interconnecting feed piping
- Instrument air supply
- Oil mist distribution header system
- Drop piping to each application point
- Oil mist fitting at each load point

Typical oil mist applications include electric motors, gearboxes, turbines, API & ANSI pumps and blower bearings.

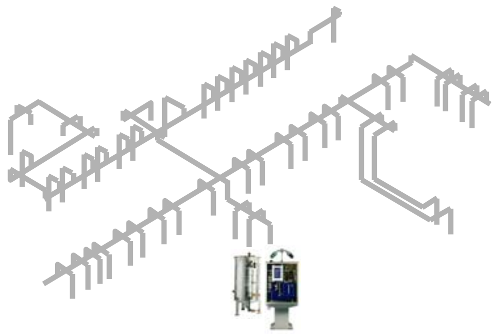

Figure 1

TYPES OF OIL MIST SYSTEMS

There are two types of oil mist systems; One-way and Closed-loop. Both systems have the same basic oil mist system components i.e. Bulk Supply Tank, Oil Mist Generator, and piping/distribution system, and oil mist connector/adapter fittings. The difference is in the piping/distribution systems. The one-way system has a single pipe header and drop pipe with no provision for the return/recovery of coalesced oil from the equipment being lubricated. The closed-loop system has a dual header system with the second header acting as the return header for coalesced oil and stray mist.

ONE-WAY SYSTEMS

The one-way system is the basic oil mist arrangement which has been installed in the refining and petrochemical industries since the 1950’s. All oil, after being atomized and sent into the distribution system, goes to the equipment, through the bearings and is then vented to atmosphere and lost. Hence the term one-way. Some previous installations have discharged the coalesced oil directly to oily water sewers or a small spent oil container. Infrequently, the oil is manually accumulated and disposed of.

Oil consumption in the one-way system is still minimal when compared to the losses of traditional sump arrangements. Oil consumption for a large scale oil mist system operating at maximum capacity (30 SCFM) is approximately 2 gallons of oil per 24 hours of operation. This volume of lubricant is sufficient for approximately 150 machines: load and driver, two bearings each.

CLOSED LOOP SYSTEMS

The closed-loop system is new technology which has been developed in the past 5 to 6 years. This design modification assists process facilities in meeting their goal of a clean environment and zero emissions. Virtually all oil that is atomized into oil mist and conveyed into the piping header system is collected/recovered and reused through the system. Careful design and implementation of such a technology allows for extensive use in the fabrics and fibers industry where no oil or oil mist is tolerated on the finished product. As environmental and safety regulations are tightened the closed-loop system allows the maintenance department to assure maximum lubrication reliability from oil mist with minimal manpower involvement.

This arrangement incorporates the standard oil mist equipment with a few special components that are unique to the closed-loop system. The most important items in this design are the collection containers with hand pumps, the de-misting vessel and the second or return header pipe. (see Figure 2) The coalesced oil drains into the oil collection containers located below the equipment where it is pumped manually into the return header, which installed for a gravity feed back. The stray mist is also drafted into the return header piping, fed into the de-misting filter, and deposited into the bulk storage tank for re-use. The de-misting filter is a dynamic device with provision for the removal of particulate matter in addition to its coalescing action. Approximately 95% of the oil and stray mist is returned for reuse, and only make up oil need be added to the bulk supply as required.

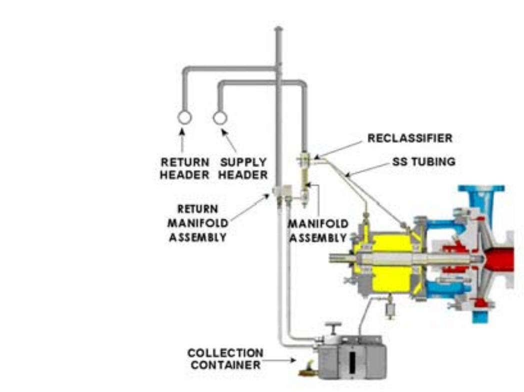

Figure 2

APPLICATION OF OIL MIST

There are two application methods within oil mist lubrication technology: pure and purge. Both methods may be used within a common system; the type of equipment being lubricated determines which method should be used. Reliability of oil mist units, systems and installation practices have improved considerably since the 1950's and 1960's when oil mist was a new concept, the highly reliable modern oil mist systems has made pure oil mist the preferred method for lubricating rotating equipment.

