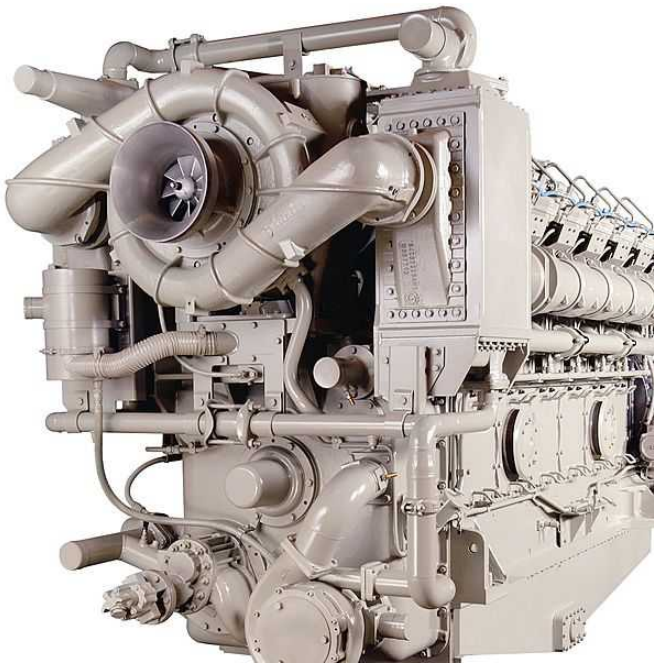


Monitoring Water in Lube Oil

Water in Lube Oil

Water is vital to life on earth, but in some contexts water is unwanted and can cause severe damage. On the other hand oil is also a important part of modern industrial machinery such as engines, gear boxes, hydraulic equipment etc.

It is an old saying that "water and oil don't mix" and numerous surveys have found that water or moisture is the second largest contamination (after particles) in oil systems and it has a damaging effect on the life time of the oil and the components in the system.

The life time of an engine, a gear box or other equipment is dependent of different factors. One of those factors is the quality of the lubrication oil used. The difference between high and low quality oil has a high influence on the life time of the system and ensuring optimal quality of the oil is a key factor.

Taking good care of your oil means keeping the oil **clean**, **cool** and **dry**.

Water contamination may cause different problems in different types of lubricating oil, although corrosion is always directly associated with water ingress.

Whatever the equipment, water can displace the oil at contacting surfaces, reducing the amount of lubrication and activating surfaces which may themselves act as catalysts for degradation of the oil.

Water in emulsified form can increase lubricant viscosity. On occasions, it has caused gross instability and dropout of the additive package. Problems will occur, whether visible or not, in any system in the presence of more than about 0.2% water (some systems are very intolerant to water contamination).

Water is an important contaminant in many lube oil systems because of its potential to cause failure via a number of mechanisms. Water contamination within lubricating

oil storage tanks can lead to microbiological growth, forming yeast, mould and bacteria that will clog filters and very rapidly corrode fuel systems.

In highly loaded lubricated contacts, particularly where oil films are thin (for example on gear teeth), water contamination can result in rapid failure through localized or general breakdown of oil film conditions. Alternatively, the mode of failure could be progressive resulting from local or generalized corrosion of components within the systems and/or through effects which impact on the functionality of the lubricant itself.

Water can enter the lube oil from different sources:

- With the new oil
- Leaking coolers
- Defective seals
- Breathers
- Condensation

Wear in Lube Oil systems

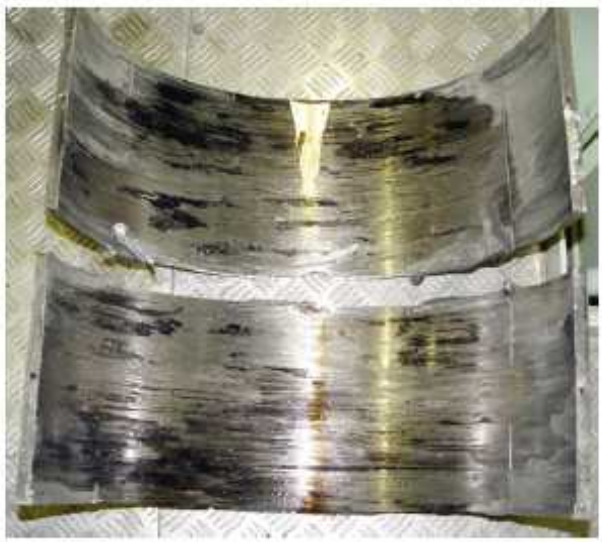
The water in the lube oil will have different damaging effects on the parts in the system:

Impaired Film Strength. Rolling elements depend on oil's viscosity to create a critical clearance under load. If the loads are too great, speeds are too low or the viscosity is too thin, then the fatigue life of the gear wheel is shortened. When small globules of water are pulled into the load zone the clearance is often lost, resulting in bumping or rubbing of the opposing surfaces.

