Pollution and hydraulic fluids: what you should know

Here are six terms used in environmental laws and regulations to describe the condition of plant effluent, which usually contains hydraulic fluids. It is cheaper to keep hydraulic fluids out of plant effluent through improved maintenance.

William Millett

There's a special nomenclature that hydraulic fluid users need to know if they are to understand what they're up against with pollution laws and regulations. These terms include: biodegradability, BOD, COD, PPM, pH and TLm. You may be familiar with two or three of these, or maybe all. They've had a great deal of publicity.

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Describing Pollution

Biodegradability is the most commonly used and misunderstood term. An organic compound capable of being oxidized by micro-organisms is said to be biodegradable. The eventual end products of biodegradation are oxygen and carbon dioxide. But the word, "biodegradable" doesn't tell you anything about time or degree. It doesn't say how fast or slow. And some compounds or mixtures are only partly biodegradable.

Hydraulic fluids are no longer "just oil". With the advent of fire-resistant hydraulic fluids and multiple oil additives, hydraulic fluids now are often chemicals or mixtures of chemicals and petroleum oil. Some are partially biodegradable, others hardly at all. Some fast, some very slow. That's why biodegradation of non-petroleum type hydraulic fluids should be specifically discussed in such terms as - does it occur? and, if so, how much and how fast? This takes us to the next term.

Biochemical?

BOD is Biological Oxygen Demand, or the amount of oxygen consumed by microorganisms that act to oxidize a waste. The process can be called biodegradation. It is an oxidizing process with the microorganisms doing the work, but requiring available oxygen to function.

BOD of a waste water is measured by treating (innoculating) the water with known microorganisms and observing the quantity

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oxygen consumed over a specified time at a specified temperature. Typical tests are at 20 C (68 F) over a 5-day period. This test is specified in the American Water Works Association book "Standard Methods for the Examination of Water and Waste Water." Results of such tests are the commonly used standards of reference when BOD is discussed.

Closely related to BOD is COD, Chemical Oxygen Demand. They both have the "oxygen demand" in common. But in the case of COD it is a chemical rather than a biological process that is involved. COD refers to the oxygen required for oxidation of oxidizable material in a waste water by chemical means. Although COD is not related to biodegradability, it does provide a point of reference with respect to the oxidizable matter in a waste water.

To measure COD, potassium dichromate, an oxidizing agent, is normally used. The quantity of oxygen required to completely oxidize all oxidizable matter is measured.

Coupling BOD and COD Values

An examination of BOD and COD values can help show how much oxidizable matter is present in a waste stream and the degree to which it is biodegradable under prescribed conditions. A low BOD coupled with a low COD indicates relatively low levels of oxidizable organic coumpounds. A low BOD coupled with a

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high COD indicates high levels of organic compounds that are not readily biodegradable. High BOD and COD values indicate relatively high levels of contamination and a high degree of biodegradability.

Note that high BOD values go had in hand with ease of biodegradability. Conversely, we cannot expect low BOD values and biodegradability from the same system. Thus, the cry for biodegradable products with negligible BOD is seen to be contrary to the laws of nature. There's more about how this applies to hydraulic fluids later on.

Another pollution term is PPM, which stands for parts per million. One part per million is the same as one milligram per liter. Here's a simple way to visualize that. If you put a one-ounce shot glass of vermouth in an 8000-gallon tankcar of your favorite gin, you'd have a 1-PPM martini. So you can see that 1 PPM is pretty small.

It's difficult to measure with precision in many tests, yet pollution control standards call for exact PPM measures. Concentrations of contaminants in waste water are normally expressed as parts per million as are values for BOD and COD. Levels of some chemicals as low as 1 PPM can be quite a problem in a small stream or in drinking water.

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The term pH is a familiar one. It's a measure of acidity or alkalinity of water solutions, and ranges from 0 to 14. Seven is neutral, above seven is basic or alkaline, below seven is acid. Each number more or less than seven represents increasingly more powerful acidity or alkalinity. That's why many states limit the pH range of waste water.

