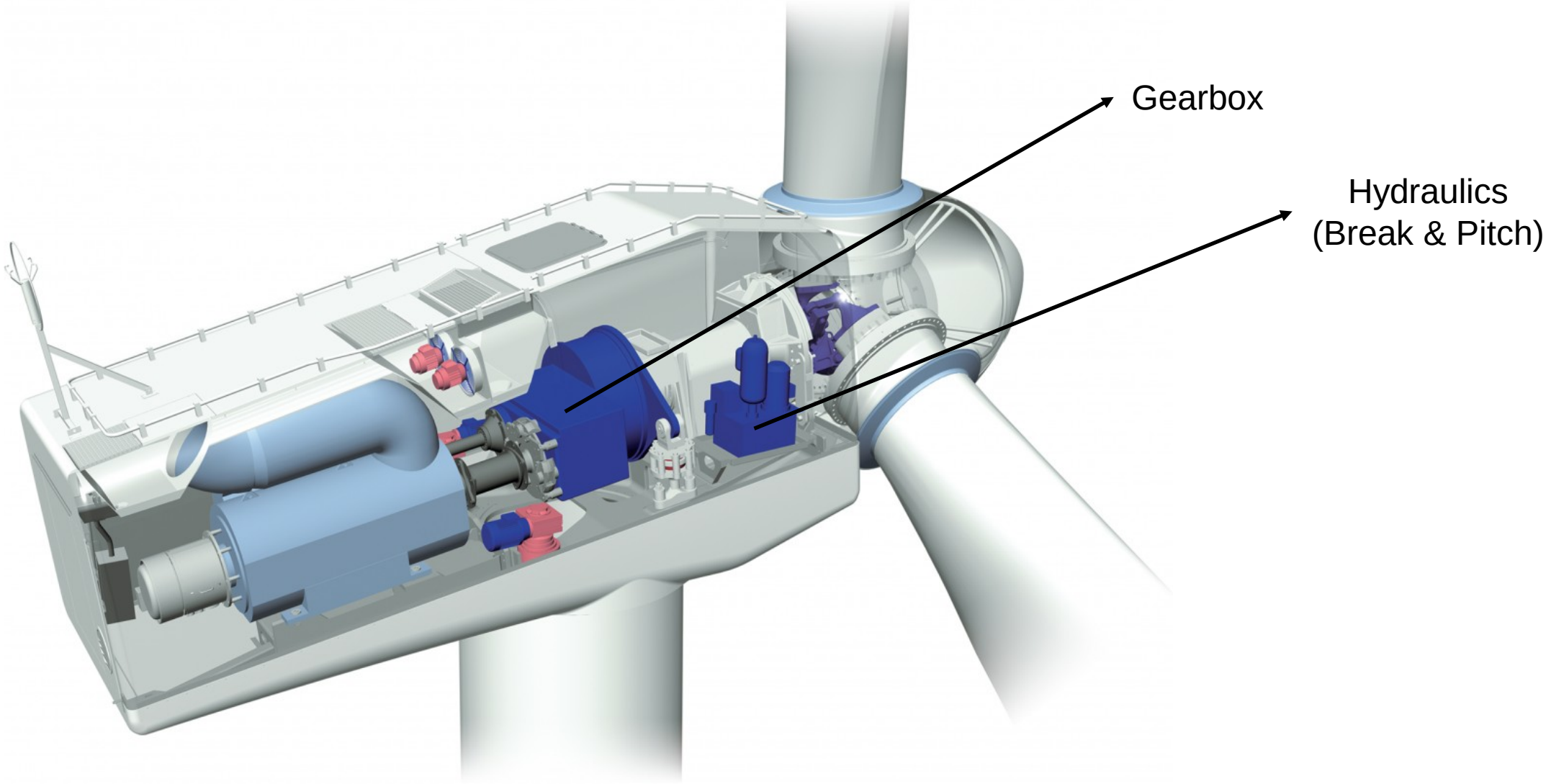
DES-CASE

Wind Turbines Applications

Protecting & Monitoring

Wind turbine application overview



Wind Turbine Failures

Wind turbine gearboxes & hydraulics (components) are often not meeting 20-year designed life.

Premature failure of these components increases:

- Turbine Unplanned Downtime (Lost Revenue)
- Unplanned Maintenance
- Gearbox & Hydraulic Replacement and/or Rebuild
- Shortened Fluid Service Life
- Warranty Reserves
- Cost of Energy

Common symptoms that are leading indicators to the premature failure of these components are directly tied to lubrication contamination.

The recommended level of contamination in a wind turbine gearbox is referred to as an ISO 17/15/12 and for the hydraulic system it is 15/13/10. Both with a target of <200 PPM of water but the contamination level is often higher on both water and particulates.

On older turbines you do not find a filtration system on the wind turbine gearbox, which means that all the contamination build-up in the system, added with new oil or generated in the turbine, stays in the system and possibly damages the surfaces of the gearbox components thereby generating even more contamination (accelerated wear).

In the new generation of wind turbines you often find an oil filter in the gear oil cooling system, but as the cooling system is dimensioned to keep the oil temperature low it is often not easy to find a filter with an acceptable efficiency.

Many of these contaminants influence equipment reliability and lifetime. Nearly 100% of all problems related to contamination of oil and other fluids can be prevented.

Proactive Solutions to Protect Wind Turbine Gearbox & Hydraulics (High Efficiency Filtration)

Desiccant Breather:

DC-EX-4

As wet, contaminated air is drawn through the unit, multiple 3-micron polyester filter elements remove solid particulate, and the color-indicating silica gel extracts moisture. When air is expelled from the container, the top foam pad prevents oil mist from contacting silica gel or entering the atmosphere. Six high-quality umbrella check-valves are located underneath the unit to isolate equipment from ambient conditions, prolonging breather life and protecting system integrity.

