TANDELTA
Oil Condition Monitoring

Implementing Tan Delta Oil Condition Monitoring

ESG

Contents

About this document

This document and its contents are the sole property of Tan Delta Systems Limited and may not be used for any purpose other than to use Tan Delta technologies and products.

This document is intended to provide more in-depth information to assist equipment owners, operators and manufacturers who are actively considering the implementation of Tan Delta oil condition-based equipment monitoring and active management solutions.

Further specific detailed product information is provided by product specific Data Sheets and Manuals which are available in the product section of our web site. www.tandeltasystems.com Or contact us directly at info@tandeltasystems.com

About Tan Delta Systems

Tan Delta Systems Limited was founded in 2007 in the UK by two engineers who had developed new, but unvalidated theories that suggested a new type of real time oil analysis could provide an answer to the problem of how to actively manage the maintenance of equipment whilst operating, effectively and efficiently.

Following many years of intense R&D which focused on developing theories and concepts into real technology, our unique FSH™ technology was developed which, for the first time, enables highly accurate and reliable analysis of oil condition in real time on active equipment. Further extensive engineering, testing and field trials across the world, confirmed that the analysis data produced by the sensor enabled equipment operators to significantly enhance and optimise the way they managed their equipment through maintenance optimisation.

Built around FSH™ technology, today Tan Delta is a global leader in the provision of condition monitoring technologies and products that provide equipment operators with the information and tools to actively manage their equipment and reduce operating costs whilst simultaneously increasing equipment output.

Equipment monitoring and management is well established as a method to reduce costs and improve productivity. However, Tan Delta technology enables a new level of cost reduction and maintenance optimisation to be achieved and this is driving adoption around the world by leading equipment operators seeking to maximise profits and maintain competitiveness.

Our solutions enable any equipment, operating in any environment to be managed more effectively and efficiently. Our customers include small operators, multi-nationals and equipment manufacturers, all with the common objective of maximising equipment reliability whilst safely minimising maintenance.

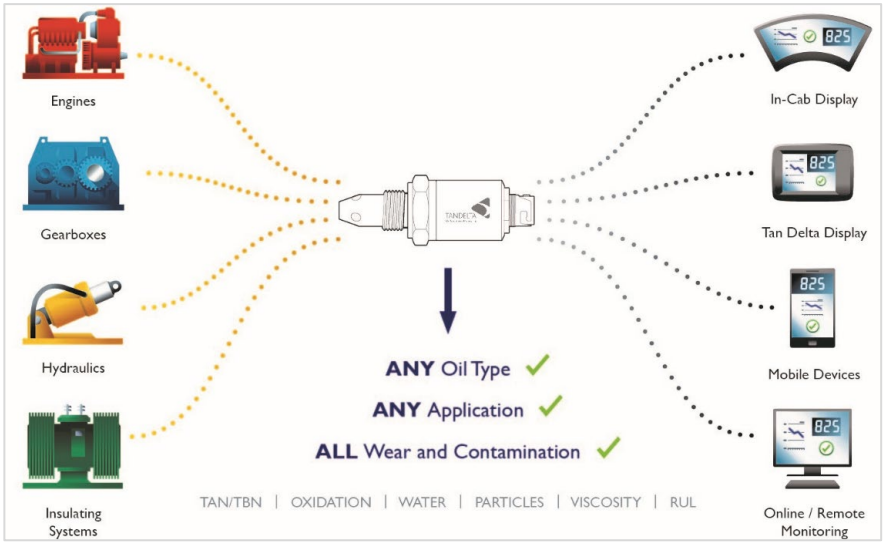
OQSx-G2
Oil Condition Analysis Sensor

Implementing Tan Delta Oil Condition Monitoring

Tan Delta oil condition monitoring (OCM) delivers significant financial benefits through enabling you to optimise your equipment maintenance to the absolute minimum without risk resulting in a multiplier of reduced maintenance costs, improved reliability and reduced waste.