Fish Kill Test

Toxicity is also important in discussing hydraulic fluids because these fluids often end up in streams or other public waterways. (And because humans handle them, although that's a different topic.) There are many ways to measure toxicity. The measure we use is based on the possible hazard to vegetative and marine life, if hydraulic fluids in a plant effluent are eventually released into a stream.

A standard "fish kill test", described in the reference book mentioned earlier, is used as the measurement. Bluegill fish swim in various PPM-solutions of test waste under standard conditions. The number of dead fish is counted and expressed in terms of the concentration (PPM) that permit 50% of the fish to live 96 hours. This would be a TLm96. A TLm96 of 100 ppm, for example, means that at a concentration of 100 ppm, 50% of the bluegill fish survive at least 96 hours. The higher the TLm 96, the less toxic the liquid.

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How to Treat Petroleum Oils

Now, how does all this apply to hydraulic fluids? First, let's consider petroleum oils. ~~Hydraulic fluids~~ They also ~~are~~ essentially non-biodegradable so it has no BOD. It's insoluble, so can't be tested for TLm in standard procedures. pH isn't a problem. Yet it is a pollutant because it floates to form a slick over water surfaces, blocking oxygen. Also, small amounts of oil remain dissolved or suspended in the water. This can be measured. The oil content can be removed by extraction with hexane and represents a portion of the "hexane extractables". Typical state legislation limits hexane extractables to between 15 and 30 PPM into a stream, or 100 PPM maximum into a sewage treatment plant.

Oil is normally separated from plant effluent by skimming or a similar process, then reprocessed or burned. Thus the major considerations with oil are the volume that is dispersed with effluent, collecting and separating it, and reusing or disposing of it.

Leakage of petroleum oil fluids can be controlled at the source with adequare attention to maintenance procedures, including the use of efficient sealing materials. Thus, control of petroleum oil hydraulic fluid pollution is technically feasible now, and increasingly implemented.

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Emulsion-Type Fluids

Emulsion-type fire-resistnat fluids must be split and separated. Treatment with acid or certain salts will do this. The oil layer is handled like petroleum oil. The water layer should be neutralized to a pH of seven. Then, it should be tested for BOD, COD, and toxicity.

Typical regulations require control of effluent pH into a stream to a range of 6 to 10 and suspended solids to a maximum level of 45 ppm. Also, effluent BOD values are often limited to a specified maximum. Effluent going into a sewer has broader latitude. But the basic point is to test the water layer, find out what's in it, and match this against regulations. If it doesn't meet regulations, dilute it or provide proper treatment.

Water-Glycols

Water-glycols are completely water soluble, unlike oils, so they present a didferent set of problems. Here, BOD, COD, pH, TLm and other measures can be made. Water-glycols have BOD values ranging from 50,000 to 500,000 PPM. Consequently, when concentrations are high, they must be diluted, reduced, or degraded before they are allowed to enter a stream.

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The best way to reduce BOD stemming from hydraulic flu ids in plant effluent is to change and tighten sealing to prevent the leakage. This saves money, too, because less fluid is used. Savings can pay for the extra maintenance. If your plant has tertiary treatment facilities, water-glycols are readily treatable. Water-glycols usually have highly suitable TLm's. They run from 500 PPM up, which is considered relatively safe.

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Phosphate Esters

Phosphate esters are insoluble in water and heavier than water. So they can be settled out in collecting lagoons and reprocessed. Because of their insolubility, typical industrial aryl phosphates biodegrade slowly, but there is a very real oxygen demand. A typical BOD value is somewhere around 35,000 PPM oxygen, which shows significant biodegradation.

TLm values of phosphate esters are not easily determined because the fluid is essentially insoluble in water. Depending on the procedure and the particular ester, TLm96 values range from 60 to 500 PPM, which represents a higher level of toxicity than water-glycols, but well within acceptable ranges for commonly used industrial products.

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Preferably, phosphate ester contamination should also be eliminated at the source through proper maintenance practice. Alternatively, they should be removed by settling. If this is

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done, the small residual quantities that remain will usually fall within the limits set by most regulating agencies. There's no evidence that phosphate esters persist in the environment, or build up in the food chain, so they are not an environmental hazard as employed.