- Removes moisture in the headspace of equipment
- Eliminates rust-forming condensation
- Prevents sludge deposits and water-contaminated oil
- Prevents contamination ingress
- Provides longer lubricant life
- Reduces wear and tear on equipment, prolongs life

Of- Line Filtration:

Off line Unit OLU1B

The off-line filtration units (OLU) are characterized by their extremely efficient filter elements with a fineness of down to 0.5 micron (hydraulics) & 5 micron (gearbox's). If required, different micron sizes are available to suit any application. The off-line units can be easily mounted to new and existing hydraulic & gearbox installations. By means of an integrated pump-motor unit in the off-line units, the oil is pumped from the reservoir through the filter unit. After filtering the oil is returned to the tank. Off-line units can continue to work even when the main system is not in use. Element change can also be done without interfering with the main system.

- Extremely clean oil due to high filtration efficiency
- Large dirt holding capacity
- Compact and easy maintenance design
- Longer usage life for oil and components

Enhancing Current Solutions Through Condition Monitoring & Connectivity

DES-CASE®

Condition Monitoring - Connected Desiccant Breather

DC-IL-EX-4

Measurements & Connectivity:

- Remaining breather Life
- Saturation direction (Moisture ingression direction)
- Temperature (Headspace representation)
- Battery life (Wireless Option)
- Wired – RS-485 (Modbus & CAN bus) & 9-28V DC Power
- Wireless – 2402.0 - 2480.0 MHz Bluetooth 4.0 Low Energy
    - Communication Range: 100ft (30m) Line of Sight

Addressable Issues:

- Moisture/Water
- Rust
- Dirt, soot
- Process contamination
- ISO cleanliness changes
- Viscosity breakdown

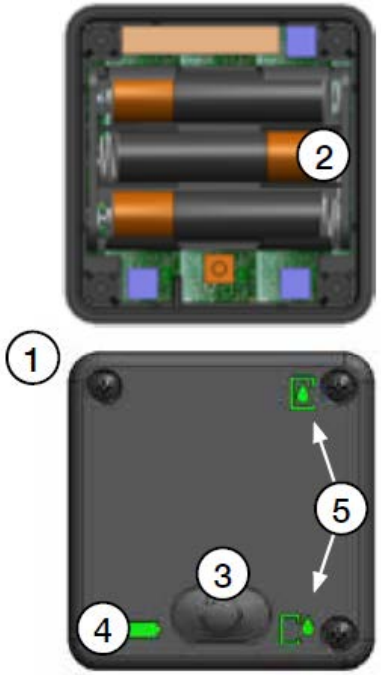
Benefits:

- Desiccant breathers are the first line of defence because they prevent harmful contaminants from entering the system.
- The connected breather provides early identification of moisture level changes in the oil and possible sources of entry making it an integral part a holistic oil condition monitoring solution
- Integration of breather condition with other CBM data sources (oil, vibration, temperature etc.) should provide critical feedback to OEMs, lubricant manufacturers etc.

Design & Technical Specifications – Wireless Module & Sensors

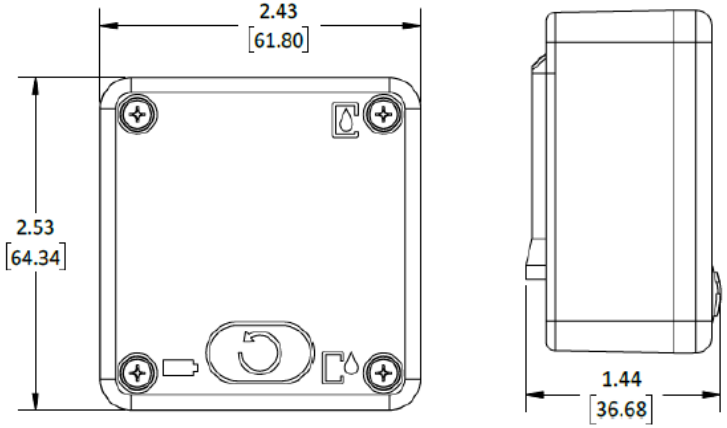
By the Numbers:

1. Sealed Rubber Cap
2. Three AAA Batteries (Wireless) & RS-485 (Wired)
3. Push Button
4. Battery indicator LED (For Wireless)
5. Saturation Direction LEDs



Dimensions (Wired Not Dimensioned):

- 2.43in L x 2.43in W x 1.44in H
- 62mm L x 64mm W x 37mm H



Environment:

- Intended for Indoor and Outdoor Use
- Altitude up to 5,000 meters
- Temperature Range:
  -4 degree F to 129 degree F
  -20 degree C to 54 degree C
- Maximum Relative humidity 100% at up to 54 degree C temperature
- Dustproof / Waterproof (IP66)
- Hazardous Ratings: Not rated for hazardous locations
- FCC, CE, REACH, RoHS

Connectivity:

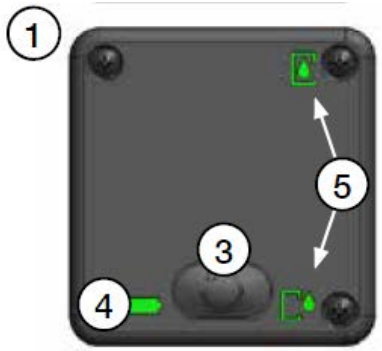
- 2402.0 - 2480.0 MHz Bluetooth 4.0 Low Energy
- Communication Range: 100ft (30m) Line of Sight