Equipment Types

Tan Delta equipment is designed and engineered to be easily installed and used on any active equipment operating in any environment using any oil type – mineral, semi-synthetic or synthetic. Data is output in a variety of formats which enables easy connection to multiple display options.

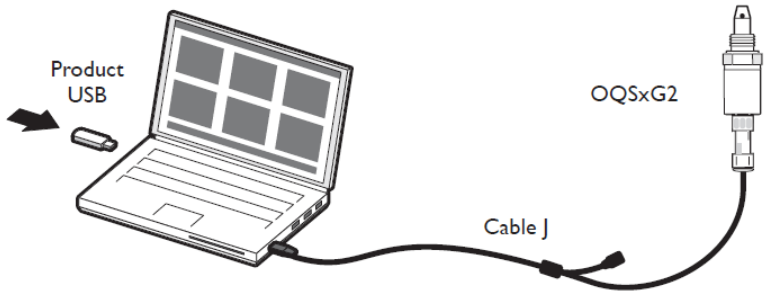


- Our sensor solutions can be used to monitor any gearbox, engine, hydraulic system or electrical insulation system such as a grid transformer – operating within any application and or environment.

Sensor Configuration

- All sensors are shipped with a standard configuration and will therefore work out of the box on any equipment and oil. However, for optimal performance the sensor should be configured to the specific oil type being used. The sensor can be configured to operate in any oil type and this is done by programming the sensor with the relevant Tan Delta Oil Profile.

- Tan Delta maintains a growing database of oil profiles covering most oil types. You can access and search our database using our sensor configuration tool (CADS). Please note the PC you are using must have an internet connection to access and download the profile.



- If you can't find a profile to match your specific oil type, no problem, simply contact our customer support team and they will recommend a compatible oil profile, or you can request that we create a new Oil Profile for the specific oil you want.

- The CADS tool enables the sensor's other settings such as data output and connectivity configurations to be determined as appropriate.

- Using the same process as described above, you can re-configure the sensor at any time.

Where and how to fit.

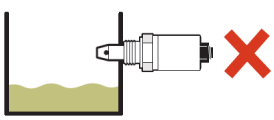
- Correct installation of the sensor is essential for optimal performance and reliability. Care needs to be taken to ensure that the sensor head is immersed in oil which is moving (live) so that the sensor head is exposed to the complete quantity of oil over time.

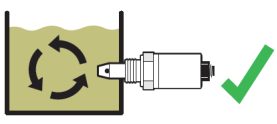
- On most equipment installation is very straight forward and can be undertaken by any maintenance personnel. Installation should take no more than one hour and can be completed in the field or during scheduled maintenance.

- Important factors that need to be considered when installing are: -

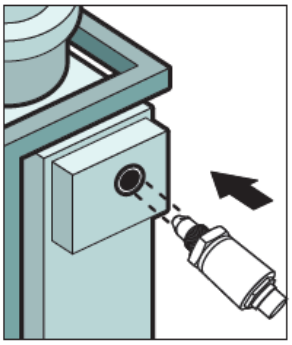
  (i) The sensor is small and very robust and engineered to operate continuously and reliably in any exposed and active industrial or commercial environment. However, care should be taken to ensure that it is in a location where it cannot be easily struck and damaged.

  (ii) The sensor head must be constantly immersed in live (flowing/moving) oil, so the sensor is able to see and analyse a representative sample of the whole body of oil.

