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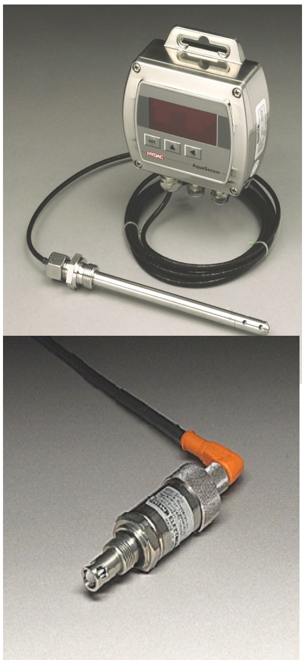
Service Technology / Filter Systems

AS1000 & AS2000 FAQs

AquaSensor AS 1000 & AS 2000 series.

Frequently Asked Questions (FAQs) and Glossary



It is almost certain that some amount of water is present in Hydraulic and lubrication systems.

With mobile and stationary hydraulic and lubricating systems there is the constant danger for water ingression in many places: Cylinders, bearing seals or the hydraulic reservoir. The main sources for the water ingression are insufficient bearing sealing, precipitation, humidity, oil-refill (new oil), splash water, underwater applications and cleaning.

Water contamination accelerates the ageing process resulting in oxidation, hydrolyses, additive depletion, reduced lubricant film strength, corrosion and damage to components.

Because of the waters destructive potential, hydraulic and lubrication fluids are best operated with water contents well below their water saturation point.
Due to the fact, that readings in ppm or percent in volume are insufficient to ascertain a harmful level of water, it is the more practical method for monitoring water in oil is to report water as percent of saturation (saturation level). .

The HYDAC AS1000 & AS2000 series AquaSensors are continuously monitoring the water saturation level along with the oils temperature. The AS1000 outputs the measuring values as 4...20mA analogue signal. The AS 2000 series includes a LED display/keypad, two analogue outputs, four easily adjustable switch outputs and a serial RS485 interface and can be easily calibrated.

Below follows a list of the most of the frequently asked questions concerning the function, use and application of the AquaSensor.
The terms highlighted in *italics* are explained further in the glossary following the FAQs.

Q: What is the operating principle of the AquaSensor?

A: A special capacitance sensor is used in the AquaSensor. Water molecules are moved into and out of the sensor by changes in the saturation level of the oil. The capacity value of the sensor changes with the population of water molecules in the sensor and is directly related to the *saturation level*. The change in capacity value is electronically converted and displayed as the *saturation level* in percent.

Q: How come water is moved into and out of the sensor?

A: The driving force behind this is the *water vapour pressure*. The water vapour pressure of the water in the oil is confronted by the water vapour pressure of the water in the sensor. Water is moved into and out of the sensor until a pressure equilibrium is reached. If the equilibrium is disturbed by adding water (increasing the water vapour pressure of the oil) or drying the oil (decreasing the water vapour pressure), water again starts to move into or out of the sensor.

Q: How does the sensor know the saturation point of a given oil, since different oils can dissolve different amounts of water?

A: When adding water to dry oil, the *water vapour pressure* increases until the oil is *saturated* with water*.* This point is called the *saturation point* and the corresponding pressure *saturated water vapour pressure.* The oil cannot dissolve any more water. When this point is exceeded, free or emulsified water is the result*.*
Although different oils can dissolve different amounts of water (in ppm) at the saturation point, the *saturated water vapour pressure* has the same value for all oil types at a given temperature. By definition, at this point the saturation level is 100%.

Example :

	Oil A	**Oil B**
Temperature	20°C	20°C
Saturation level	100%	100%
Saturated water vapour pressure	2,3 kPa	2,3 kPa
Water concentration at saturation	78 ppm	358 ppm

Q: What is the relation between *water vapour pressure* and *saturation level*?