Power:

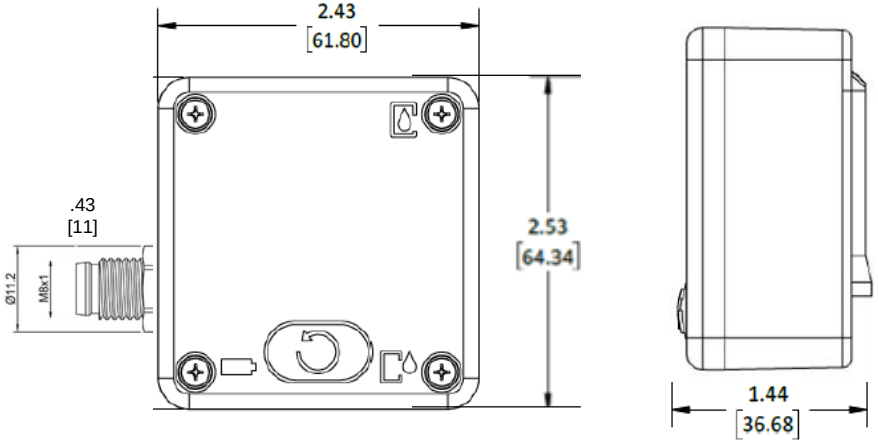
- Supply Source: Three AAA Battery (Supply Voltage: 4.5 V)
- Battery Life Expectancy: 2 Years (use & temperature dependent)

Design & Technical Specifications – Wired Module & Sensors

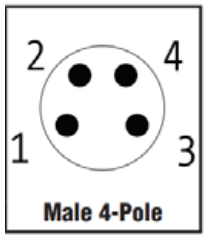
By the Numbers:
1. Sealed Rubber Cap
3. Push Button
4. Battery indicator LED (For Wireless)
5. Saturation Direction LEDs



Dimensions (Wired Not Dimensioned):
- 2.86in L x 2.43in W x 1.44in H
- 73mm L x 64mm W x 37mm H



Wired Pins:



Environment:
- Intended for Indoor and Outdoor Use
- Altitude up to 5,000 meters
- Temperature Range:
  -4 degree F to 129 degree F
  -20 degree C to 54 degree C
- Maximum Relative humidity 100% at up to 54 degree C temperature
- Dustproof / Waterproof (IP66)
- Hazardous Ratings: Not rated for hazardous locations
- FCC, CE, REACH, RoHS

Connectivity:
- RS-485 (Modbus & CAN bus protocols)

Power:
- 9-28V DC

Design & Technical Specifications – Module & Sensors

Data Value Meanings & LED Display/Symbol Indication:

<u>Battery Life (Wireless):</u>
Green: 100%-21%
Yellow: 20% - 11%
Red: 10% - 0%

<u>Breather Life:</u>
Green: 100% - 21%
Yellow: 20% - 1%
Red: 0%

<u>Saturation Direction:</u>
Top: Moisture From Asset Headspace
Bottom: Moisture From Ambient Air
Both: Coming From Asset Headspace & Ambient Air

Data Storage:

- Data readings every 60 min
- Stores 365 days of hourly data points

Additional Value Provided:

<u>Improved Performance (Scientific & Accuracy):</u>

- Up to 20% More Life (Temperature dependent)
- Better Accuracy of when breather needs changed to still protect asset

<u>Early Detection:</u>

- Proactive approach to water ingression

<u>Solve Problems:</u>

- Use trend data to help analyze & solve lubrication contamination issues

<u>Stay Safe:</u>

- Ability to avoid: Fall Concerns/Dark Areas/Hard to Reach Areas

Product Install & Start UP

Wired & Wireless

Wireless Only

1.

Remove Plugs & Install Breather

2.

Wireless: Install Batteries & Download App

Wired: Connect Cable & Program

3.

Set Up User Account

4.

Breather Set Up

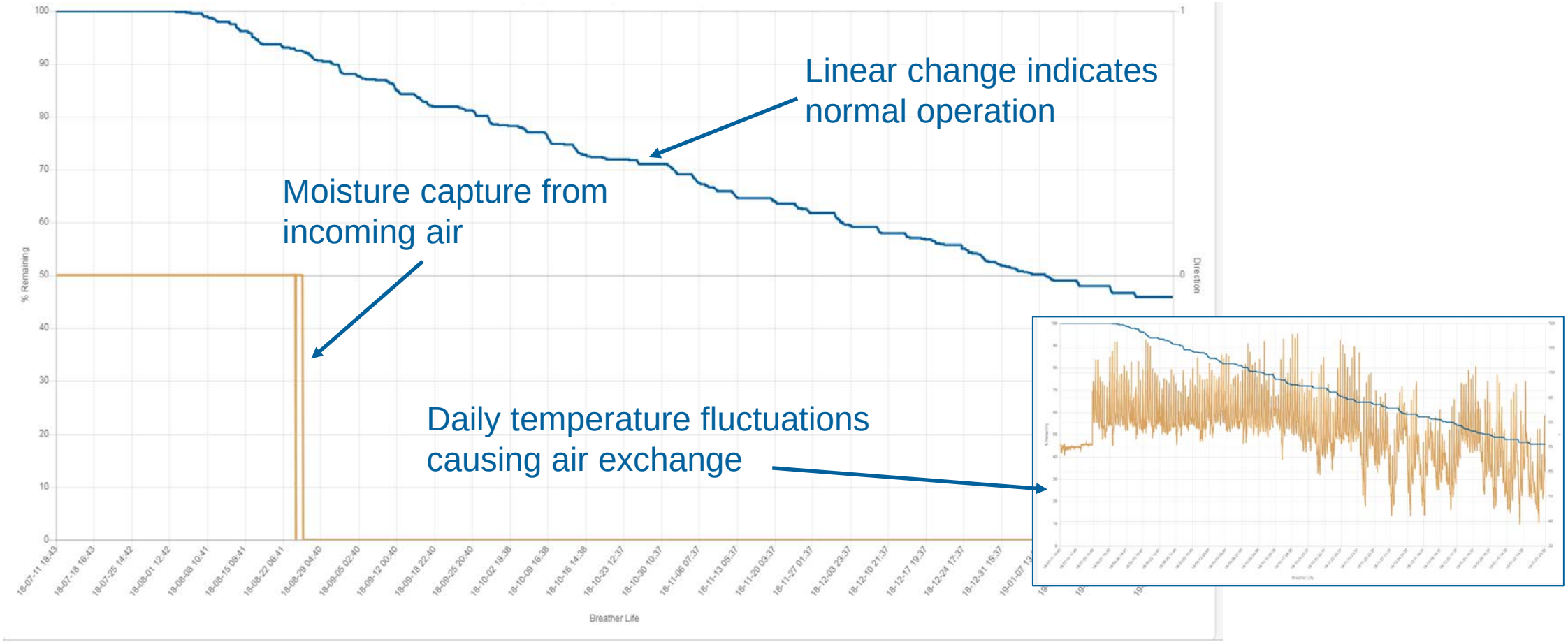
5.

