Written by Heinz P. Bloch Contributing Editor
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As the reader will recall from Part I of this two-part article, dry sump oil mist on electric motors represents wellproven technology. In the mid-1960s, oil mist—a mixture of 200,000 volume parts of clean and dry plant or instrument air with one part of lubricating oil—gained acceptance as the ideal lubricant application method on rolling element electric motor bearings in several major United States oil refineries. Since then, this lubrication method has gained further acceptance at hundreds of reliability-focused process plants in this country and overseas and, as of the late 1990s, many thousands of electric motors were being lubricated by dry sump oil mist. Remember: Whenever oil mist is used for pump lubrication, its extension to cover electric motor drivers will be very inexpensive.

The right bearing and correct installation

Oil mist cannot eliminate basic bearing problems— it can only provide one of the best and most reliable means of lubricant application. (Refer again to Fig. 1.) Bearings must:

1. Be adequate for the application, i.e. deep groove ball bearings for coupled drives, cylindrical roller bearing to support high radial loads in certain belt drives, or angular contact ball bearings to support the axial (constant) loads in vertical motor applications.
2. Incorporate correct bearing-internal clearances.
3. Be mounted with correct shaft and housing fits.
4. Be carefully and correctly handled, using tools that will avoid damage.
5. Be correctly assembled and fitted to the motor caps, carefully avoiding misalignment or skewing.
6. Be part of a correctly installed motor, avoiding shaft misalignment and soft foot, or bearing damage incurred while mounting either the coupling or drive pulley.
7. Be subjected to vibration spectrum analysis. This will indicate the lubrication condition in regard to lubricating film, bearing condition (possible bearing damage) and general equipment condition, including misalignment, lack of support (soft foot), unbalance, etc.

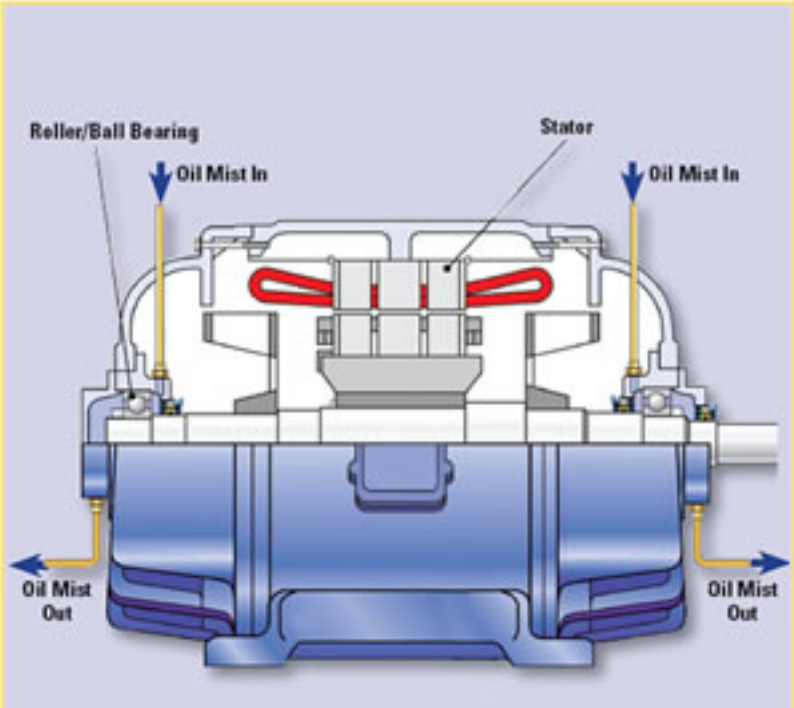

Fig. 1. How oil mist is applied to modern electric motor bearings

Additional considerations when converting electric motors that are already in use

When converting operating motors from grease lubrication to dry sump oil mist lubrication, consider the following measures in addition to those mentioned in the previous list:

1. Perform a complete vibration analysis. This will confirm pre-existing bearing distress and indicate if such work as re-alignment and/or base plate stiffening is needed to avert incipient bearing failure.
2. Measure the actual efficiency of the motor. If the motor is inefficient, consider replacing it with a modern high efficiency motor, using oil mist lubrication in line with the aforementioned recommendations. This will allow the capture of all benefits and result in greatly enhanced return on investment.
3. Last, but not least, evaluate if the capacity of the motor is best suited for the application. "Best suitable" typically implies driven loads that represent 75% to 95% of nominal motor capacity. The result is operation at best efficiency. Note that converting an overloaded, hot-running electric motor to oil mist lubrication will not usually be of economic benefit and will lead to marginal improvement at best.

Regarding explosion-proof motors

Although explosion-proof motors have been successfully lubricated with pure oil mist for at least three full decades, questions are occasionally raised as to whether explosionproof (XP) electric motors are suitable for this mode of lubrication.

