Mark Barnes

MIXING Part 2 Oil & Water:

Strategies for Removing Water

Water is a pervasive contaminant. Present in all but the most arid environments, the impact of water on equipment health and machine reliability can be devastating. In Part 1 of this article (Feb/March 2011), we examined the impact that water has on both the lubricant and its ability to support dynamic loads. In Part 2, we'll look at how we can control moisture under even the most extreme conditions.

Like any contaminant, the key to controlling water is to restrict its ingression as much as possible. While that may be easy to say, the reality of actually preventing water from entering a machine can be challenging, particularly in environments where water is used either as part of the manufacturing or cleaning process, or in ambient operating environments where moisture and humidity are commonplace.

The first place to start when trying to prevent water ingress is to look at access points, such as vents, breathers, fill ports, and seals. Most standard breathers or fill ports supplied by OEMs do a very poor job of preventing external contaminants from entering the machine and typically do nothing to eliminate water ingression. Breathers need to be upgraded to include both particle removing and desiccating media to help prevent both solid contaminants and moisture from entering the machine. In addition, fill ports need to be modified to allow oil to be added without opening the machine to the ambient environment. This is easy to achieve using quick-connects and custom adapters that replace conventional fill ports (Figure 1).

Figure 1: This fitting can be used to replace a standard fill port on a hydraulic or lube oil reservoir to allow for the non-intrusive addition of make-up oil. The breather port on top is fitted with a desiccant breather capable of excluding both particles and moisture.

In industries where severe levels of water or humidity are present, the use of hybrid breathers are recommended on any non-circulating system. This type of breather includes an expansion chamber, which serves to keep the machine sealed from the outside environment, while allowing for volumetric changes due to fluctuations in operating and ambient temperature (Figure 2).

Figure 2: Hybrid breathers help to keep non-circulating systems sealed from the outside environment.

Aside from breathers and fill ports, seals are the next most likely ingression points. Often, our machines are equipped with simple lip seals that offer little to no barrier to atmospheric moisture ingress. Where practical and where the cost can be justified, seals should be upgraded to exclusion seals, such as labyrinth or magnetic face seals.

In some industries, such as food processing or pharmaceuticals, sanitation is a fact of life. Often requiring the use of 300 psi of water pressure, elevated temperatures, and harsh chemicals and cleaners, sanitation is one of the leading causes of mechanical failure in any food production environment. Left unchecked, machines become "target practice" for errant hoses as the sanitation crew go through the nightly ritual of cleaning.

As much as possible, the sanitation crew should receive some very basic instruction on which parts of the machine to avoid with water spray. While not always possible, shaft seals, breathers, and fill ports are all areas that should not be directly sprayed if it can be avoided. If not possible due to the proximity to the production process or degree of contamination on the machine, provision should be made to plumb the fill port or breather to a location where sanitation is either not required or doesn't need to be directly sprayed. In some cases, a similar result can be achieved by using passive shielding: simple stainless steel covers that prevent moisture from hitting the machine surfaces.

Even with the most diligent efforts to exclude moisture, inevitably water will get into the machine in high-humidity or wet-process applications. So how can we remove water once it's been ingested? The answer depends on a number of factors, including lubricant type, sump capacity, and the ultimate level of water that is tolerable.

Where only gross water contamination control is required, it may be sufficient to allow the oil to sit on the bottom of the sump and be drained off periodically, particularly if the oil has good demulsibility and a long residence time in the tank. But in most cases, the oil will not de-train water fast enough, or water levels need to be kept much lower than simple gravity separation/drain will allow.

Under these circumstances, we need to look for other separation techniques, such as those outlined below and summarized in Table 1.

Coalescing Systems

Coalescing units come in many different sizes and designs. However, they all ostensibly work in the same way, containing an element or media that has an affinity for water. As the oil-water mixture passes through the element, the water is attracted to hydrophilic (water-loving) media. Once sufficient water has been absorbed onto the surface of the media, small water droplets combine to form larger droplets, which fall under gravity to the bottom and can be manually drained off. Effective for continual removal of gross water contamination from low-viscosity oils, coalescing units don't do so well when the water is held in a tight emulsion, which can occur with highly additized, heavily contaminated, or degraded oils .

Figure 3: Example of a skid mounted vacuum dehydrator

Water Removal Elements

For removal of water from smaller sumps, such as small pumps and gearboxes, water removal elements can be effective. Typically used in a filter cart or offline filtration unit, water removal elements contain a material that has an affinity of water. However, unlike coalescing units, water is absorbed directly into the media. Media include cellulose, molecular sieves, and special polymers similar in functionality to the polymers found in baby diapers that absorb and swell to trap water. Most elements can hold as much as a gallon of water and can be effective at removing free and emulsified water from smaller sump systems.