Done

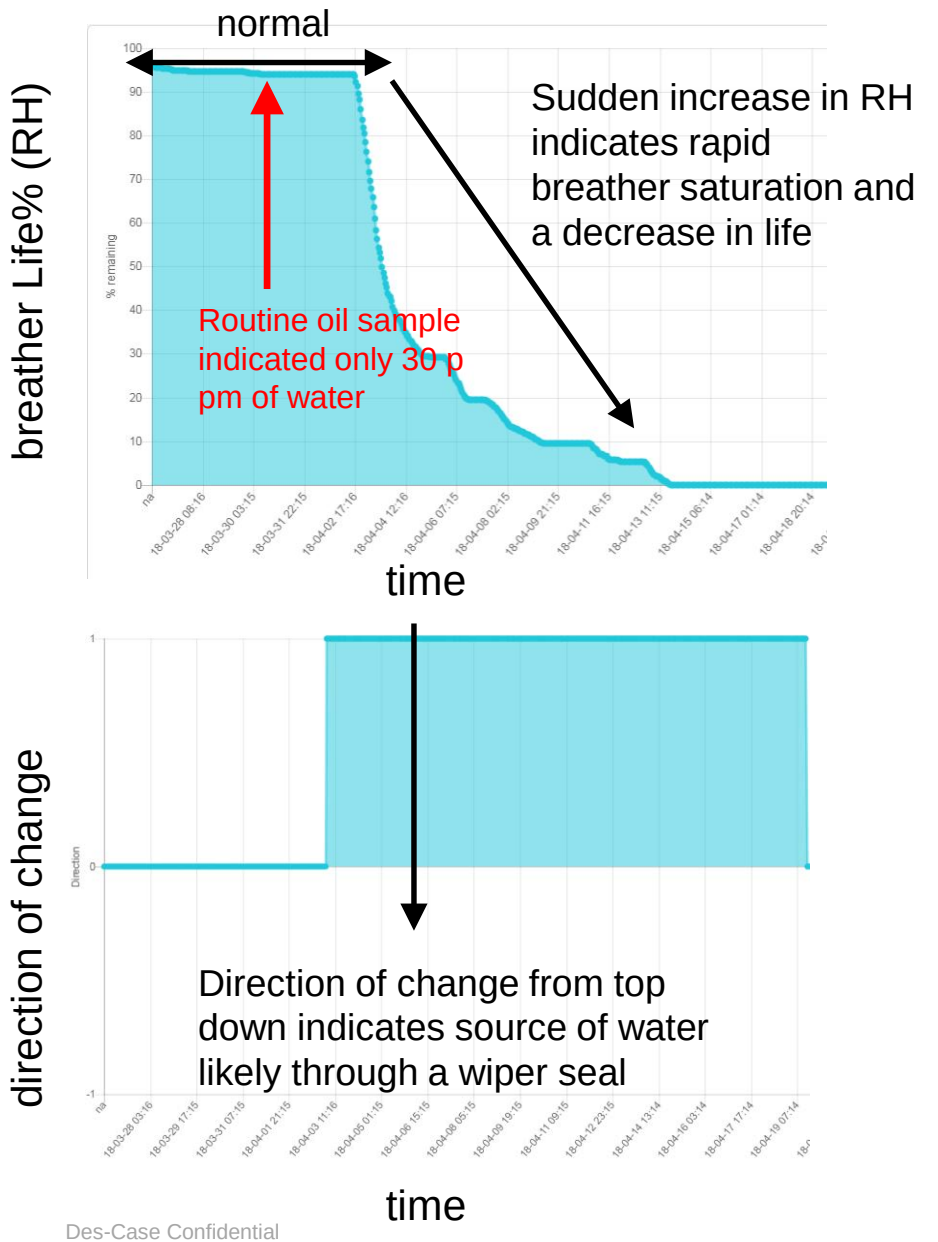
Condition Monitoring - Connected Desiccant Breather

An example of normal operation with DC-IL-VG-4 breather on industrial gearbox

- Lubricating oil and headspace are dry
- Breather is preventing moisture from entering
- Projected end of useful life is 7/26/19 (Installed on 7/11/18)



Connected Breather Predictive Analytics Case Study



- Breather installed Feb 2018 on critical hydraulic system
- “Normal” performance for first month showing low RH% in headspace and 30 ppm water in oil
- Sudden increase in RH% plus direction of change (top down) indicates water ingress 2 days after oil sample
- Customer reported “operations team steam cleaned system”, forcing water through a seal
- Without IsoLogic™, problem may have gone undetected until next schedule oil sample 30 days later

Connected Breather Gearbox Fault Tree Analysis

Is the rate of change of the desiccant faster than normal?

