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Lubrication of Wastewater Treatment Plants

Proper maintenance of the equipment in wastewater disposal has become more important and more complex. There have been many new technical developments (some mandated by the EPA, OSHA and the USDA/FDA) as well as new equipment put into use. The impact of federal legislation dealing with water quality and pollution has had a major effect on wastewater engineering. There is a much greater emphasis on the reuse of wastewater and land treatment systems. Tertiary and advanced treatment systems are becoming standards rather than utopian ideas.

All of this advancement and sophistication demands more highly trained people and much better knowledge and practices in the field of maintenance and lubrication. More complex machinery and processes require better knowledge of lubricants and their application. Lack of knowledge in either area can create problems, but especially in application. It can cost four or five times as much to apply the lubricant as it does to buy the lubricant.

Lubrication is the lifeblood of any mechanical system. It is especially significant with wastewater disposal systems, where lubricants are constantly harassed, diluted or destroyed by water, sand, dirt, dust, acids, caustics, cold, heat and the dynamics of the chemical processes involved. A judicious selection of quality lubricants is the key to reducing energy consumption, prolonging equipment life, and reducing associated costs.

Overcoming Friction

To begin, however, we should look at the reason why we lubricate – to overcome friction.

Solid Friction (Sliding)

The result of moving one solid body across another is solid friction, also known as “sliding friction.” This resistance to motion is caused by the rubbing of tiny, rough projections or asperities, on the surface of all solid bodies. These

projections are readily apparent on a brick or rough timber and can be seen under a microscope on the most smoothly polished wood or metal. Even bearing surfaces that appear clean and smooth have asperities that cause friction. Hence, we arrive at a simple definition of lubrication – the substitution of solid friction with fluid friction.

Fluid Friction (Shear)

Most lubricants are fluids. When solid surfaces are separated by fluid, the form of friction changes from solid to fluid. Fluid friction is the resistance of the fluid to being separated or moved. The particles composing the fluid stick together or show cohesion. When two bearing surfaces move, the lubricant molecules must move across each other. This resistance to moving, also known as “shear,” is fluid friction. Compared to solids, fluids cause little friction because they are composed of easily separated, smooth particles. When a fluid lubricant is used between two solid surfaces, these particles fill up the spaces between the projections and, in effect, smooth out the solid surfaces.

The thicker or more cohesive a lubricant, the greater the friction or drag, or the greater the resistance to flow. Resistance to flow is also a definition of viscosity. Therefore, the thicker or more cohesive a lubricant, the greater its viscosity or consistency. This means that the heavier an oil is, the greater its fluid friction. In addition to being cohesive, a lubricant should be adhesive. It must stick to metal or have the ability to coat metal. This combination of cohesion and adhesion is what makes the lubricant resist being squeezed out of a bearing. It determines whether or not the lubricant will maintain an unbroken film between rubbing surfaces.

Lubricant Selection

From this discussion, the first rule of lubrication becomes obvious. "Use the lightest possible weight lubricant consistent with the application." In other words, the best lubrication and least amount of friction will come from the thinnest lubricant that has sufficient film strength to carry the load.

In order to be able to select the correct lubricants, all maintenance and lubrication personnel should have some familiarity with specifications. This is not to advise buying on specification, because quality lubricants can perform far better than most specification lubricants. However, it is helpful to be familiar with the physical characteristics of lubricants such as those listed below.

Oil Characteristics

- **Viscosity** is the thickness or weight of oil, defined as resistance to flow and measured by time.
- **Viscosity index** is the rate of change in viscosity in relation to temperature. All oils thicken when cold and thin when hot, but at different rates. The higher the viscosity index, the less the viscosity changes with temperature change.
- **Flash point** is the elevated temperature at which vapors begin to come off the oil and an open flame will flash the vapors.
- **Pour point** is that temperature below which the oil will not pour, or will flow very slowly, after a period of time.
- **Oxidation resistance** is a measure of the life of the oil. Oxidation is often measured by the degree of acidity of the oil after exposure to heat, air and catalysts. The amount of change in acidity will provide an indication of oil life in service.

Grease Characteristics

- **Penetration** is the distance that a cone of specific shape and weight will sink into grease in five seconds. It functions to assign an NLGI grade to a grease, but does not measure texture, such as buttery, tacky, fibrous, etc., nor does it indicate any performance characteristic.
- **Dropping point** is the temperature at which the first drop of oil from the grease runs out of the test cup under prescribed conditions.
- **Base soap** is the thickener used in oil to make grease. The type of soap determines some of the grease characteristics.
- **Base oil viscosity** determines some of the grease characteristics. For example, heavy oils are good for heavy-load and slow-speed applications, while light oils are better for low-temperature or high-speed use.
- **Stability** is measured by the change in worked penetration, which is measured by ASTM D1831 (also known as the Shell roll test). This test measures the greases's ability to withstand working, shearing and turbulence in bearings without changing consistency.

Lubricant Recommendations

Basic products needed in a wastewater treatment plant are electric motor grease, tough multipurpose grease, EP gear oil, R&O turbine oils and engine oil. There may be more than one viscosity of gear oil required, as well as two grades of turbine grade industrial oil and possibly lighter or heavier grades of other products. Cross recommendations can be made, e.g., gear oils for oil-lubricated electric motors and some turbine oils for gears. Turbine oils also can be recommended for most other oiled points.