PURE OIL MIST

Pure oil mist is often referred to as dry sump oil mist, which indicates that no oil or grease is maintained in the bearing housing being serviced. The bearings are lubricated directly and continuously by a supply of fresh, condensed clean oil. Coalesced oil is obtained by the introduction of turbulence into the feed mist stream within an enclosed space. Additional condensing action is provided by the rotation of the bearing elements. The mist application fittings (reclassifiers) are individually sized to each bearing or the equipment chamber. This is necessary to feed the appropriate amount of lubricant to the each of the various sizes and types of bearings found within a drive/load string. While pure oil mist is the primary means of lubrication for operating equipment it also acts to preserve and protect the rolling elements within stand-by or stored equipment.

Typical pure mist installations lubricate rolling element bearings, such as those found in pumps, motors and pillow block bearings. It is applicable to both grass roots and retrofit installations. Pure oil mist is the preferred method due to its improvement of rotating equipment reliability and economy of operation.

PURGE OIL MIST

Purge oil mist is often referred to as wet sump oil mist, which indicates that an oil level is maintained in the equipment being serviced. The oil mist is applied on top of the oil sump which creates a slight positive pressure that prevents thermal cycling of the cavity and eliminates the intrusion of airborne contaminates. Purge oil mist is not the primary means of lubrication for operating equipment but it is extremely effective in preventing water build up and corrosion in stand-by, idled and stored equipment.

The equipment outfitted for purge oil mist is typically gearboxes, turbines with sleeve bearings, motors with sleeve bearings and oil reservoirs of lube oil systems. (see figure 3) The continuous film of oil that is applied to internal machined surfaces prevents corrosion from forming and causing premature equipment failure.

The oil mist injection point must be above the oil sump with an unobstructed flow path to a vent, also above the oil level. This can be accomplished by using two separate openings on top of the housing, or by using a vent fill assembly in a single opening. The vent fill assembly incorporates a mist injection tube, connection for venting and a removal cap for adding oil to the sump. The pressure above and below the oil level must be balanced by using an oil level sight assembly or a constant level oiler with balance line. An overflow tube incorporated in the oil level sight assembly and constant level oiler is adjusted to allow excessive oil buildup to overflow to the collection container and to vent the bearing housing. The top of the overflow tube should be set ¼" above the desired oil level.

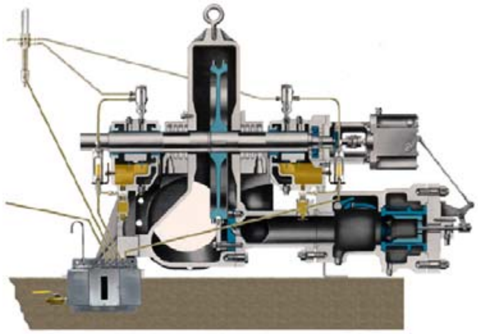

Figure 3

VENTING

Venting of carrier air from closed housing is required to permit the continuous flow of oil mist into the housing. Although it is not always necessary to insure through–flow of oil mist for single-row radial bearings, it is nevertheless good practice to do so. On thrust-loaded rolling element bearings, the oil mist should always be routed through the bearing rolling elements in order to insure that complete lubrication occurs. It is always prudent to review the bearing housing configuration so the correctness of venting or mist through-flow can be ascertained.

SEALS

Seals should be installed on both ends of horizontal TEFC motors and on both sides of the bearings of ODP motors. Many motors have been connected to oil mist systems without seals on the bearing brackets, however many users are concerned about oil collecting on the base plates and exterior of the motor. In some cases the cooling fan(s) on motors without seals pull outside air and contaminants into the bearings through the vent/drain line. This can be detected by checking the pressure on the drain line with a manometer.

GENERAL GUIDELINES

TEFC horizontal motors are prime candidates for oil mist lubrication. Only motors 15 HP and larger should be considered. The mist inlet must be located in the top of the bearing bracket and the drain in the lower part of the bearing. Coalesced oil must not be allowed to accumulate in the bearing. (see Figure 4)

Stray mist will migrate into the stator housing and a small amount of coalesced oil will accumulate. This oil must be drained through a case drain. If motor is equipped with drain (s), use drain ports provided. If motor does not have a stator housing drain port, it will be necessary to drill and tap a 3/8” drain port.

Motor lead wires must be made of, or fitted with, an oil impervious material such as Teflon or Polyolefin. Fill motor lead passage into junction box with a resin. This resin is used to prevent egress of oil mist into the motor junction box.

Vertically mounted motors over 3HP should be considered on a case by case basis for oil mist. These motors are more susceptible to oil handling and drainage problems, which require special bearing housing designs.

Motors with plain bearings / sleeve type must be purge misted. The oil sump must be maintained to insure adequate lubrication.