YES

Is the breather saturating from the top (+1) or the bottom (-1)

top down (+1)

Source of moisture is internal to the gearbox. Check for:

1) new oil that has not be pre-filtered to remove moisture and particles
2) old oil in the gearbox that is saturated with water
3) water/humidity ingression through a shaft seal interface
4) a leaking water oil cooler or heat exchanger

bottom up (-1)

Source of moisture is external to the gearbox. Check for:

1) excessive ambient humidity
2) water directly contacting breather
3) thermal syphoning caused by constant changes in oil and/or air temperature

NO

Continue to monitor and schedule change out when breather approaches 0-10% remaining life

Condition Monitoring – Connected Off Line Filtration

What are we monitoring in oil?

- Wear Particles
- Content of Water
- Degeneration (Chemical footprint) of the oil

This allows us to:

- Compare cleanliness to manufacturer spec
- Take action to avoid costly failures

Condition Monitoring – Contamination Monitor Sensor

Measurements & Connectivity:

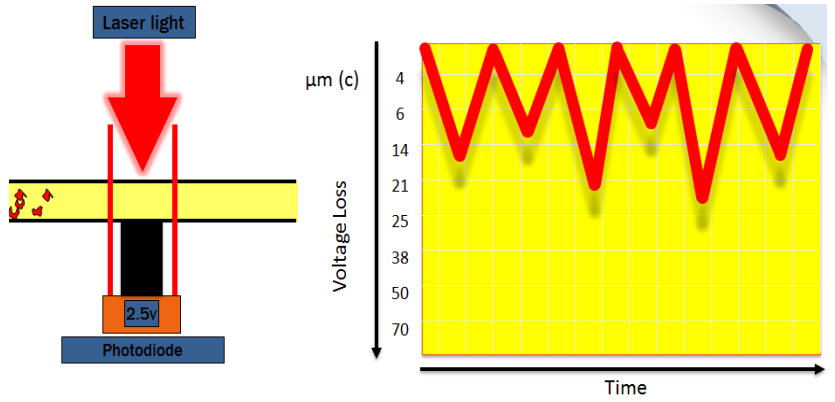
- Oil trending particle sizing 8 channels > 4,6,14,21,25,38,50,70 µm (To revised ISO 4406 Standard)
- Oil temperature
- Water activity (0-70 RH%)
- RS-485 (Modbus & CAN bus)

Addressable Issue:

- Oxidization process
- Moisture/Water
- Dirt
- Process contamination
- Wear particles
- ISO cleanliness changes
- Viscosity breakdown

Benefits:

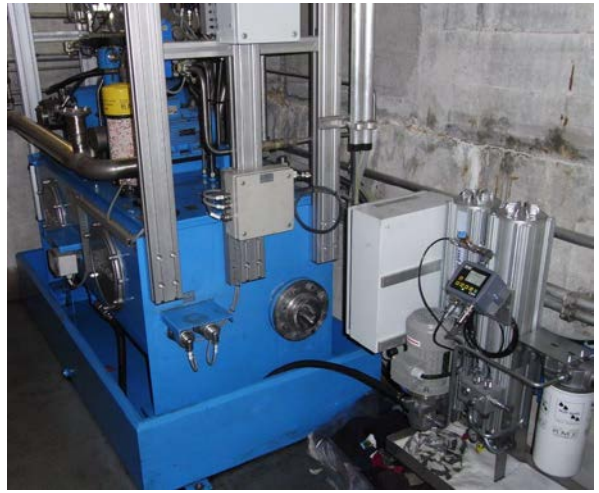
- Oil condition is an excellent indicator of early problems which cause unexpected breakdowns. Early identification enables wear and thus increase equipment efficient operating life. remedial action and reduced breakdowns.
- Maintaining optimal oil condition can dramatically reduce long term equipment



Voltage drop = Size of particle

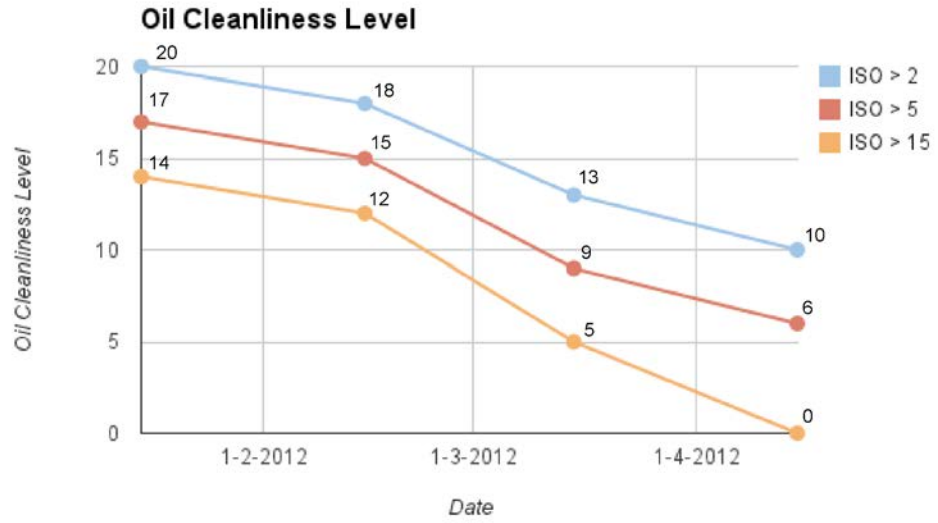
Contamination Monitoring Case Studies

Units were installed on two turbines
on the gear oil and
also on the hydraulic control systems



