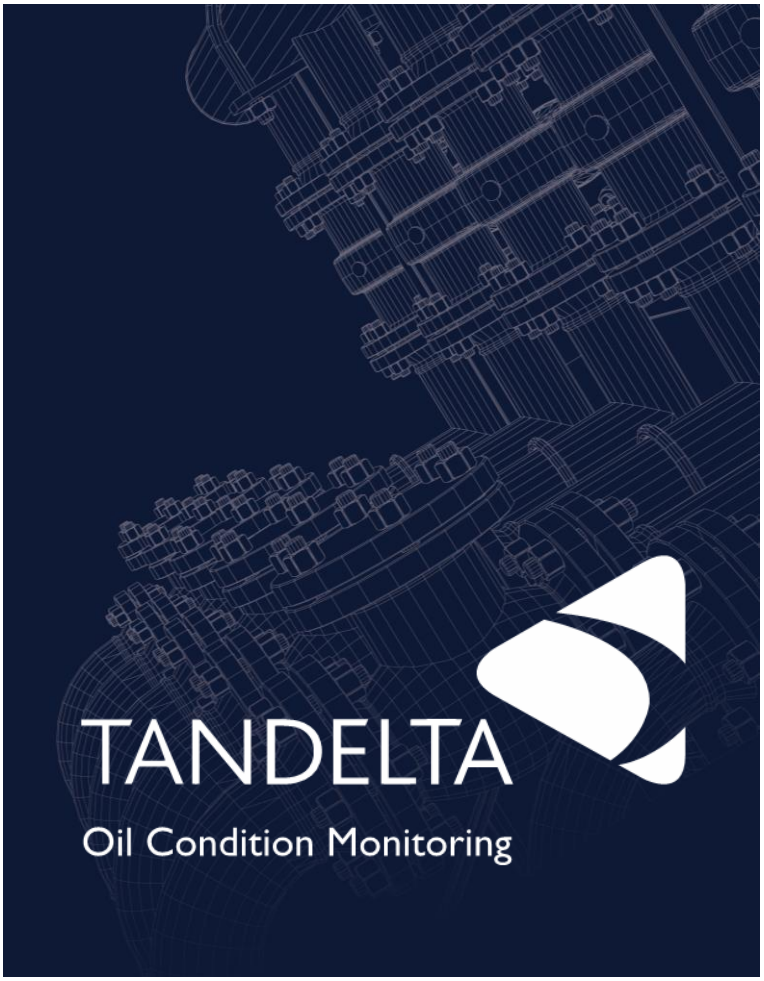

APPLICATION GUIDELINES

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1 Introduction to the Guide

Different applications present varying challenges to effective lubrication and have different effects on the oil used to lubricate them. As such the Tan Delta sensor will provide different data trends which should be viewed and analysed accordingly. The following document will provide guidance on these differences to allow you to maximise the potential of Tan Delta Oil Quality Sensors and provide real operational benefits.

The following information provides a general overview of 4 common applications, however within each of these, there are many factors which can affect the sensor readings. As such, we can always offer bespoke advice to our individual customers.

2 Different Types of Application

Tan Delta Systems Oil Quality Sensor (OQSx) is designed to accurately detect any changes in oil condition no matter what the cause in any oil on any application. This guide will concentrate on the main four application areas; engine, gearbox, hydraulic and transformer. Each of the four areas would normally encounter only a small number of potential oil failure modes, these are listed below:

- Engine – Additive Depletion and TAN/TBN Change / Water or Coolant Contamination
- Gearbox – Contamination (water/incorrect oil) / Accelerated Oil Wear / Air
- Hydraulic – Contamination (water/incorrect oil) / Accelerated Oil Wear / Air
- Transformer – Water / Insulation Breakdown (dissolved gases)

As we are confident that in most cases each application will only encounter a small number of potential failure modes we can also be confident in what to expect from the OQSx in terms of behaviour to overall oil condition changes.

2.1 Engine Oil

In an engine application we expect to see a significant change in oil condition over time and an increasing decline in Tan Delta Number (TDN). This is mainly due to the combustion process of the engine and subsequent high operating temperatures which cause significant chemical changes. When we graph the OQSx data in general we should expect to see something similar to the graph below in Figure 1.

Figure 1 – typical engine oil life cycle.

Alert and alarm levels should be set to reflect the engine oil degradation pattern, this will always be application and environment specific however a general rule of thumb would indicate that a new oil would start its life at approximately 900 TDN. To ensure maximum protection of the asset, the alert level in the example above has been set at 600 TDN as an early warning system and then the alarm level set at 450 TDN. Over a period of time,

and in conjunction with laboratory analysis, these limits can be fine-tuned to be optimised specifically for the installation.

2.2 Gear Oil

When we consider a gear application, we would expect different behaviour to that of engine oil. Under normal operation, assuming the gears are in good condition and the lubrication is correctly specified, then the data should remain fairly flat, with a gradual rate of decline. Any deviation from the flat line should be considered a call to action, initially to qualify the oil condition via laboratory analysis. In extreme cases where oil change is very severe (300TDN+) then immediate shut down or oil change may be the required course of action. Increased rate of change can be caused by a variety of issues, including;

- Contamination from water or other external substances.
- Incorrect oil – For example topping up mineral oil with synthetic oil or vice versa.
- Oxidation due to high friction or overloading and the subsequent increased temperature and wear metals.
- Poor oil change – This can leave behind various chemicals that attack the anti-oxidant additives and promote quicker deterioration. The sensor can be used to check oil changes are being carried out correctly, as the readings should always return to the same 'clean point'.