A: Technically speaking, the AquaSensor measures the *saturation level* of oil by looking at the *water vapour pressure.* The simple relation between *water vapour pressure* and *saturation level* is:

$$Saturation\ \ level[\%] = \frac{measured\ water\ vapour\ pressure}{saturated\ water\ vapour\ pressure} * 100$$

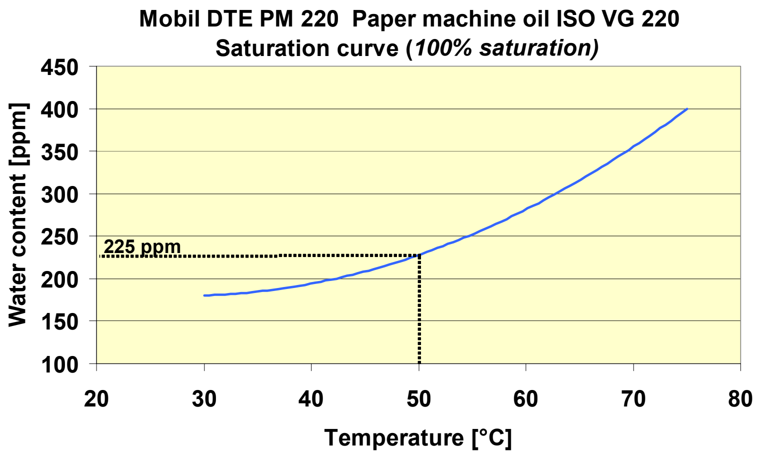
Q: What is the advantage of measuring the saturation level rather than ppm?

A: Using readings in ppm to ascertain a harmful level of water is difficult due to differences in fluid properties, including oil age, fluid type and additive levels. E.g., a water content of 300 ppm in a synthetic Ester would be ideal, but, the same water content would have disasters consequences. Furthermore, this gives only a quantitative measure and does not answer the question whether or not

the water content is still acceptable. By contrast, the saturation level provides a clear indication of the fluid's condition as it is directly related to the oils saturation concentration (*Saturation point*).

F: What is the relation between the saturation level and the content in ppm?

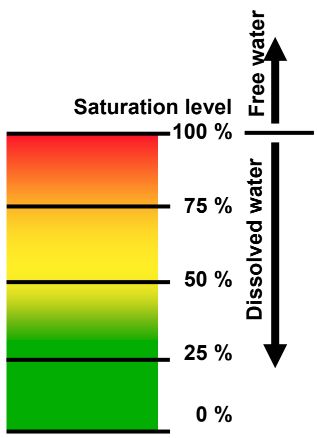
A: A measured saturation level is equivalent, at a given temperature, to a certain water content in ppm. Is the saturation curve of the fluid known, the saturation level can be converted into a ppm value. Unfortunately, such curves are rarely made available by the oil suppliers. The reason is the laborious determination and because there is no standardised procedure available. Furthermore, the saturation curve changes with the ageing of the oil and would only be valid for new oil.
Nevertheless, is a saturation curve available, the conversion can be done according to the following example:



Excample:
Meassured saturation level @ 50°C: 45%
From saturation curve: Saturation point @ 50°C: 225ppm

$$\text{ppm}_{(50°C,\ 45\%\text{saturation})} = \frac{225\text{ppm} \times 45\%}{100\%} = 101\text{ppm}$$

Q: What is the desired saturation level in hydraulic and lubrication systems?



A: Since the effects of *free* and *emulsified water* are more harmful than those of *dissolved* water, water levels should remain well below the saturation point. However, even water *in solution* can cause damage and therefore every reasonable effort should be made to keep saturation levels as low as possible. There is no such thing as too little water.
As a guideline, we recommend maintaining saturation levels below 45% in all equipment.

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AS1000 & AS2000 FAQs

Q: What is the best location for installing the AquaSensor in a hydraulic/lubrication system?

A: This depends on the application. If the intent is to monitor a potential water leak source, the sensor should be placed downstream of the potential water source.
Generally speaking, the fluid should circulate freely around the sensor as increased flow increases the response speed. Therefore, it is advisable to install the sensor in the return line rather than in the hydraulic tank.

Q: What fluids can be used with the AquaSensor?

A: All mineral-based oils, HFD, HETG, HEES and Skydrol (Phosphate ester version) have been tested successfully. For other fluids, please contact us.