Turbines

Hydraulic System



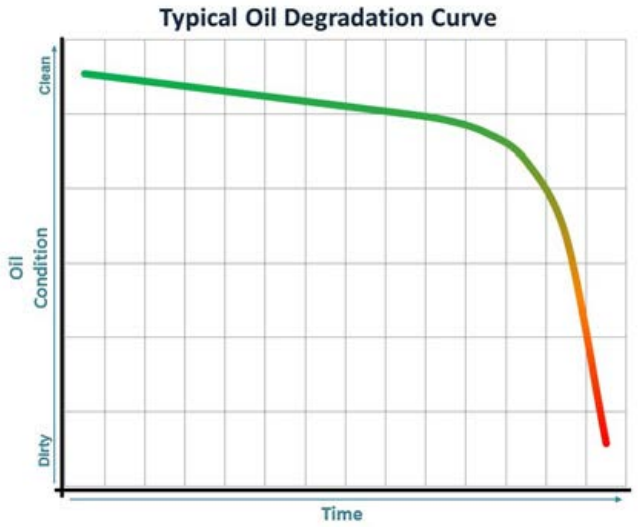
Condition Monitoring – Oil Quality Sensor

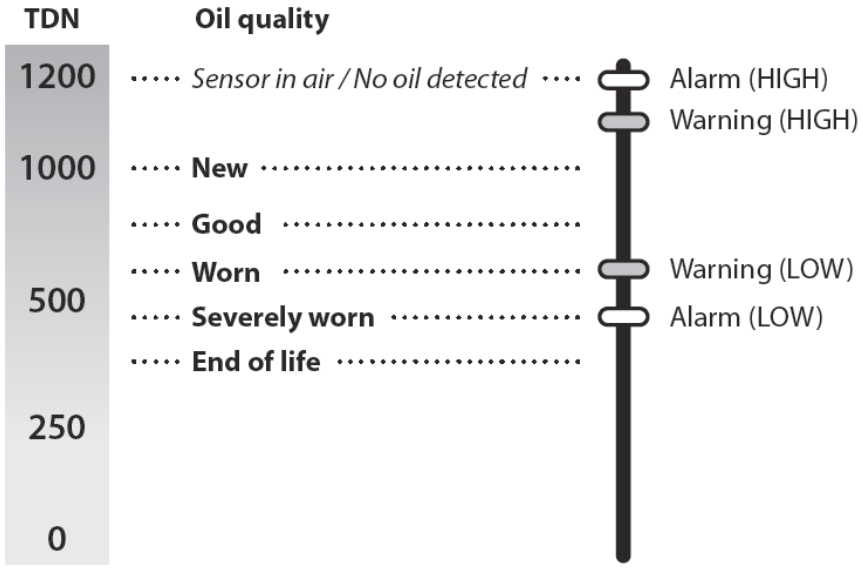
Measurements & Connectivity :

- Oil quality
- Oil temperature
- RS-485 (Modbus & CAN bus)

Addressable Issues:

- Moisture/Water
- Glycol, fuel
- Dirt, soot
- Process contamination
- Total Acid No. (TAN)
- Total Base No. (TBN)
- Wear particles
- ISO cleanliness changes
- Viscosity breakdown
- Polymer shear





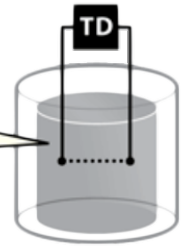
Benefits:

- Oil condition is an excellent indicator of early problems which cause unexpected breakdowns. Early identification enables remedial action and reduced breakdowns.
- Maintaining optimal oil condition can dramatically reduce long term equipment wear and thus increase equipment efficient operating life.

RMF Systems Oil Quality Sensor (OQS)