Dependant on the application and environmental conditions, gear oil should have a very long useful life, unlike that of an engine oil. There is a tendency for operators and maintenance personal to reduce oil sampling frequencies because of this, so having the OQSx installed on critical assets provides confidence that the condition of the oil is monitored 24 hours a day 365 days a year.

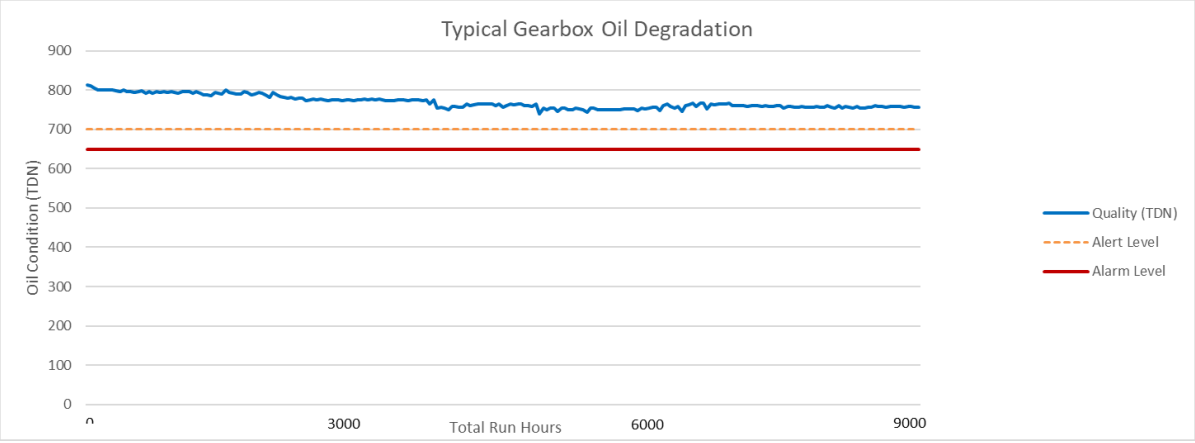

Figure 2 – typical gearbox OQSx output data.

Figure 2 above illustrates what should be expected from the OQSx real-time oil condition data. From above we can see a slow decline in oil condition of a 9000 hour period, the alert and alarm levels are set to ensure that any deviation from normal operation are detected immediately and the operator is notified.

2.3 Hydraulic Oil

In a hydraulic system we would expect to see a similar pattern to that of a gearbox application, however most hydraulic systems are susceptible to water ingress mainly due to the oil reservoir tank. As the tank breathes when oil levels increase and decrease moisture can be drawn through the tank filter and introduce water to the lubrication system. If not handled correctly this can have adverse effects on the hydraulic system including corrosion of pipework and in most cases will be very expensive and time consuming to resolve.

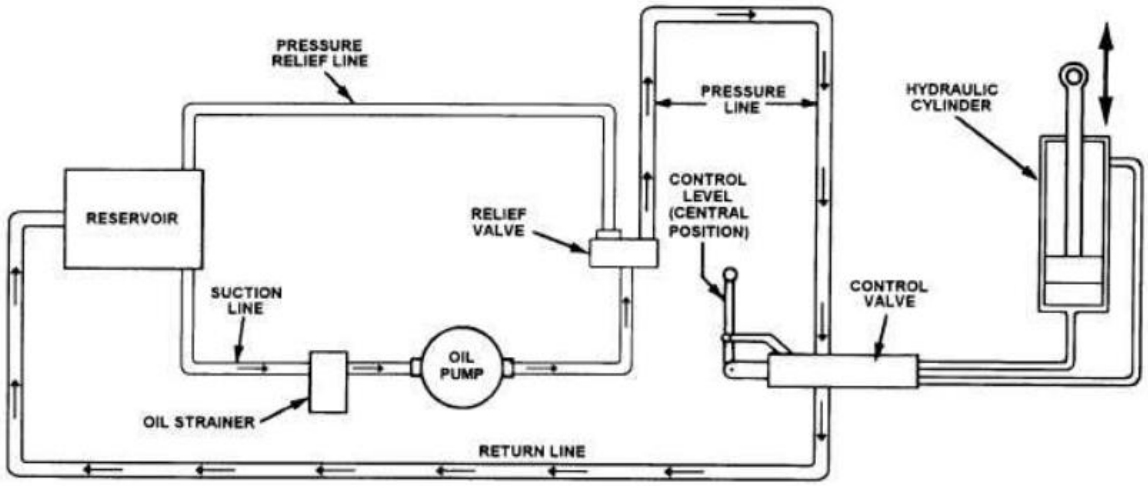

Figure 2 – Hydraulic system schematic diagram.

Increased temperature is a major cause of problems in hydraulic systems at it causes the oil to break down. This begins to occur in mineral oils once the temperature is over 60˚C and increases at an exponential rate as the temperature rises. By measuring both the oil temperature itself and the chemical changes occurring as a result, the Tan Delta sensor gives operators the best possible chance to prevent oil breakdown and varnishing. High fluid temperatures are often a result of underlying machine issues, and so a proactive response to this can help avoid significant problems.

Another major cause of problems is aeration and/or cavitation. The sensor gives very high readings when exposed to air, and so sudden upward spikes can be indicative of this.

2.4 Transformer Oil

As with the hydraulic and gearbox oil in a transformer oil system we would expect to see very little change in oil condition. Most operators have established knowledge of the useful life of oil in transformers and employ an oil filtering system to maximise oil life and also to ensure critical high value assets are protected. Generally, a shift of +/- 50TDN is a signal that significant enough change has occurred to warrant a sample being taken for analysis.