Warning!

Part I of a Two-Part Series on Wet-Mix Equipment Maintenance

Improper On-Job Lubrication Will Dramatically Reduce Wet-Mix Equipment Service Life

Do you know how to properly lubricate your wet-mix pump?

By Oscar Duckworth

Two new wet-mix shotcrete pumps are ordered by different clients. Although both pumps are identical in every way, one pump will cost less to operate and last far longer than the other. Why? Wet-mix pumps require specific on-the-job lubrication procedures which are unique to this type of equipment. But many operators possess very little knowledge on how to properly perform these critical maintenance steps.

Specific lubrication procedures must be properly performed at every use or frequent component failures and diminished service life will result. Do you know what these essential procedures are and how to properly perform them?

Understanding the Lubrication System

Wet-mix pumping equipment is a costly investment. Its long-term performance and durability will ultimately be determined by the effectiveness of the equipment's various lubrication systems.

Typical wet-mix pumping equipment uses at least four individual lubrication systems. Each system possesses specific maintenance requirements.

Diesel engine internal components are lubricated and cooled by a pressurized oiling system that circulates oils with specific properties necessary for diesel engine longevity. The hydraulic system is protected by special high-pressure hydraulic fluids which are continuously supplied to critical components, then cooled and filtered during operation. Aside from recommended maintenance intervals and monitoring fluid levels, both of these sophisticated lubrication systems require little on-the-job maintenance.

Engine and hydraulic systems power the concrete pumping components that do the work of supplying high-pressure concrete to the placement system. The concrete pumping components—concrete cylinders and piston cups, shift valve bearings, seals, and/or outlet flange bearings—and the hopper re-mixer, must operate while fully immersed in concrete. Additionally, these parts must function without the benefits of a sophisticated lubrication system. Even the most modern pumping equipment relies on comparably primitive forms of lubrication to prevent wear and corrosion of precision concrete-pumping component surfaces.

The concrete-pumping piston cups and hard-chromed material cylinders are typically lubricated and cooled by water. The use of other lubricants, however, such as water-soluble oils or hydraulic fluid, can greatly increase component service life. An ample volume of water-box lubricant (typically filled to the centerline of the piston shafts) is required to adequately cool and protect these critical components.

Depending on internal wear, water-box lubricants slowly bypass the concrete piston cups and are lost during pumping. Although quite robust by design, if a pump is operated for even a few moments without adequate water-box lubricant, concrete cylinders and piston cups can become scored and permanently damaged. Lubricant levels within the water box must be checked, refilled, or topped off daily before startup. This mandatory pre-start ritual must never be overlooked by the operator and crew.

The Essential Function of Grease

Casual research indicates that many operators improperly grease their equipment, often with

destructive results. To the untrained eye, correct and incorrect greasing methods appear the same. Operators and crew must understand the function of grease to properly lubricate wet-mix pumping equipment.

Grease is typically a petroleum product that is suspended in a soap-like thickening agent. Greases are rated for their temperature and melting rate, the ability to inhibit oxidation and corrosion, and their level of protection for metals in the presence of water. Greases are application-specific (think submerged boat trailer axle versus very hot truck disc brake rotor).

It is important to understand the various functions that grease must accomplish within wet-mix pumps. If properly applied, grease prevents metal-to-metal contact at the critical internal bearing surfaces of concrete pumping components. Greases provide lubrication and corrosion protection by coating action. Its viscous fluid component lubricates clearances between parts that are relatively large, but for small clearances, the molecular soap layers provide the lubrication. Water-resistant greases may be used for a wide range of equipment and are very good choices for wet-mix equipment. However, grease must be applied properly within a bearing surface, or it will not provide adequate protection.

Unlike typical oils, greases do not easily flow at normal temperatures. This means that to be effective, grease must be installed by force, directly to wear surfaces through small ports or passageways within the bearing surface or housing. Grease must then completely coat all the surfaces which require protection from corrosion and wear, and be routinely replenished as mechanical energy pushes the product aside. As the grease coating diminishes, the protective layer is lost. Wear and corrosion begin immediately.

When used properly, grease will reduce or even completely eliminate corrosion and wear at critical surfaces. Many critical bearing surfaces are required on typical wet-mix pump designs. Any component within the material hopper that must rotate or slide will possess some form of bearing surface. All of these surfaces are continuously exposed to abrasive concrete slurries during daily operation.