In a typical wastewater treatment plant process, the unit group of electric motor, gear reducer, coupling, and then pump, blower, etc. is repeated over and over, with minor differences incorporating couplings and chain or belt drives. These unit groups are interspersed with equipment of various configurations. Other major groups would be air generation, engines for power and heat generation and miscellaneous equipment.

Gear Reducer

Following is a list of equipment types commonly found in wastewater treatment facilities and the lubricant types recommended for each. Many of these pieces of equipment can use the same lubricant. Whenever possible, consolidation is recommended in order to reduce inventory, availability concerns and chances of misapplication. Lubricant consolidation also can reduce costs by eliminating specialty products and enabling the purchase of fewer products in larger volumes.

- **Electric motors** will range in all sizes from fractional horsepower to several hundred horsepower. They may be grease- or oil-lubricated. If grease, a top-quality, stable, water-resistant, high-melting-point product should be selected. A good choice would be an NLGI 2 complex grease with rust and oxidation (R&O) inhibitors and extreme pressure (EP) characteristics. If oil is used, it should be an R&O turbine oil with anti-wear additives. Certain gearboxes will require the same type of oil, and the same grade might be able to be used for both the motors and the gearboxes. Other gearboxes will use an EP gear lubricant that might be suitable for electric motors, thus reducing the number of lubricants.

- **Gear reducers** are used in conjunction with electric motors all over the wastewater plant. Most of them will call for an SAE 90 mild-EP lubricant. Many are subject to water contamination, so the best quality oil should be selected, one that will not emulsify with water, allowing excess water to be drained off. Some gear manufacturers prefer non-EP, R&O turbine oils. The possibility of changing these units to gear oil should be investigated in order to use a single product for all enclosed gears.

- **Chain drives** are efficient, economical and versatile. They can be lubricated by hand, drip, bath or spray. The American Sprocket Chain Manufacturers Association recommends oil for chain lubrication. Turbine oils and gear oils would be appropriate. It is important that the pin and bushing be lubricated, so penetrating qualities are desirable. The oil should have good R&O and anti-wear qualities. In certain applications, spray-on grease or solvent cutback greases can be used. For some chain drives – as well as some gearboxes, conveyors, pumps and couplings – there may be grease-lubricated points that require a tougher grease than the grease for electric motors. This grease should be a multipurpose, EP, waterproof grease with a high melting point.

- **Pumps** may be rotary, piston or turbine type and are usually grease-lubricated except the turbine types, which are drip-oil-lubricated at the lower bearings and greased at the top. A multipurpose grease should be used for its sealing ability and impact resistance. Turbine pumps use an R&O turbine oil.
- **Air compressors** are numerous in any large treatment plant. There are banks of them to supply air to the sludge aeration areas, and individual units scattered throughout for various needs. Different types in use include rotary units that use a light oil and reciprocating units that use a heavier oil. Whether light or heavy, the oils should be of the same turbine grade quality, incorporating R&O and anti-wear characteristics. These oils should be long-lasting with low-deposit tendencies.
- **Rotary blowers** can be lubricated with grease or oil. If grease, it should be the tough multipurpose type. If oil, it should be an R & O turbine oil.
- **Gas, diesel or dual fuel engines** are used to drive air compressors and generators and sometimes serve as a source of heat. Gas or dual fuel engines are often powered by the methane generated in the sludge digestion process. A top-quality engine oil will normally be used for these engines. Some gas engines require a low-ash oil, but it should still be of the same quality. Some branded oils have special additives and inhibitors and far outperform conventional oils. Using these can reduce lubricant, maintenance and energy costs. Small gasoline engines can use the same engine oil selected for larger engines.
- **Conveyors** often are the combination of electric motors, gear drives and chains, and the previous recommendations would apply.

Air Compressor

- **Couplings** can be either grease- or oil-lubricated. A multipurpose grease or turbine oil is recommended.
- **Construction equipment, trucks and tractors** should come under the maintenance and lubrication program with the same consideration as stationary equipment. Quality engine oils, tough multipurpose grease and long-life gear oils should be used. The best products will reduce downtime and extend life.

Maintenance Program

Overall, and of great importance, is the concept of planned lubrication and maintenance. This should begin with the installation or initial use of any piece of equipment. For example, when gearsets are initially placed in operation, they should be run for brief periods of time with no load, or light loads, if possible. This applies equally to mobile and stationary equipment.

On any new gearbox or any piece of equipment, the initial fill of lubricant should be drained after a short period of operation to remove contaminants and initial wear metal. A reasonable drain period, or relubrication period, should be established and maintained. The drain period should be related to operating temperatures, load, contamination and other influences. Under extreme or severe conditions, the drain period should always be reduced.

The maintenance personnel should be aware of normal operating temperatures. If a bearing cap that can normally be touched suddenly becomes so hot it cannot be touched, then something is wrong and should be investigated. Records should be carefully kept on each piece of equipment. Each lubrication and maintenance or repair function should be recorded separately. With this information, extended drains or energy saving lubricant packages can be evaluated.

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