Corrosion. Even soluble water can contribute to rust formation. Water gives acids their greatest corrosive potential. Etched and pitted surfaces from corrosion on gear parts disrupt the formation of critical elastohydrodynamic (EHD) oil films that give bearing lubricants film strength to control contact fatigue and wear. Static etching and fretting are also accelerated by free water.

Hydrogen-induced Fractures. Often called hydrogen embrittlement or blistering, this failure mode is perhaps more acute and prevalent than most tribologists are aware. The sources of the hydrogen can be water, but also electrolysis and corrosion (aided by water). There is evidence that water is attracted to microscopic fatigue cracks in gear parts by capillary forces. Once in contact with the free metal within the fissure, the water breaks down and liberates atomic hydrogen. This causes further crack propagation and fracture. High tensile-strength steels are at greatest risk. Risk is posed by both soluble and free water.

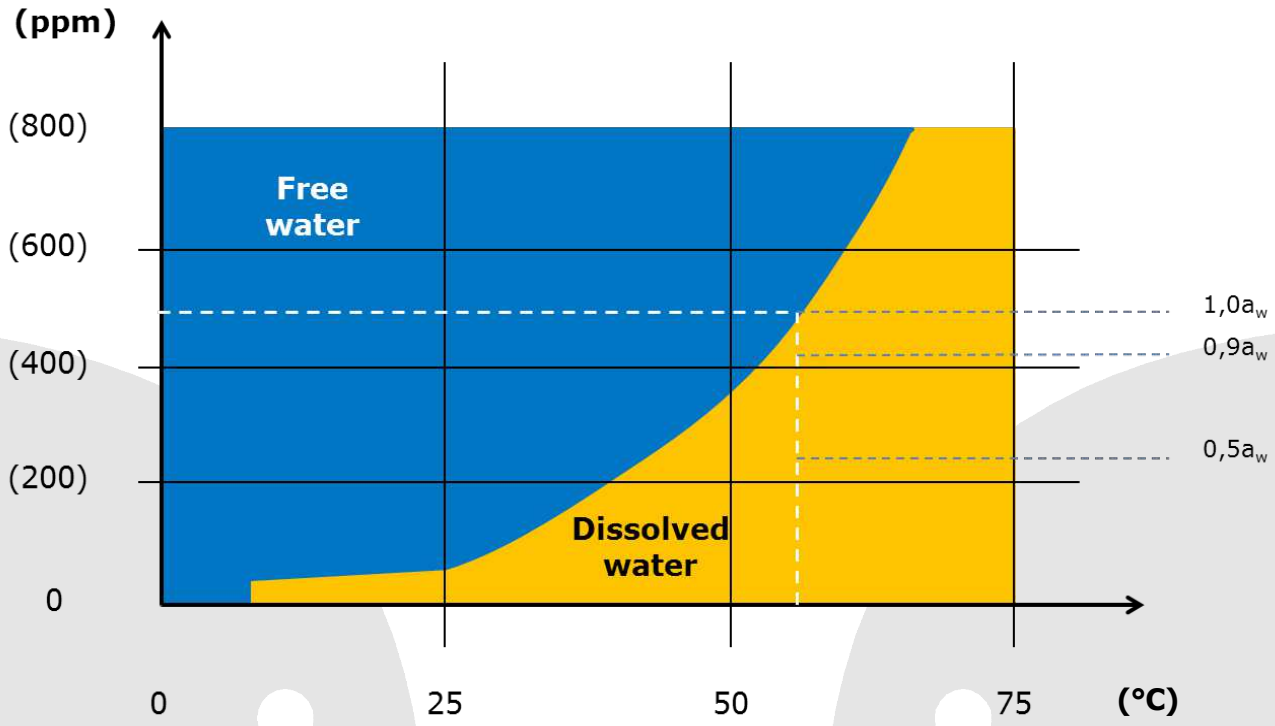
Signs of wear on engine



Pic. 1 Damage to cross-head bearing on a MAN 2-stroke engine

Measuring Water Activity in Lube Oil

Traditionally the water content of oils (not only lube oils) has been measured using either chemicals or laboratory equipment. The result of these test normally will give the amount of water in the oil as a percentage (%) or as ppm (parts per million)



Pic. 2 Water content in oil

The "*%*" or "*ppm*" value will give a good indication of the total water content in the oil – it will however not tell you how close you are to have free water in your system. As it can be seen from Pic. 2 any oil can hold a certain amount of water ("Dissolved water") – if more water is added to the system "free water" will be formed. Free water is what has the damaging effect on the oil quality and on the equipment.