Dealing with codes and practices…

The selection, operation and even maintenance of industrial equipment in the developed countries often are influenced by industrial standards, regulatory agencies and certain applicable codes. Major companies, though, superimpose their own design standards, specifications and best practices. It can be shown beyond any doubt that many of these practices reflect advanced thinking that is often years ahead of current regulatory edicts. Nevertheless (more recently), some of these practices have come under scrutiny. In the case of oil mist applied to explosion-proof electric motors, the scrutiny was not prompted by any safety incidents. Rather, it has been brought on by the fact that we live in litigious times and lawsuits are costly.

It appears that the acceptability of dry sump oil mist on explosion-proof motors relates to third-party approval and the original equipment manufacturer's certification of the motor. For years, users have provided all except their explosion-proof electric motors with a small (3 mm) weep hole and have given XP-motor drains closer attention. The latter are furnished with either an explosion-proof rated vent or a suitably routed weep hole passage at the bottom of the motor casing or lower edge of the end cover. Intended to drain accumulated moisture condensation, the vent or weep hole passage will allow liquefied or atomized oil mist to escape. Note, however, that explosion-proof motors are still "explosion-proof" with this passage. (*For example, Baldor • Reliance Motors [formerly Reliance Electric] tackwelds an explosion-proof "XP-breather drain" to the motor brackets. The suitability of this line of motors for Class 1, Group C and D locations was specifically re-affirmed by the manufacturer in July of 2004.*

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Not being familiar with dry sump oil mist, though, causes some motor manufacturers and third party validation providers to take the position that explosion-proofmotors lose this "listing" once any modifications are made to the motor.

Highlighting oil mist for XP motors

As the name implies, explosion-proof motors are intended for use in hazardous areas. The majority of hazardous areas in hydrocarbon processing facilities are designated as Class 1, Division 2, Groups B, C and D.

The Class 1 area designation indicates that either a flammable liquid or vapor or both are present. (Class 2 designations are reserved for areas where combustible metal, carbon fines or other combustible dusts such as grain flour or plastic are present).

The "Division" label is used to better describe the probability of flammable gases or vapors being present in a Class 1 or Class 2 location.

- Division 1 is intended for locations where ignitable concentrations of flammable gases or vapors can either exist under normal operating conditions, or might be present while the equipment is undergoing repair or maintenance.
- Division 2 defines the area or location where the flammable liquids or vapors are possibly present and/or:

1. Normally confined within closed containers or closed systems and are present only in case of accidental rupture or breakdown of such containers, or in case of abnormal operation of equipment; or
2. Where ignitable concentrations are normally prevented by positive ventilation; or
3. An area adjacent to a Class 1, Division 1, location.

The "Group" designation has four subgroups, or gas groups—*appropriately called Groups A, B, C and D* . Determining the proper group classification for flammable gases and vapors requires monitoring and describing explosion pressures and maximum safe clearances between parts of a clamped joint under

certain prescribed conditions whereby a test gas is mixed with air and ignited.

The test values obtained for a reference gas are compared with the gas or gases of interest; these must now be tested under the same conditions. Gases having similar explosion pressures are grouped together. However, Groups C and D contain the majority of flammable gases and vapors. Group A only contains acetylene, while Group B generally contains hydrogen and other hydrogen-rich gas mixtures, plus a few other flammable gases.

An important concession is made by the National Electrical Code (NEC) for equipment used in Division 2 areas, where flammable gases are normally not present, i.e. a refinery or petrochemical plant under normal conditions. If they meet stipulated criteria, the NEC allows the use of certain types of devices and materials that may not be listed by third party, or "listing" agencies. For instance, these exceptions to the NEC's general code requirements permit general-purpose enclosures if the electrical current interrupting contacts are:

1. Immersed in oil; or
2. Enclosed within a chamber that is hermetically sealed against the entrance of gases or vapors; or
3. In non-incendive circuits; or
4. Part of a "listed" non-incendive component; or
5. Without make-and-break or sliding contacts.

Except for the above exclusions, the National Electrical Code/NFPA 70 ("NEC") requires that all electrical apparatus installed in classified (hazardous) areas must be approved for use in the specified Class and Group where it is to be used. Once an electrical apparatus is described as "explosion-proof," it is implied that the device has been evaluated and approved for use in a particular Class and Group. The evaluation or approval agency was earlier called a "third party." In the United States, third parties include Underwriters Laboratories (UL), Factory Mutual (FM) and others. Once an apparatus or device has been evaluated and approved for a particular Class or Group, it is labeled "listed" by the agency.

In most Class 1 Division 2 hazardous areas, the electric motors are not, and do not need to be "explosion-proof." The overwhelming majority are non-arcing induction motors that meet the requirements of the applicable and allowed exceptions. These non-explosion- proof motors can be adapted for dry sump oil mist lubrication by simply connecting oil mist supplies and vents to the existing connections used with the explosion-proof units. Because these motors are non-arcing and an explosion-proof housing is not needed for Division 2 service, the case drain

fitting can be removed and a drain can be installed without in any way affecting the suitability of the motor for Division 2 service.