Centrifuge

Centrifuges are used in numerous applications to separate materials that have different specific gravities. Since most hydrocarbon oils typically have a specific gravity in the range 0.85 - 0.90, compared to 1.0 for water, centrifuges can be effective at removing water continuously, particular with lightly additized, low-viscosity oils. Centrifuges become significantly less effective where additized composition, oil age, or other contaminants create a tight oil-water emulsion, but they do a good job of removing gross water contamination in larger sump systems.

Vacuum Dehydration

Vacuum dehydrators work on a very basic principal: water and other liquids will boil at lower temperatures when the pressure is reduced. To illustrate this concept, consider the difference between the boiling point of water at sea level and in the mile-high city of Denver, Colorado. While water boils at 212 °F (100 °C) at sea level, water boils at around 203 °F (95 °C) in Denver due to the reduced pressure at elevation. Most vacuum dehydrators work at a pressure of -25 to -28 inHg, which is equivalent to just 1/15th the pressure at sea level. At -28 inHg, water will boil at just 80 °F (26 °C). In essence, a vacuum dehydrator is nothing more than a vacuum chamber with a vacuum pump and heating element. By lowering the pressure to -28 inches of mercury, while simultaneously heating the oil to 140-150 °F, water is literally boiled off of the oil without causing the oil to oxidize. Vacuum dehydrators come in a number of different sizes and configurations, from small ½ GPM portable units to larger 40-50 GPM permanently mounted units, but they all contain the same basic elements.

While vacuum dehydrators can be slow at removing large volumes of water, there can be little doubt that when it comes to removing water to low levels, vacuum dehydration is probably the best option. For lightly additized oils, such as turbine oils and transformer fluids, vacuum dehydrators can remove as much as 90-95% of all dissolved water, as well as free and emulsified water, resulting in levels of water often below 10-20 ppm.

Even with the most diligent efforts to exclude moisture, inevitably water will get into the machine in high-humidity or wet-process applications. So how can we remove water once it's been ingested?

In some industries and environments, water can be one of the leading causes of premature failure. Left unchecked, it can effectively reduce equipment life to just a fraction of its design life. But with some simple care and attention, water can be controlled, removed, and eliminated from machines, no matter how severe the environment.

Mark Barnes recently joined Des-Case Corporation, a leader in the field of contamination control and lubrication management, as Vice President of the newly formed Equipment Reliability Services team. Mark has been an active consultant and educator in the maintenance and reliability field for over 17 years. Mark holds a PhD in Analytical Chemistry and is a Certified Maintenance and Reliability Professional (CMRP) through SMRP. Visit www.descase.com.

	Water Removed		
	Free	Emulsified	Dissolved
Gravity Separation	yes		
Coalescers	yes		
Polymer Media	yes	yes	
Molecular Sieve	yes	yes	
Cellulose Media	yes	yes	
Centrifuge	yes	yes	
Vacuum Dehydration	yes	yes	yes

Table 1: Comparison of water removal methods

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May 17-20 - Seattle, WA
June 7-10 - Myrtle Beach, SC
June 14-17 - Denver, CO
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September 13-16 - Charlotte, NC
October 11-14 - Dallas, TX
October 25-28 - San Diego, CA
Nov 29- Dec 2 - Charlotte, NC
December 6-9 - Houston, TX

ANALYSIS I (ISO CATEGORY II)
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September 13-16 - St. Louis, MO
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December 6-9 - Charlotte, NC
December 13-16 - Houston, TX

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April 5-8 - Dallas, TX
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July 12-15 - Myrtle Beach, SC
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July 18-22 - Myrtle Beach, SC
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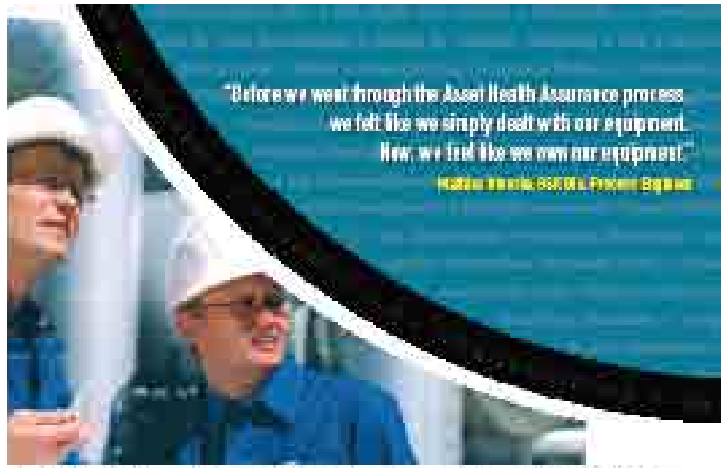

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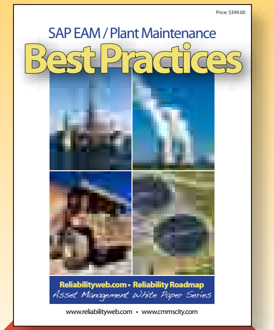

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