The water activity in the oil can be compared to the relative humidity (%RH) in the air.

When measuring the "water activity" or "a_w" you will get a value between zero (0) and one (1,00) where 0 is no water and 1,00 means that the oil is saturated with water and if any more water is added to the system free water will be formed.

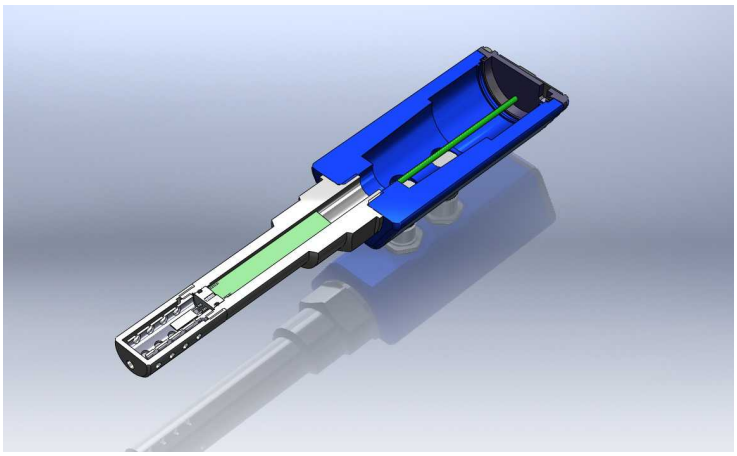
Why WIO200?

Why should you install a WIO200 sensor in your lube oil system? Because the sensor when installed will monitor the moisture level in the oil around the clock, you will not have to take oil samples, you will not have to wait weeks for lab results and the sensor will measure on the total volume of oil and not only a small ½ liter sample.

In addition to the above you will get a very early warning when water has entered your oil system and a warning before free (and damaging) water is formed in the system. Thus you are able to stop the system or to take preventive actions before serious damage can happen to components in the system.

Taking an oil sample is not as simple as it may sound and different people get different results even when taking oil samples from the same system and using the same equipment.

Installing the **WIO200** will beat "the human factor" and you will have the same procedure each time – all the time!

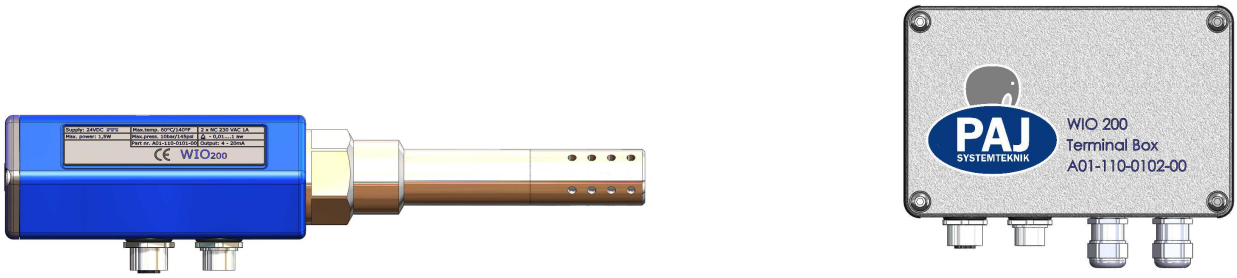


Pic. 3 ***WIO200*** *(cut)*

WIO200

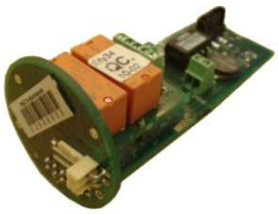
In the context of oil quality PAJ has developed and manufactured a sensor for user that measures water content in oil. The water-in-oil sensor can be used to measure the water activity in lubrication oil…

The **WIO200** sensor system consists of a **WIO200** sensor, terminal box and cables. The **WIO200** sensor is an in-situ sensor which measures water content in lubrication oil on ship engine or similar.