Petroleum Fractions and Phosphate Esters

Some hydraulic fluids are combinations of selected petroleum fractions and phosphate esters. In effluent traps or settling ponds, they will rise to the surface where they can be removed and treated as oil. BOD and fish toxicity considerations that apply to oil and phosphate ester apply to these fluids.

Chlorinated Hydrocarbons

Some hydraulic fluids contain chlorinated aromatic hydrocarbons.

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BOX

How to Reduce Hydraulic Fluid Pollution Immediately

A plant can take steps immediately to minimize hydraulic fluid pollution:

- locate leaky seals and replace them.
- tighten the system to minimize all sources of leakage.
- install collectors or drains to isolate any fluid that leaks out of the system.

In most plants, this is enough to solve a problem, if one exists.

We're convinced the eventual answer to hydraulic fluid pollution is to keep fluids in the system, where they belong. In the meatime, leaking fluid should be contained, and kept out of general plant effluent. If you can keep it separated, it can be reconstituted, treated separately, or released slowly into effluent to meet requirements.

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Pollution Glossary for Fluid Power Designers

API Separator: A facility for separation of oil from waste-water by gravity differential and equipped for recovering the separated oil and removing sludge. Developed by the Committee on Disposal of Refinery Wastes of the American Petroleum Institute.

Biochemical Oxygen Demand (BOD): The amount of oxygen utilized by organisms in the biochemical oxidation of organic matter in waste water in a specified time and at a specified temperature. BOD is determined entirely by the availability of a wastewater component as a biological food and by the amount of oxygen utilized by the microorganisms during oxidation. Hence it is not related to chemical oxygen demand.

Biodegradable: Capable of being oxidized by microorganisms.

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Biodegradation: Metabolic utilization by microorganisms of a component in a wastewater stream.

Biodegradation System: A waste treatment facility or system in which undesirable components of the flow are removed by biological means, such as living organisms in an activated sludge unit.

Biological Oxygen Demand (BOD): See Biochemical Oxygen Demand.

Chemical Oxygen Demand (COD): A measure of the oxygen equivalent required for oxidation by chemical means of organic and oxidizable inorganic matter in wastewater, corrected for the influence of chlorides present.

Clarification: A process in which suspended material is removed from a wastewater. This may be achieved by sedimentation, with or without chemicals, or filtration.

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Dissolved Solids: Chemical substances either organic or inorganic that are dissolved in a waste stream and which constitute the residue when a sample is evaporated to dryness.

Ecological Balance: Status of the mutual relations amoung organisms and between them and their environment.

Emulsion: A hetrogeneous system consisting of one liquid dispersed in the form of fine droplets in another liquid in which it is insoluble. Unaided separation of the two liquids occurs very slowly.

Gravity Separation: Separation of suspended material from a waste-water flow by settling under quiescent conditions. This procedure is based on the mechanism of gravity differential, the gravity difference between the suspended material and the water carrier.

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Oxidation: A chemical reaction or process in which oxygen usually is added to a substance. For example, sodium nitrite ($NaNO_2$) is oxidized to sodium nitrate ($NaNO_3$) or phenol (C_6H_5OH) is oxidized to carbon dioxide (CO_2) and water (H_2O).

Parts Per Million (ppm): The unit commonly used to designate the concentration of a contaminant or substance in a waste water in terms of weight, for example, one pound per million pounds, etc. Ppm is synonomous with milligrams per liter (mg/l) which is replacing the term ppm.

Sedimentation: The process of subsidance and deposition of suspended matter from a wastewater by gravity.

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Segregation: The act of separating and keeping apart one waste stream from another.

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Settleable Solids: That portion of the suspended solids in a waste stream capable of settling in unit time.

Suspended Solids: Solid particles or insoluble liquid droplets suspended in a waste flow. Also, the quantity of insoluble material obtained by filtering a quantity of waste through a filter.

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Should we credit API & ASLE for the Glossary?

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