Compressed air condensate

Keep it out of your waste water stream, keep yourself out of trouble with the EPA

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Do you know where your compressed air condensate is? Do you know if it is breaking the law? Are you breaking the law by not knowing the answers to these questions?

Over the last several years, most compressed air system users have been "hammered" with questions like these from vendors selling a solution to a complex problem. They use shock words to make you aware of the true situation:

- all compressed air systems generate condensate
- lubricated compressor systems will leave oil in the condensate
- the quantity of oil must be addressed to be in compliance with local, state, and Federal environmental regulations
- whether non-lubricated compressed air systems may have oil in the condensate depends on the quality of the air entering the compressor and what is injected into the air downstream of the compressor.
- most condensate from oil-free systems is "clean" by today's standards.

Source of condensate

What is the source of the condensate in a typical compressed air system? It is present, as humidity, in the air to be compressed that enters the system. Pressurizing humid air reduces its ability to retain moisture in the vapor state. Hence, the excess condenses from the vapor state to the liquid state.

Every component in the air stream, including the mechanical separators, receivers, coalescing filters and refrigerated dryers, serve as collection sites for the compressed moisture that was present in the ambient air. The condensate is a mixture of water and some amount of some type of lubricant. Since the condensate has a measurable oil content, for purposes of disposal, it is classified as "oil".

The average compressor system generates condensate with a 50 to 1 ratio of water to oil. Assume that you collected 100 drums of raw condensate. Without effective separation, you will have 100 drums of material that must be treated as if it was oil. With effective separation, on the other hand, you will have 98 drums of water that can be legally and safely drained away and only 2 drums of oil to handle.

Consider an example that assumes the ambient conditions are 70°F and 80% relative humidity. A fully loaded 100 hp compressor with a refrigerated dryer running for 3 shifts to provide 100 psig can produce 3.5 to 4.0 gallons of condensate per hour. This is equivalent to 75 or 80 gallons per day.

Oil handling costs may vary from 0.25 to 1.50 dollars per gallon. Without separation, this is a substantial expense—20 to 120 dollars per day. With separation, the oil handling cost would be 0.40 to 2.40 dollars per day. Therefore, it does not make economic sense to pay to dispose of the unseparated waste condensate. This sets the stage for a great opportunity for savings, and as is often the case, a great opportunity for risk. Regardless of who sells you the separation equipment, regardless of the claims made to induce you to purchase, regardless of your hopes and expectations, the responsibility for handling the waste water known as condensate, the responsibility for remaining in compliance with environmental regulations rests with the owner of the air system—the generator. Any fines and penalties that are levied accrue only to the generator. It behooves anyone concerned with this issue to become familiar with the applicable rules and regulations, the basic technology, capabilities, and limitations of the oil/water condensate separators and the vendors that sell them.

Regulation and separator overview

In most cases, compressor condensate gets dumped to either a publicly operated treatment works or to a company's storm water system. Discharges to waterways from publicly operated treatment works are regulated by the State. The Federal EPA backs up the State regulations with guidelines and enforcement. The publicly owned treatment works must file the same National Pollutant Discharge Elimination Permit that any large firm with storm water runoff is required to file. EPA guidelines covering pretreatment standards and the treatment works itself regulate industrial discharges to the publicly owned treatment works for specific industries.

Generally, water discharge requirements to a treatment works mandate a maximum oil/grease concentration from 0 to 250 parts per million as determined by EPA Method 413.1 or 413.2.

The State, through the National Pollutant Discharge Elimination System permitting process, regulates storm water discharges. The EPA recommends handling oil/water with the Best Available Technology.

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method with the tightest limits and is generally the technology of choice. Each State is required, by its acceptance to administer the permitting process, to have a guideline for oil and grease limits. The Federal standard is 10 parts per million (maximum) but the State standards can be stricter.

**EPA intent**
The environmental policy of the United States is broad and complex. Throughout the maze are at least three recurring themes that relate to the air compressor condensate question:

- Waste fluids are best treated or eliminated at the site of generation. Transportation on roads is accepted but clearly not preferred.
- Once generated, the liability for the waste fluid rests with the generator. The “waste hauler” has some liability, but the generator still receives the bill if the fluid is disposed of improperly.
- Putting waste on the ground contaminates the soil and the ground water. The contamination must be removed before the property title changes hands. The generator gets the bill.