Motors with sealed bearings “ Lube for Life” and explosion proof motors must not be oil misted. Modification and / or repairs to explosion proof motors require recertification by an authorized representative from a Nationally Recognized Testing Laboratory (NRTL) such as Underwriters Laboratories.

Interface threads must accommodate a standard pipe thread connection. Equipment should be permanently tagged, “Oil Mist Lubricated”. New equipment must be shipped with the inlet/outlet connections sealed.

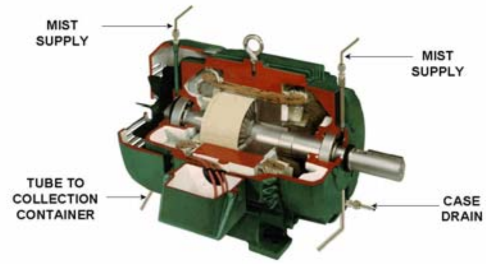

Figure 4

BENEFITS OF OIL MIST

Lubrication is vastly simplified by centralized systems that are more easily managed and are far less maintenance intensive than typical methods of lubrication.

A reduction of the greases and oils in inventory yields both space and cost savings. Similarly, large amounts of time can be re-directed through the elimination of attempted re-lubrication assignments required by the multitude of machines throughout an entire petrochemical facility. Understandably, maintenance of a correct amount of clean lubricant in each bearing crucial in preventing equipment failures, and with conventional methods is manpower intensive. In all likelihood, there are units that receive too much attention, and the remainder which receive virtually no care.

The Electrical Apparatus and Service Association (EASA) has studied electric motor failures over several decades. Their studies note that over 80% of these failures were caused by mechanical faults. Most of these relate directly to bearing damage caused by lubrication induced problems. Hence improved lubrication techniques have a dramatic effect on equipment service life. The total savings from avoided repair costs and increased operating time are, by themselves, a considerable amount

When a pure oil mist is applied to oil sump type bearings the small amount of oil consumed in the continuous mist flow offsets the sump's oil consumption, typically up to 40%. Also, oil sump change intervals are extended to 2 and 3 years. Optional oil recovery systems reduce oil consumption up to 95%.

Oil, whether by itself or as a component in grease, degenerates with oxidation, elevated temperatures and the inclusion of wear debris. Bearing life is directly related to the lubricity, cleanliness and temperature of the lubricant. A pure oil mist system eliminates oil oxidation, grease carrier degredation, and the recirculation of wear debris over bearings

Pump bearings run approximately 35°F cooler when lubricated by pure oil mist. Elimination of the oil sump allows the bearings to operate cooler; bearing fatigue life is shortened approximately 11% for every 10° F increase in bearing temperature.

Bearing cooling water has been deleted from many centrifugal pumps with a positive effect, regardless of the pump product temperature. Experience shows that uncooled bearings will often operate more reliably than bearings cooled by water.

Research conducted by Texas A&M University has shown that pure oil mist deposits a wear resistant carbonaceous film on the wear surfaces of rolling element bearings. Whereas this deposit is not formed with the conventional sump lubrication. Pure oil mist extends the L10 life of the bearing up to 6 times.

Oil mist systems that are properly maintained have demonstrated incredibly high service factors and reliability. Contrary to intuition, temporary loss of oil mist to a pump or motor is not likely to cause an immediate and catastrophic failure due to the lubricative effect of the carbonaceous film. Tests by various oil mist users have proven that bearings operating within their load and temperature limits can continue to operate without problems for periods in excess of eight hours.

Additionally, the injection of oil mist into the bearing cavities of stand by or stored equipment also diminishes the impact of damage due to corrosion, reducing the time and cost of repair or rebuilding of mothballed equipment.

A 15,000 HP electric motor being protected in storage by a small Closed-Loop oil mist system. (see Figure 6)

Figure 6

CONCLUSION

Centralized oil-mist systems continue, for many in process industries, to be their technically preferred approach for lubricating rotating equipment. Oil mist technology has kept pace with other developments in these industries especially in the area of microprocessor controls and process monitoring. In addition, system design specifications have expanded allowing oil mist systems to reach further and today's distribution systems are more efficient because they allow coalesced oil to return to the central mist generator for reuse.

Components such as mist manifolds have been redesigned and improved and new devices such as vent/fill assemblies and automated drain legs have been developed making today's systems more efficient and cleaner than defined and delivered by prior technology and installation practices. The invention and commercialization of closed-loop, circulating oil mist systems and related demisting equipment have positioned oil mist for greater use by process industries in an environmentally conscious world. Oil mist now meets the requirements for clean, emission-free operation while still delivering the improved reliability results expected of oil mist.

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