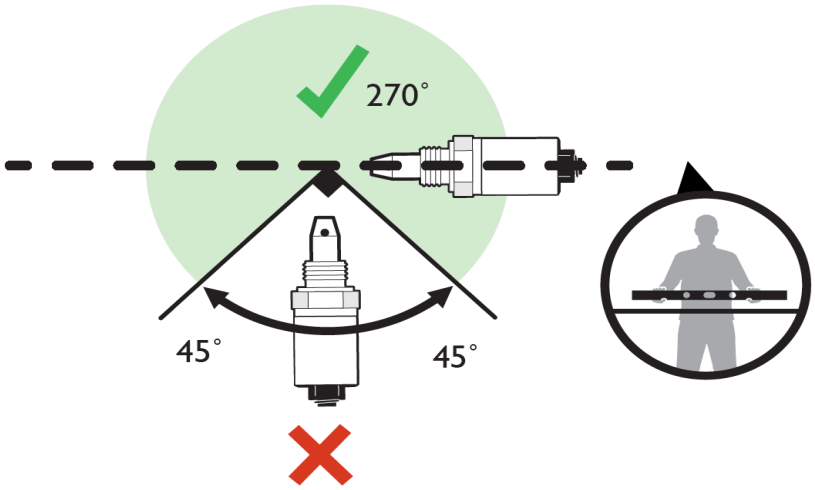




(iii) Typically, the sensor is installed at an existing inspection/sample port, and simply screws into the port in replacement of the existing plug. If a suitable port is not available, then Tan Delta Customer Support can assist and provide other options, such as our standard manifolds.

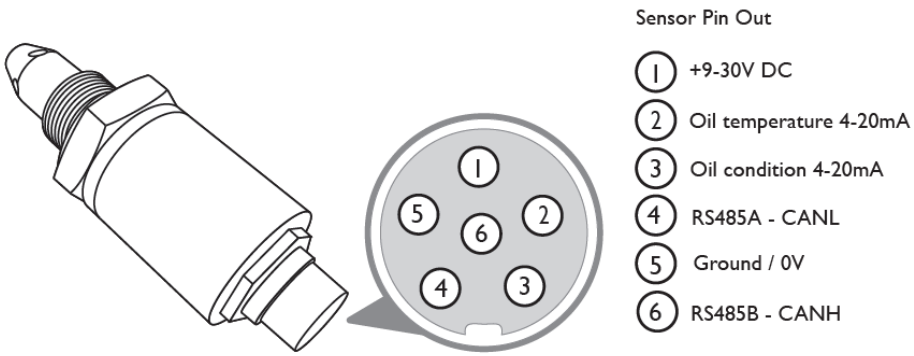


(iv) The sensor will operate in any orientation; however it is important that the orientation is correct as depicted below so that the sensor head does not become obstructed with any large particles or debris in the oil which will then reduce or impair performance.



Connection – Power & Data

- The sensor uses a 6 pin Bulgin 4000 series connector. This single connector provides all power and data inputs/outputs. Tan Delta provides a full range of standard and custom cables to suit any application.



- The sensor requires a continuous power supply to operate (9-30Vdc, at least 100mA). When connected to power the sensor goes through a self-check process which takes approximately 30 seconds. In the event of power-loss the sensor will automatically restart with the same configuration and then continue to report oil condition.

- The sensor supports a variety of data output protocols that include 4-20mA, Modbus, CANbus and J1939 all over RS485, which enables plug and play compatibility with most display and telematic monitoring systems. During the configuration of the sensor you can specify the specific data protocol.

- The sensor outputs the following data values:

  (i) Sensor unique ID – serial number
  (ii) TDN Oil Condition – oil condition scale calibrated from 1200 to 0.
  (iii) Oil condition loss factor expressed as a percentage change from new baseline.
  (iv) Oil Temperature.

Please note: Tan Delta Number and Loss Factor % are mathematically equivalent.

Displaying sensor data.

- The built-in flexibility of the sensor makes displaying the data straight forward. The sensor supports data output in multiple standard formats used by most display and PLC networks and systems. Your options are:

  (i) Dedicated Tan Delta Displays. These offer simple, plug and play display and functionality for our sensors. Connect directly to one or more sensors, display real time oil condition, oil temperature, rate of change, continuous log data and download and or wirelessly stream to your computer or mobile device.