Why Wet-Mix Equipment Requires Specific Lubrication Techniques

All machinery applications require some form of lubrication. Typically, lubricants are provided under pressure to critical bearing and seal surfaces through a recirculating oiling system. This method is impractical in a wet-mix pump application (excluding engine and hydraulic components) due to the constant exposure and potential contamination from abrasive, corrosive, concrete slurries. Lubrication by grease is common for machinery undercarriage components, sliding surfaces, and articulating arm pivot bearings. If grease is applied at the proper interval, it offers excellent lubrication for these applications. But greasing requirements differ for wet-mix pump applications due to the near-continuous immersion of components within the abrasive, corrosive, concrete slurries.

Fig. 1: Unnecessary corrosion and wear on critical bearing surface is likely caused by improper grease application

Wet-mix shotcrete pumps are usually positive displacement swing valve configurations. Swing valve designs (swing tube, rock valve, or gate valve) use very large sealed shaft bearings that

Fig. 2: Typical S tube shaft bearing

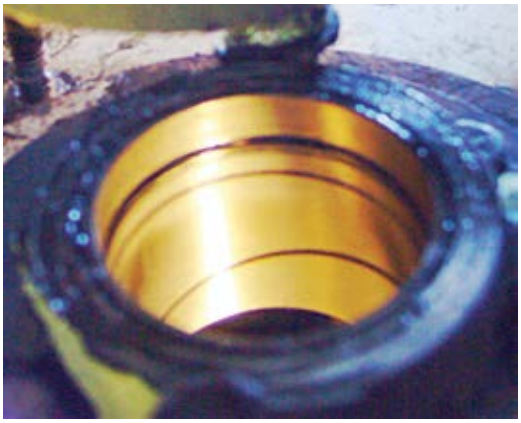

Fig. 3: Properly lubricated shaft bearing at 3000 hours

permit valve rotation between material cylinders during pumping.

Additionally, swing-tube-type pumps use large, sealed outlet bearings that are directly exposed to and vulnerable to damage from pressurized abrasive slurries. Insufficient or contaminated grease within any of these critical points can cause immediate, severe damage.

When grease is properly applied at seal and bearing surfaces, it lubricates and protects, but also acts to fill available space between the bearing, shaft, and sealing surface, thus denying access to incoming abrasive slurries. To accomplish this, a greasing device must be connected to a permanently affixed grease fitting. Applied under pressure, grease must flow through a series of small drilled passageways that direct grease to completely fill and coat the bearing surfaces. Because functioning grease fittings act as one-way valves, greases cannot be pushed backward and out of the way by pressurized slurries attempting to flow into the bearing surfaces.

Why Grease Doesn't Work

Applying grease does not provide permanent lubrication. When grease is used in wet-mix pump applications, its benefits are temporary at best. Grease within a bearing area does not break down or disappear from use. Rather, as the bearing surfaces are rotated, grease is slowly pushed aside. With continued movement, contamination in the form of concrete slurry can enter the bearing area and mix with the remaining grease to form a corrosive, abrasive paste. Even though grease is present, the protective properties of the grease are lost. Contaminated grease has the abrasive properties of sandpaper, so continued movement causes severe wear and permanent damage to the affected bearing and seal surfaces.

Because greases' protective properties in wet-mix pump applications are temporary, to be effective, grease must be continuously replenished before mixing actions alter the grease layers' beneficial properties. To accomplish this, grease intervals must occur far more frequently than most operators realize. Because unintentional mixing of concrete slurries and grease does not occur with typical construction equipment, most mechanics and operators are unaware of the required timing of grease replenishment for wet-mix pumps. Even veteran operators may not be able to accurately pinpoint the optimum interval to replenish grease.

Wet-Mix Grease Requirements Are Unique

Experience proves, despite a rigorous greasing regimen, abrasive concrete slurries will still manage to enter, contaminate, and damage critical seal and bearing surfaces.

Once past the seal, concrete slurries tend to harden, and will quickly plug the small grease replenishment grooves within the bearing surface, effectively ending the component's ability to accept future grease. Without sufficient grease, abrasion and corrosion will permanently damage the affected bearing surfaces.

At this point, complete breakdown and disassembly is the only viable option to prevent a major bearing failure.

This is why wet-mix pump grease requirements are unique. In addition to normal replenishment, greasing during the washout process is required to flush accumulated slurry residue from bearing surfaces before it can harden.