Safety of XP motors for Class 1 Division 1 service

Regrettably, some listing agencies in the United States seem to believe that oil mist applied to the bearings makes the motor different from what was originally approved. Not understanding oil mist, they take the position that by in any way adapting plugs and drain fittings to oil mist application, mist venting and mist draining, the safe clearance requirements between clamped components used in the original design requirement may have been changed. Therefore, they consider the approval listing void and claim the motor is no longer suitable for use in Class 1 Division 1 service. In view of this stance taken by third parties, even a major provider of oil mist systems in the United States does not allow its employees to make on-site modifications to convert or connect an explosion-proof motor to oil mist. That said, a number of clarifications are in order here.

Summary And Guidance For Using Oil Mist

With TEFC electric motors…

1. On operating or field conversions, apply oil mist per Fig. 2.

With WP II electric motors…

1. On operating or field conversions, apply oil mist per Fig. 2.
2. When specifying new motors intended for oil mist lubrication, exercise whatever internal sealing option is deemed desirable.
3. On in-shop conversions, install internal seals to reduce dust accumulation.

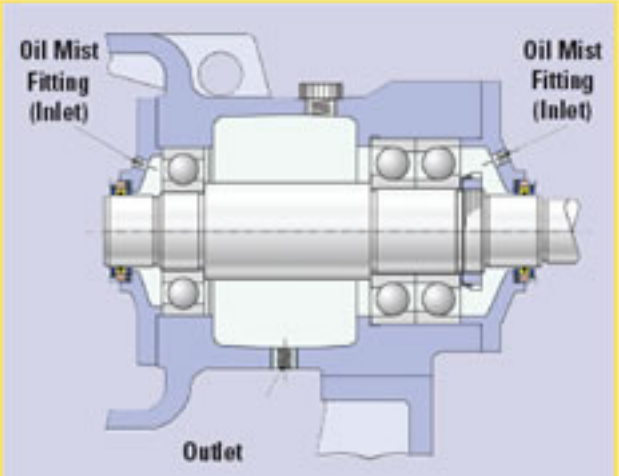

Fig. 2. "Through-flow" oil mist application, per API-610 8th and later editions

With explosion-proof electric motors…

1. Specify oil mist lubrication on data sheets when purchasing new explosion-proof motors.
2. Before applying oil mist to an existing explosion-proof motor, remove the motor from service and send it to an authorized motor repair facility to make the necessary XP-breather drain modifications. The repair facility should be recognized by the original motor manufacturer and, if re-listing is desired, be able to certify the modified motor with the required third party for the applicable hazardous listing.

First and foremost is the fact that explosion-proof motors were successfully converted to oil mist lubrication by undisputed best-of-class petrochemical companies three decades ago and have since given safe and reliable service. These forward-looking companies, for whom safety is of utmost importance, correctly reasoned that all electric motors, regardless of classification, were assembled and being operated in an ambient environment. Thus, they always are filled with ambient air; certainly none of these motors are provided with mechanical seals that would positively prevent an interchange or communication between motor-internal air and the surrounding ambient air. Should an explosive gas mixture prevail in the vicinity of such motors, there would now exist the possibility of the motor ingesting this explosive gas mixture. If, on the other hand, such a motor were filled with the demonstrably non-explosive oil mist at slightly higher-than-atmospheric pressure, the probability of the motor becoming filled with an explosive gas mixture would be greatly reduced. In other words, knowledgeable user companies have long recognized that an oil-mist-lubricated motor operating in a Class 1 Division 1 environment is safer than a conventionally lubricated electric motor operating in the same environment.

It also may be argued that item 2, and possibly one or two other items cited as exclusionary by NEC, allow the user to reason that oil mist existing at a pressure higher than atmospheric complies fully with the spirit of the listed exclusions.

References

1. Bloch, Heinz P., and Alan Budris, (2006), *Pump User's Handbook: Life Extension*, Fairmont Press, Inc., Lilburn, GA, 30047; ISBN 0-88173-517-5, pp. 265-290

2. Bloch, Heinz P., and Abdus Shamim, (1998), *Oil Mist Lubrication: Practical Applications*, Fairmont Press, Inc., Lilburn, GA, 30047; ISBN 0-88173-256-7, Fig. 9-7, p. 109

3. Shelton, Harold L., "Estimating the lower explosive limits of waste vapors," *Environmental Engineering*, May-June 1995, pp. 22-25

4. Lilly, L.R.C., (1986), *Diesel Engine Reference Book*, Butterworth & Co., London, U.K., ISBN 0-408-00443-6, p. 21/3

Contributing editor Heinz Bloch is the author of 17 comprehensive textbooks and over 340 other publications on machinery reliability and lubrication. He can be contacted at: hpbloch@mchsi.com