  (ii) Existing monitoring display on equipment. It is likely that these will accept standard industrial data output protocols such as CANbus, all of which the OQSx-G2 supports. In this situation the display may have configuration settings which need to be adjusted so that the sensor data is displayed in a particular section of the display – check the manufacturer's instructions.

  (iii) Telematic systems & modems. You can select the format of data that is most appropriate for your target telematics system and simply connect the sensor to your telematics modem which will relay the data to your system. The information received can then be displayed.

Integrating into your maintenance program.

Once installed you have access to high quality and reliable information on the maintenance status of your equipment. This is easily integrated within your existing maintenance programs to act as the trigger for maintenance action instead of traditional time based maintenance rotas.

The applied principle, is that the sensor provides an accurate statement of oil condition by way of a single number (Tan Delta Number – 'TDN'). This number is also an accurate indicator of the maintenance status of your equipment. The rate of change of this number enables you to forecast when the specific equipment requires maintenance and thus schedule accordingly.

Maintenance Optimisation (DMO)

We recommend that you adopt one of two methods to trigger maintenance.

A - Run to Limit (Traffic Light)

This approach uses two simple values (Limit and Alarm) between which you should undertake maintenance.

The limit value is the point at which you should plan maintenance as is convenient for the operating schedule of your equipment and the alarm value is the absolute latest point at which the equipment should receive required maintenance.

1) Identify the correct Dynamic Maintenance Optimization (DMO™) limit value and alarm value, either in TDN or milliamps (4-20mA), from the tables below according to your application – irrespective of oil type. The different values reflect the characteristics of the specific application types.

DMO™ Value		Diesel Engine	Gas Engine	Hydraulics	Compressor	Gearbox
Limit Value	TDN	400TDN	760TDN	760TDN	650TDN	700TDN
	4-20mA	13mA	9.4mA	9.4mA	10.5mA	10mA
Alarm Value	TDN	300TDN	660TDN	660TDN	600TDN	500TDN
	4-20mA	14mA	10.4mA	10.4mA	11mA	12mA

1) If the sensor is not integrated into an existing logging & analytics system, make a note of the live TDN value at regular intervals (based on your inspection schedule). We recommend once a day if possible to give you an accurate trend. You can use the Tan Delta tracking template document and simply write it down, or a simple spreadsheet, or if you have a more sophisticated application the data can be imported.

2) Once the live TDN or 4-20mA value reaches the *Limit Value* then it is time to plan maintenance within a reasonable period of time – but before the *Alarm Value* is reached. If the live TDN limit reaches the alarm value, then the oil is now not fit for purpose and immediate action must be taken as damage and lower equipment efficiency is now highly likely.

B - Predictive

1) Identify the correct Dynamic Maintenance Optimization (DMO™) value, either in TDN or milliamps (4-20mA), from the table below according to your application. The different values reflect the characteristics of the specific application types.

DMO™ Limit Value		Diesel Engine	Gas Engine	Hydraulics	Compressor	Gearbox
Limit Value	TDN	400TDN	760TDN	760TDN	650TDN	700TDN
	4-20mA	13mA	9.4mA	9.4mA	10.5mA	10mA
Alarm value	TDN	300TDN	660TDN	660TDN	600TDN	500TDN
	4-20mA	14mA	10.4mA	10.4mA	11mA	12mA

2) If the sensor is not integrated into an existing system, make a note of the live TDN value at regular intervals (based on your inspection schedule). We recommend once a day to give you an accurate trend. You can use the Tan Delta tracking template document and simply write it down, or a simple spreadsheet, or if you have a more sophisticated application the data can be imported.

3) Calculate the rate of change (RoC) each time, by subtracting the previous TDN reading from the live one and divide by the days or hours between them.

4) Subtract the live TDN from the previously recorded TDN value and divide by the RoC. This will give you an accurate estimate of the time until your equipment requires maintenance (ETM – estimated time to maintenance) based upon its actual condition and operating status.