During each washout, concrete slurries and contaminated grease must be flushed from seal and bearing surfaces by vigorously adding additional grease until a clean flow of grease is visible outside the seal surface. If this critical step is omitted even once, slurry residue can remain and harden within the sealed bearing assembly. Countless major failures can be directly attributed to improper on-the-job wet-mix pump greasing/flushing procedures.

To provide optimum bearing service life, lubrication of the greaseable components of a wet-mix pump requires two distinct steps. The first step is rigorous grease replenishment during use. Manufacturers may recommend specific intervals; however, veteran operators replenish grease far more often. Because excess greasing cannot damage wet-mix equipment, it is best to be safe.

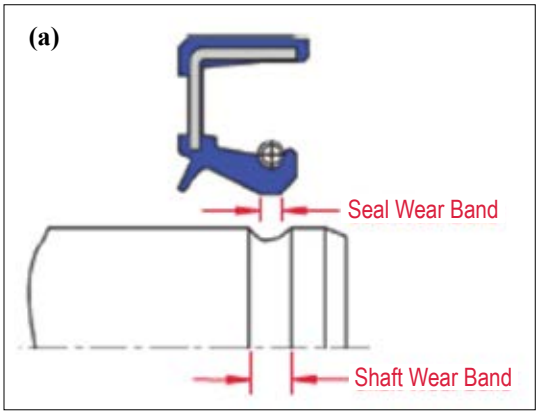

Fig. 4: (a) Note tight conditions within sealed bearing assembly; (b) bearing shaft showing significant corrosion and wear

The second step, flushing at the washout, is time-sensitive. To be effective, concrete slurries must be flushed from bearing and seal surfaces before they begin to harden. Stroke the pump in reverse and add grease until fresh, clean grease exits all bearing surfaces. If this critical step is missed even once, trapped concrete slurry residue can harden and clog grease replenishment channels within the bearing, making future greasing impossible.

Generic automatic lubricating devices are available and can be fitted to wet-mix pumps. Unfortunately, these devices can provide a false sense of security. Although effective at replenishing grease, their proper operation is difficult to validate; a costly bearing assembly failure may be the first sign of an automatic lubricator malfunction. Additionally, lubricators are not programmable to facilitate flushing during the washout procedure. Pumps fitted with automatic lubricators must use the manual override feature to flush bearing assemblies during washout.

What if a Fitting Will Not Accept Grease?

At normal temperatures, all grease fittings should readily accept grease. Wear, contaminants, or external damage can prevent a fitting from accepting grease. Try a new fitting and a more powerful greasing device in conjunction with heat and vibration to free up clogged grease channels. However, bearing assemblies which will not accept grease are often blocked with hardened residue and will require complete disassembly.

The most common cause of major bearing failure, hardened concrete residue within bearing assembly, is completely preventable by the use of proper on-the-job lubrication practices.

In closing, wet-mix pumps, properly lubricated, may provide many years of trouble-free service, or conversely if not maintained require frequent major repairs. Proper daily on-the-job lubrication procedures are the single largest factor determining your pump's long-term performance and durability.

Wet-Mix Lubrication Checklist

- Verify oil, hydraulic fluid, and water-box lubricant levels before every startup.
- Use the manufacturer-recommended grease or a good-quality, water-resistant grease.
- Train all operators of on-the-job lubrication requirements. Be sure a functioning grease gun

Fig. 5: Properly lubricated outlet bearing assembly at 3000 hours displays no visible wear

and a supply of grease is ALWAYS available.

- Know the location of all grease fittings, even the hidden ones.
- Be sure ALL grease fittings are functioning properly and readily accepting grease. If a fitting will not accept grease, immediately take necessary steps to restore greasing function.
- During EVERY washout, completely flush all concrete residue from bearing assemblies before it can harden. Stroke the pump in reverse and add grease until fresh, clean grease exits all bearing surfaces.

*ACI Certified Nozzleman **Oscar Duckworth** is an ASA and American Concrete Institute (ACI) member with over 15,000 hours of nozzle time. He has worked as a nozzleman on over 2000 projects. Duckworth is currently an ACI Examiner for the wet- and dry-mix processes. He currently serves as ASA Executive Committee Secretary and newly appointed Chair of ASA's Education Committee. He continues to work as a shotcrete consultant and certified nozzleman.*

Fig. 6(a) and (b): Swing-tube shaft and outlet bearing assembly is totally destroyed at 1600 hours due to poor on-the-job lubrication practices. Note hardened concrete residue has clogged grease grooves of outlet housing on right