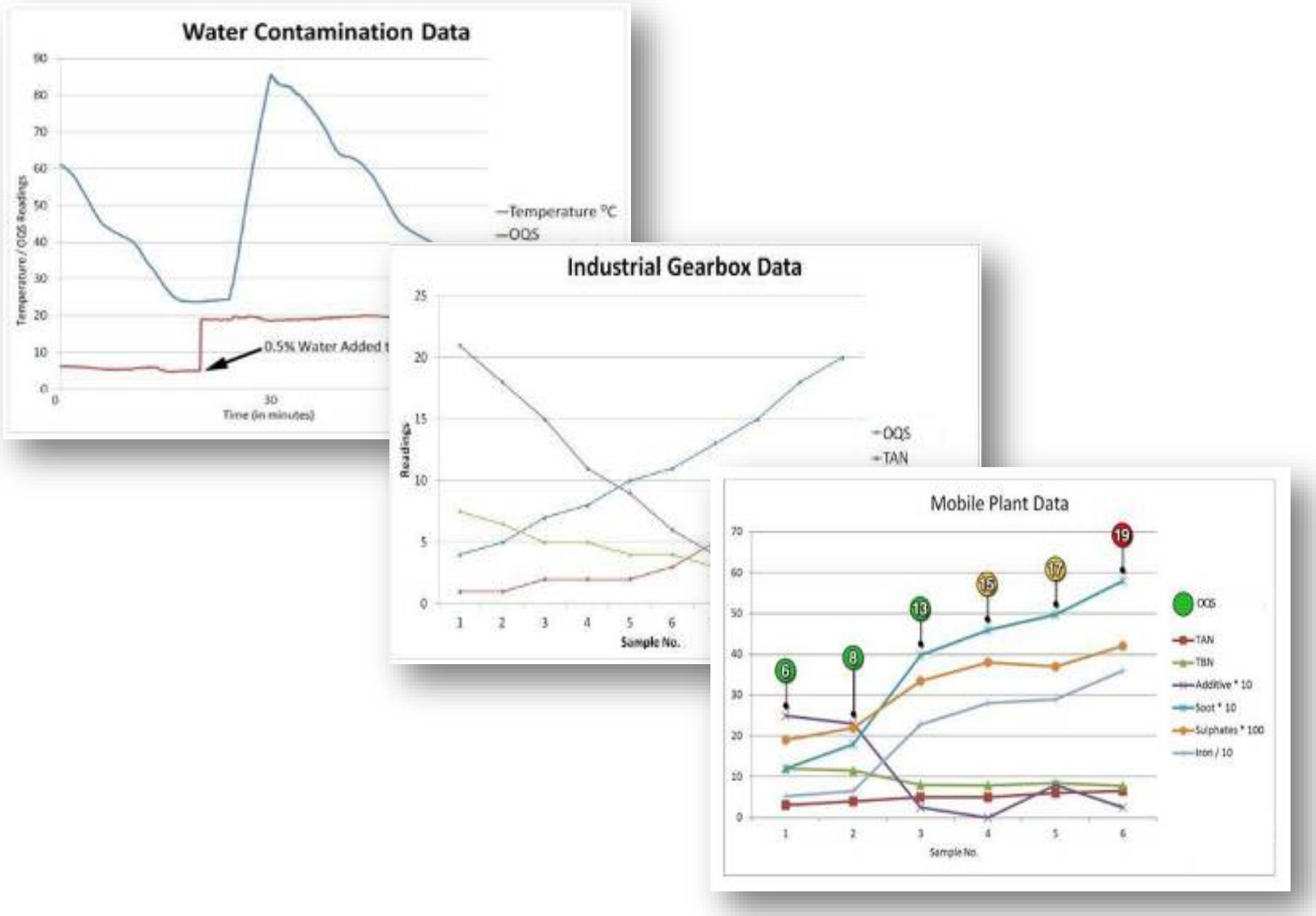
This device works in a similar way to the dielectric sensor but measures both the capacitance and the conductance (a combined measure known as permittivity) of the oil.

The combined data provides a reading that is much more accurate to the change in quality of the oil.