Q: What viscosity limits are there?

A: Generally speaking, the AquaSensor does not have any viscosity limitations from a measuring point of view. However, low viscosity oils provide for a higher response speed. This is because there is a quicker exchange of oil close to the sensor. Furthermore, high flow rates and high viscosity's would cause too much mechanical pressure on the AS. Therefore w viscosity range is specified in the data sheet.

Q: Are there any other limitations to using the sensor?

A: There is a certain temperature range and a maximum flow rate specified in the data sheet.
Apart from that, the only systems in which the AquaSensor is of no use are those with a free water condition at all times (without any intention to change this condition) as it would display 100% saturation at the time. Furthermore, the AS must not be used in water based fluids such as oil in water emulsions (HFA), water in oil emulsions (HFB) or water glycol (HFC).

F: What are the effects of high pressures and pressure fluctuations on the measurement?

A: One effect is, that the amount of water an oil can dissolve is slightly pressure dependent.
Another effect is a changing water absorbing capacity of the sensor itself.
The total effect is however marginal and is about 0,02% FS / bar.

F: What are the differences of the AS 1000 and AS 2000 series?

A: The main difference of the two units are the features and therefore the price.
The AS2000 includes a LED display/keypad, two analogue outputs, four easily adjustable switch outputs and a serial RS485 interface and can be easily calibrated.

AS1000 & AS2000 FAQs

The especially for the serial production designed As1000 is a advancement of the AS2000 and is extremely reliable on account of its compact, rugged design. He offers only two 4…20mA analogue outputs for saturation level and temperature.

Q: Is calibration and adjustment of the AS 1000 possible ?

A: A calibration (verification) is possible with the Calibration- and Adjustment set (part no: 3122629) using an special additional adapter, which can be ordered with part no: 3225997. The adapter will be included in the set. An adjustment is not possible. Only the AS2000 offers that feature.

.Glossary

DISSOLVED / IN SOLUTION - These terms refer to a homogenous mixture of two fluids — in this case oil and water —, implying that the individual water molecules are discrete and mixed with the oil molecules. The water is in solution. The sample cannot be separated by allowing the solution to stand at a given temperature. The fluid is clear.

FREE WATER - This describes the condition in which a fluid is saturated and is past the point where water is in solution. If more water is added to the oil, the water sinks to the bottom and the oil rises to the top. The visible horizontal line at the boundary between the two elements is called the *interface*.

EMULSIONS - Another example of free water is emulsions. They form when enough mechanical agitation acts on the fluid so that the free water forms a cloudy mixture of water and hydrocarbons. The mechanical shearing action creates very small water droplets which have too much surface tension to join and form an interface. This is still free water as it is not in solution, but it does not create an interface boundary, causing a visible cloud or haze instead.

SATURATION / SATURATION POINT - At this point the fluid carries as much water in the dissolved state as it possibly can at a given temperature. At this point the saturation level is 100%. If *any* more water were to be added, a free water condition would result and that would be the beginning of an emulsion or an interface. When the saturation point is given, a corresponding temperature is also given because saturation varies according to temperature.

SATURATION LEVEL / PERCENT SATURATION - This is the degree of saturation which indicates what percent of maximum possible water in a dissolved state is in the oil. A reading of 0% would indicate oil free of water, while a reading of 100% would indicate oil that is saturated with water.

WATER VAPOUR PRESSURE - This is the pressure exerted by water vapour. Water gives off vapour, consisting of molecules that have evaporated and are in a gaseous state.
The presence of water in oil results in a water vapour pressure on the surface of the oil. This water vapour pressure depends on the water content, the type of oil (including additives and particles), and temperature. If the ambient water vapour pressure is higher than that of the oil, water moves into the oil. By contrast, if the ambient water vapour is lower, water evaporates out of the oil.

SATURATED WATER VAPOUR PRESSURE - When adding water to oil, the water vapour pressure increases until a maximum value. The vapour is then said to be *saturated vapour* and the pressure it exerts *saturated water vapour pressure*. In oil this is the case when a maximum amount of water is dissolved.