*Pic. 4 **WIO200** sensor and connection box*

The **WIO200** sensor system is produced, tested and calibration at PAJs production facilities in Soenderborg, Denmark. Each element in the **WIO200** system, from electronically print to mechanical parts is rigorously tested for errors before being assembled into a complete **WIO200** system. PAJ collect data out thru the entire assembly and stored all information, ensuring full traceability. After assembly the **WIO200** systems are placed in a long burn-in test before being calibrated. PAJ burn-in test ensures all **WIO200** systems will work even under harsh conditions.



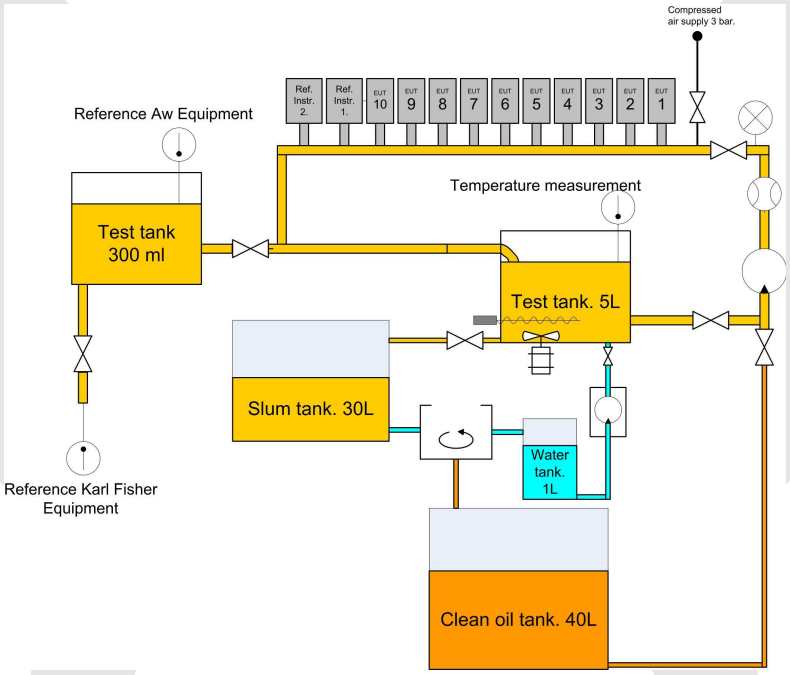
*Pic. 5 The **WIO200** main computer uses energy efficient components and only RoHs approved components.*

Calibration and testing in oil

During the development of the sensor we found that if you want to have a reliable measuring you must calibrate the sensor in oil – and preferably in the actual oil from the lube system.

That is why PAJ Systemteknik calibrates all sensors directly in oil. On request the buyer can get any oil, new as old, installed into the calibration system. Purchased sensors will then be calibrated and verified in the requested oil.
The default oil is SAE30 oil.

The calibration system is seen below (Pic. 6). Ten sensors at a time are calibrated in oil, using two reference sensors. Reference sensors are calibrated using a seven point calibration, ensuring high precision. Out thru the calibration process water in dropped into the oil, in tiny amount until the reference sensors reached 1.0 aw. After calibration the water is automatically removed from the oil and all sensors are tested for incorrect measurements and spikes. All systems must measure the correct water activity level within +/- 0.03 aw. each sensor is delivered with an individual calibration certificate.



Pic. 6 ***WIO200*** *calibration system*

PAJ Systemteknik

PAJ Systemteknik develops, manufactures and services devices for OEM-companies. The core competency consists of delivering products that must observe strict operational and quality demands.

Both the development and the production and the transition between happens problem and risk-free for the customer whether the solution is a safety-critical component in trains, medical instruments that must not fail or advanced laboratory instruments.

The focus is on long term cooperation with customers by being single source supplier from development through to maintenance.

Quality control is according to ISO 9001, ISO 13485 (Medico) and IRIS (Railway), while manufacturing according to IPC A Class 3 and ICE 61340-5-1 ensures customer satisfaction - every time. Consideration for the environment is ensured through ISO 14001-certification.

For more information please contact:

www.DIMAR-TEC.com

DIMAR-TEC Pte Ltd
7 Toh Guan Road East #08-01, Singapore 608599
Tel: +65-6565 0992 Fax: +65-6566 7804
email: info@DIMAR-TEC.com
www.DIMAR-TEC.com