**Alternative to treatment**
The alternatives to treating the waste condensate are sanitary sewers and waste haulers. Sanitary sewers dump to the local publicly operated treatment works. The treatment works have specific oil/grease regulations for the influent they will accept and the regulations vary widely by locale. In general, air compressor condensate will need some level of treatment if it is to be dumped to a sanitary sewer. Some generator’s policies call for treatment beyond the requirements of the local sewer district requirements.

Waste hauling is frequently used for waste air compressor condensate. The cost of this option ranges from 0.25 to 1.50 dollars per gallon.

**Separator equipment overview**
There are several technologies to separate oil from water. These include gravity separators, gravity pre-separation with coalescing filters and carbon afterfilters, membrane separation, nanofiltration, gravity pre-separation with prefilters and membrane ultrafiltration. The list goes on.

**Gravity with carbon**
This approach ejects the depressurized condensate to a specially designed tank fitted with a dirt catch basin, baffles to control flow, and separate drain ports for the oil and the water. In this equipment, any oil not in solution or suspension will float to the top of the tank to be removed with a skimmer.

The advantage of gravity-based units is that they are economical and simple to maintain and operate. The disadvantage to this type of technology is that it is not effective on oils in suspension or in solution. It also shows limited success with oils with a specific gravity close to that of water.

A gravity separation system with a large activated carbon afterfilter can deliver effluent with a hydrocarbon concentration as low as that from any other method. The activated carbon has a limited life that depends on the type and quality of the oil. The system continues to operate well as long as the activated carbon filter is fully charged with fresh carbon as required.

There is no way to tell if the activated carbon is saturated with contaminant other than by testing the effluent on a regular basis. If saturated, the loaded carbon must be disposed of in a legal manner.

**Gravity with coalescing and carbon**
These separators use a gravity separator as a first stage of treatment followed by a uniquely designed coalescing filter to remove the dissolved or suspended oils. The coalescing filter collects and removes the larger size particles in suspension. Then, the second filter element, the activated carbon, removes the smaller particles from suspension by a process of adsorption.

When properly applied, designed, and operated, these separators are effective in removing free oil and unstable oil suspensions or emulsions from the water. Besides good performance, this system offers simple maintenance and low maintenance cost.

This approach, however, will not remove stable oil emulsions or dissolved oils. For example, effluent oil concentration can be as low as 15 milligrams per liter for petroleum oils, 15 to 20 mg/l with diester synthetics, and as high as 300 mg/l with soluble synthetics. As with the gravity type of separator, if given sufficient carbon capacity, the system can meet the discharge requirements but the economics may not be there.

**Membrane separation**
The major groups of membrane separation technologies are microfiltration and ultrafiltration. There is also a relatively new technology called nanofiltration. Microfiltration and ultrafiltration refer to selective filtration on the basis of molecule size.

Nanofiltration selectively separates the water from the contaminants on the basis of molecular structure and characteristics like polarity using a polymeric membrane designed to prohibit passage of a particular element or group of elements. The separation is not based exclusively on size.

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ogy is a low pressure process—50 to 100 psig—that pumps waste water to the inside of hollow tubular membranes. The inside of the hollow fiber has a special coating selected for the application. The purified water passes through the membrane walls while the waste concentrate passes out through the length of the hollow tubes.

Gravity with prefilters and ultrafilters
These units include a gravity removal section for free oil, a surge tank section, circulation pump, prefilters, and a membrane ultrafilter. With the exception of stable emulsions and soluble oils, these units can handle most lubricants and can deliver consistently acceptable levels of oil removal economically.

Ultrafiltration uses membrane filtration through microscopic pores to separate the constituents on the basis of molecular weight and size. The water is forced out through the pores and oil and other concentrates, other than stable emulsions and soluble oils, remain in the tube and pass to the waste outlet. The life of the ultrafilter is dependent upon the inlet waste concentration to which it is subjected.