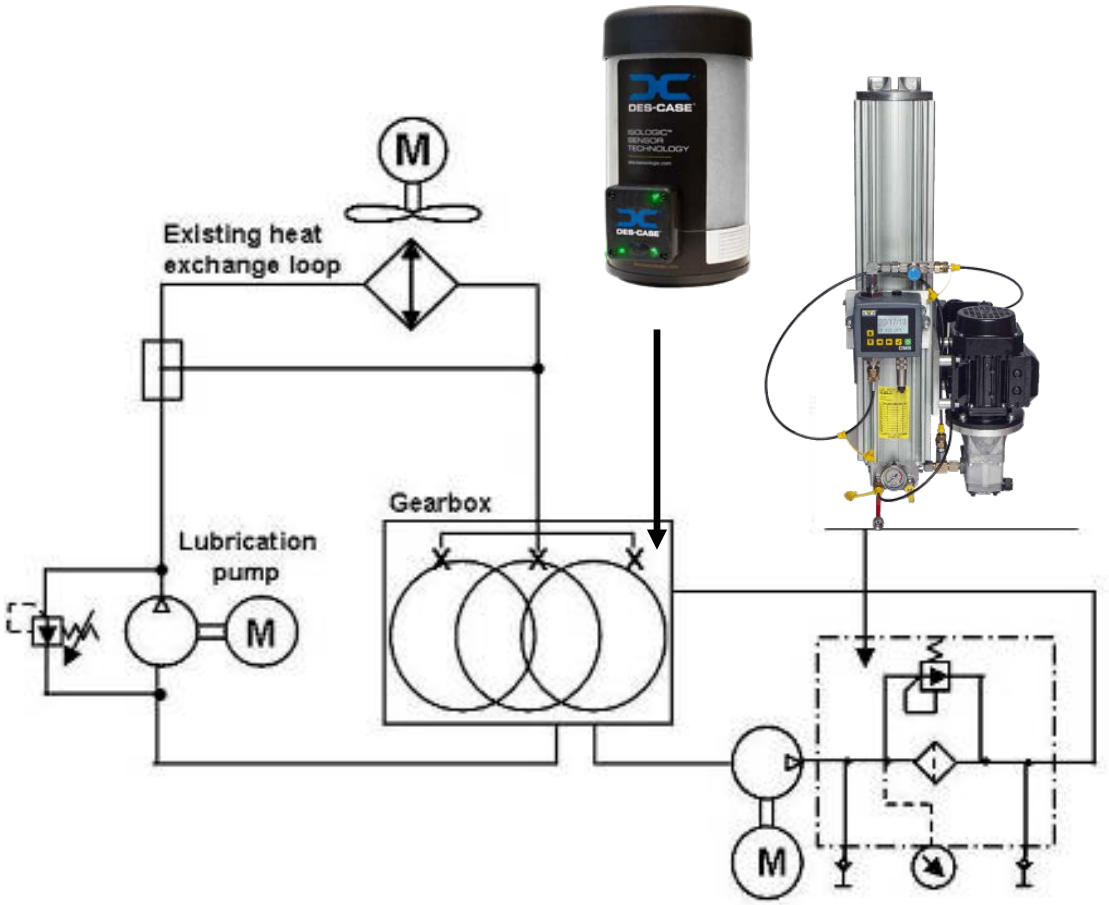


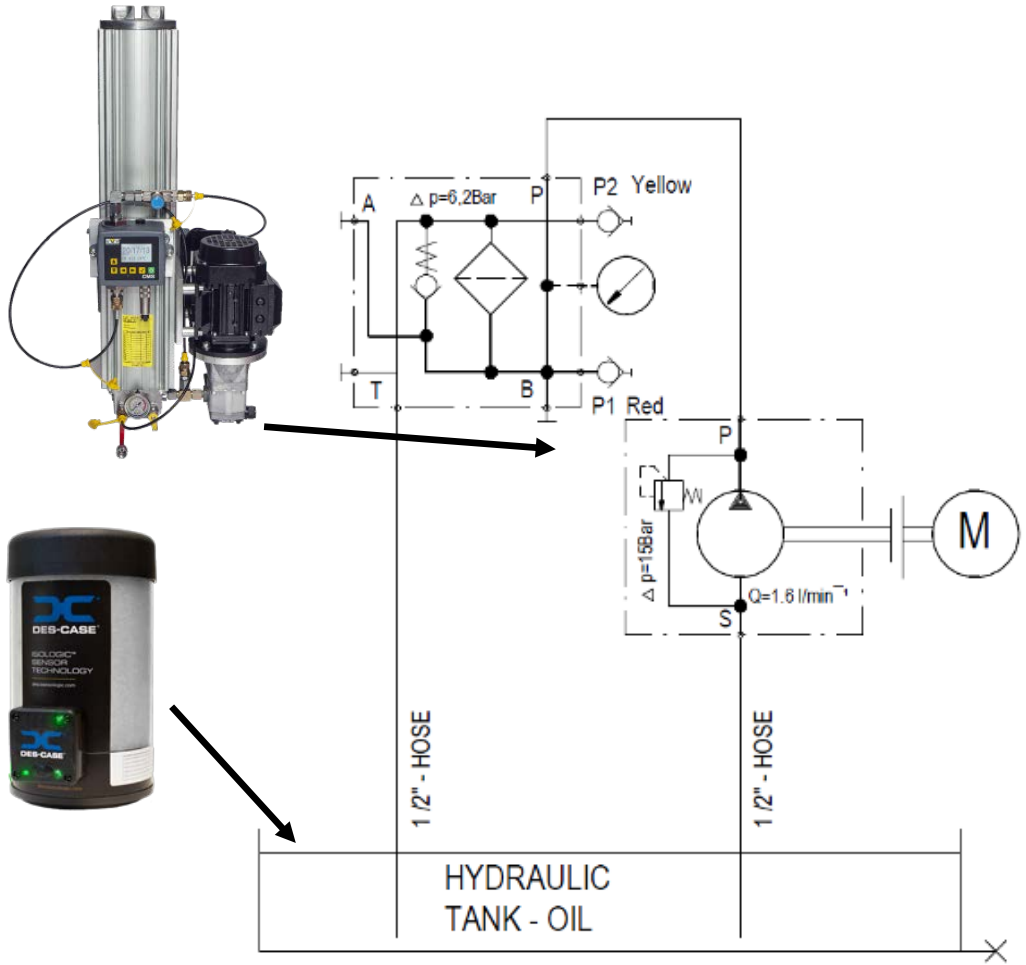
Oil Quality Case Studies

1. Food Processing
   - OQS detected low level contamination < 50ppm
2. Large Gearboxes
   - OQS detected intermittent moisture issue
3. Extreme Installation
   - Monitoring industrial gearboxes where conventional Condition Monitoring methods won't work

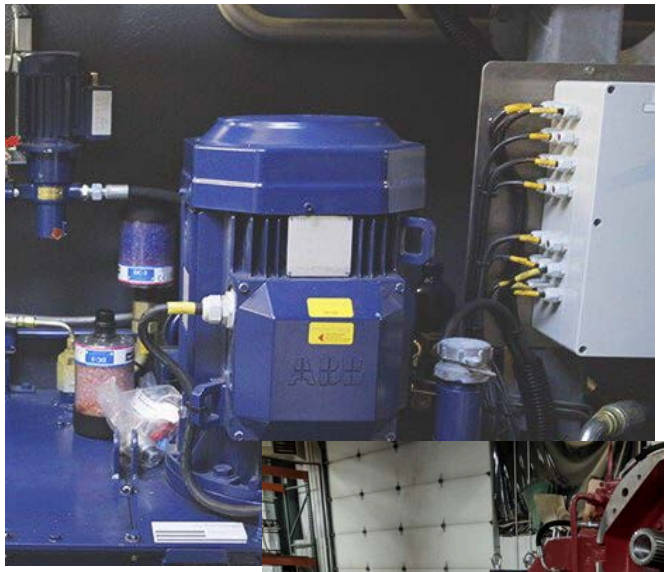


Applying Solutions To Wind Turbine Applications





Application Examples



High Efficiency Filtration & Condition Monitoring Savings

Experience proves that turbines utilising high efficiency filtration and oil condition monitoring program are able to:

- Extend component life
- Maximise turbine productivity
- Minimise unscheduled downtime
- Safely extend overhaul intervals
- Improve repair time
- Increase turbine life
- Reduce maintenance cost
- Reduce product cost

Thank You

DES-CASE®