Example:

Asset: Transmission – Fracking Rig
Oil Type: Shell Spirax – Synthetic S6 CXME 10w40
Limit Value: 400 TDN
Alarm Value: 300 TDN

Date & Time	TDN	ROC	ETM
01.03.20 – 13:00	800	0	
03.03.20 – 14:00	780	20/2 = 10	780 - 400 / 10 = **38 days**
05.03.20 – 10:00	760	20/2 = 10	760 – 400 / 10 = **36 days**
07.03.20 – 16:00	739	21/2 = 10.5	739 – 400 / 10.5 = **32 days**
10.03.20 – 08:00	717	22/2 = 11	717 – 400 / 11 = **29 days**

This example shows that as of 10th March 2020, the condition status of the equipment is fine with a TDN of 717, and based upon the same usage pattern, maintenance should be planned for 29 days' time in the future.

Please Note:

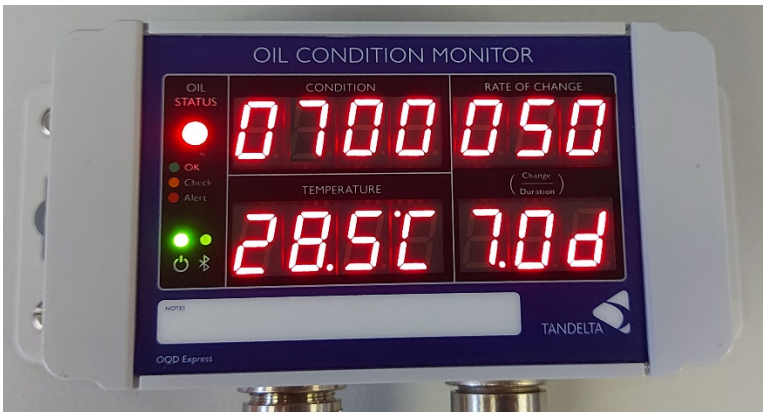
- If you connect the sensor to the Tan Delta EXPRESS display the RoC calculations are automatically done for you with constant updates. The RoC is continuously displayed, and you can configure maintenance notice alerts, for example a 10 and then 2 day ETM alert for convenience.

The above display is on a gear box on a mine rock crusher where the limit value is 700 and the alert value is 500. It shows the equipment maintenance status is OK with a live oil condition of 860TDN and a RoC of 40TDN per seven days. As such in around 4 weeks maintenance should be planned but undertaken within 8 weeks of that point. So the latest time this gearbox requires maintenance is in 12 weeks.

- Equipment maintenance status is constantly changing and is not linear, thus using the linear method above where the latest rate of change is assumed to be constant going forward will result in some accuracy variance which reduces to almost zero towards the absolute DMO™ point (alarm value). As such we recommend targeting the mid point between the Limit and Alarm value if using the linear method. If more accurate forecasting is required, which considers the non-linear variations to predict the ETM, the accuracy of our sensor allows this, please contact Tan Delta Customer Support for further guidance.

Advanced Fault Detection (AFD™):

Fault detection is achieved by the sensor detecting unexpected changes in oil condition. This is reflected in an unexpected change in the rate of change. The magnitude of that change is an indicator of cause and severity.



Tan Delta EXPRESS display has generated an alert (RED LED) because the rate of change has changed to 50 from 40 which is a change of more than 5%. The oil condition remains OK, but the alert indicates there is a hidden issue which requires inspection within a reasonable time period.

- As a general rule of thumb, if the expected rate of change, suddenly changes by more than 5% this indicates there is an issue and you should inspect your equipment within a reasonable time period.
- If the RoC changes more than 10% this indicates a major issue and immediate inspection and possible shut down should occur to prevent damage.
- Extreme changes indicate specific failure modes and thus necessary action should be taken immediately. Fuel in the oil will result in TDN spiking to +1060, insufficient oil +1140 TDN and if the oil becomes completely unserviceable, <350TDN.

Sensor Maintenance:

- Once installed and configured the sensor does not require any maintenance.