Gravity with prefilters and ultrafilters
These systems use a gravity removal section for free oil, a surge tank section, circulation pump, coalescing filter and a nanofilter. They claim an ability to successfully separate the most common rotary and reciprocating lubricants, including polyglycols. Their separation performance meets or exceeds current compliance requirements anywhere in the United States.

Commercial nanofiltration units available today claim the ability to economically handle most common compressor lubricants including stable emulsions and soluble oils while delivering a consistent carryover of 10 milligrams of oil per liter, or less.

Distillation
This type of oil/water separator works by exposing the mixed condensate to a continuous low level of heat input sufficient to evaporate the water but not sufficient to significantly vaporize the oil. The water vents to atmosphere in the form of uncombined water vapor. The remaining oil is ready for removal and disposal. Distillation separators will handle every form of oil—free, emulsions, and solutions. Another advantage is that

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For example, a sample of the hydraulic fluid can be evaluated to determine the degree of contamination which can foretell approaching problems.

A periodic slip test can be performed to check the current volumetric efficiency of the system's components. If your unit's volume drops, or there is considerable shock present, or if your unit is not functioning properly, an electronic profile can be taken on a recorder and compared to the original specifications indicating areas of possible concern.

If it is determined that major repairs are required, you should consider using Oiligear's Factory Exchange Program where a remanufactured exchange pump is shipped to you while you keep running with your worn unit. After you make the exchange, you send your worn unit to Oiligear where it will be remanufactured and placed in our exchange inventory.

Field repair, factory remanufacturing and factory exchange are three methods Oiligear offers to help your maintenance crews keep downtime to a minimum.

Delivery time will depend on the type of unit involved, its controls, and whether your unit is to be remanufactured or exchanged. Oiligear maintains a multi-million dollar inventory of basic "D" pumps for same-day to three-day delivery on standard exchange pumps. Standard remanufactured pumps require from one to four weeks for delivery.

For more information on Oiligear's "Stay on Steam" Program, write for Bulletin #10901 or call the Oiligear Company, 2300 S. 51st. Street, Milwaukee, WI 53234. Phone (414) 546-5880 or (414) 327-1700. FAX (414) 377-0532.
Spotlight: Compressors & Dryers

these units do not require continuing replacement of coalescing filters, activated carbon, or membrane modules. The units discharge no liquid water so there is no waste water issue.

The disadvantage of distillation separators is a higher initial cost and a continuing operating cost of energy.

Understanding the types of lubricants and the mechanism of condensate formation and separation aids in further analyzing the type of oil/water separation system might best fit the needs—both current and future.

Types of compressor lubricants
Compressor lubricants fall into one of the following classifications listed in the order of their degree of difficulty in separating from water:

- petroleum, mineral, or hydrocarbon oils,
- automatic transmission fluids,
- poly alpha olefins,
- diesters,
- and polyglycols.

The petroleum oils are immiscible and insoluble in water. Normally, they spontaneously float to the surface of the water. However, high shear in the compressor and certain additives can produce stable, difficult to separate emulsions of these otherwise insoluble oils.

At the other end of the spectrum are the polyglycol synthetic oils which have a solubility of about 600 milligrams per liter in water. These lubricants provide excellent compressor operation, long life, and low maintenance requirements but they are difficult to separate from water.

The lubricants between these extremes exhibit properties of intermediate characteristic. For example, automatic transmission fluids are similar to petroleum oils. Diesters are more easily emulsified but they are not soluble. Diesters have a specific gravity near that of water and they will not separate well through the action of gravity alone.

The oils and water mix by means of several mechanisms:
- dispersion of immiscible oils in water,
- emulsions in which the oil is strongly bonded with water,
- and solutions in which the oil is actually dissolved in water.

Further, additives in the lubricants prevent bacterial growth, rusting, corrosion, and emulsification. These additives can affect the selection of the separation process.

Summary
This technology is developing and new products are being introduced every day. The responsibility for discharging “clean” water to the environment rests entirely with the condensate generator. Selecting, installing, maintaining, and monitoring an effective condensate separation system is an important project for any company. It can carry significant cost saving opportunities and offers potential risk. It should be done in conjunction with knowledgeable, professional companies and consultants.

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