Application Note

Laboratory Density & Concentration Measurement

Determining the kerosene content in helicopter turbine oil using a DMA 35N EX Petrol

Introduction

With some helicopter turbines, such as the Artouste III B from Turbomeca, kerosene enters the oil system and changes the composition of the oil.

The reason for this permanent ‚thinning' of the turbine oil with kerosene could be:

-) Leakiness around the fuel pump
-) Leakiness around the fuel controller
-) Leakiness around the injection pipe
-) Leakiness around the „flexibox"

When the kerosene concentration in the turbine oil reaches a certain level, safe operation of the engine can no longer be ensured. Therefore, after a given number of operating hours, the kerosene concentration in the oil must be checked.

Hints:

-) The descriptions and data given in this report apply to the „Artouste III B" turbine.

-) However, other turbines have this problem and the DMA 35N EX Petrol can also be used here for control measurements.

-) Table 1 gives an overview of turbine types and the helicopter models they are used in.

Turbine	**Helicopter**
Artouste II C	Alouette II SE 3130
Artouste III B	SA 315 B Lama, SA 316 B Alouette III
Astazou II A	SA 318 Alouette II
Astazou III C2 and III N2	SA 341 Gazelle
Astazou XIV B and XIV F	SA 319 B Alouette III
Astazou XIV H and XIV M	SA 342 Gazelle
Turmo III C7	SA 321 Super Frelon
Turmo III C4	SA 330 Puma
Turmo IV C	SA 330 Puma

Table 1: Overview of the turbines from Turbomeca in which oil thinning must be measured. (Source: http://www.turbomeca.com/public/en/societe/turbines_home.php)

After every 25 operating hours, the kerosene concentration in the oil must be checked.

According to the manufacturer, operation of the turbine must be stopped when the kerosene concentration reaches 10% w/w or mechanical defects may occur.

Traditionally, these measurements are carried out with fragile glass areometers. The disadvantages of these areometers are the large sample volume required, the complicated procedure and relatively long analysis time. Sometimes it is also necessary to adjust the glass areometer with a weight (e.g. a metal ring) to suit the engine oil.

The portable density meter DMA 35N EX Petrol performs the measurement quicker and easier, and requires a minimum amount of sample.

Measuring principle

The density of the oil/kerosene mixture is measured in a hollow, oscillating U-tube. The oscillating frequency of the U-tube is directly dependent on the density of the sample.

The addition of kerosene changes the density of the oil. Therefore, knowledge of the density of the oil/kerosene mixture gives insight into the kerosene content. The higher the kerosene content, the lower the density of the mixture.

Hint:

-) To make the measurement even more convenient, a polynomial function can be integrated into the DMA 35N EX Petrol. This calculates the kerosene concentration from the measured density and displays the result.

-) To develop a suitable polynomial requires a table with the density of the oil/kerosene mixture as a function of the kerosene content (see Table 2, Appendix A).The density values are dependent on the oil and kerosene used. A different polynomial must therefore be developed for each product.

Adjustment

The DMA 35N EX Petrol is already adjusted when delivered.

Readjustments are quick and easy, requiring only distilled water. Experience has shown that adjustments are only required twice a year.

Filling sample and measurement

The sample is filled directly from the turbine through the filling tube of the DMA 35N EX Petrol (see Fig. 1):

Fig.1 Filling sample from the oil container

-) Press the pump lever on the DMA 35N EX Petrol.

-) Dip the filling tube into the oil.

Hint:

-) The standard filling tube is 16 cm long. To fill samples which are harder to reach, a 60 cm tube can be used.

-) Release the pump lever. This fills 2 to 5 ml of sample into the measuring cell of the DMA 35N EX Petrol.

-) Take the filling tube out of the oil container.

-) Within seconds, the result can be read off the large, digital display, and stored.

If a polynomial function has been integrated (see “measuring principle”), the result is shown directly as % kerosene content. Independent of the current sample temperature, the automatic temperature compensation immediately gives a comparable measuring value at 20 °C.

The whole measuring range is covered by a single instrument.

-) After reading off and storing the result, place the filling tube over a waste vessel and press the pump lever. The measured sample is removed from the measuring cell.

-) Up to 1024 measurements can be stored, manually or automatically, in the integrated memory of the DMA 35N EX Petrol.

Hints:

-) To obtain correct measuring results, the sample temperature must be between 0°C and 40 °C.

-) When a series of samples is measured, the measuring cell should be rinsed once with new sample before the measurement to prevent carry-over effects.

Cleaning

After completing the measurements, the measuring cell must be cleaned with a suitable solvent:

1) Press the pump lever on the DMA 35N EX Petrol.

2) Dip the filling tube into a vessel full of solvent. Release the pump lever. This fills the measuring cell with solvent.

3) Leave the solvent in the cell for a short time.

4) Place the filling tube over a waste vessel and press the pump lever. The solvent is removed from the measuring cell.

5) Repeat steps 1) to 4) until there are no more sample residues in the measuring cell.

Accessories

Stored measuring values are transferred via an optional infrared/RS 232 serial interface. The data can be sent to a printer or a PC with RS 232 interface.

Features and benefits of the DMA 35N EX Petrol

- Small sample volume (2 to 5 ml)
- Covers the whole measuring range
- Automatic temperature correction
- Measuring uncertainty 0.001 g/cm^3
- Memory for up to 1024 results
- Interface for data transfer to computer or printer
- Robust design
- Large, easy-to-read digital display

Appendix A:

Table 2, excerpt: „Density of an oil / kerosene mixture (2 – 10%w/w kerosene, 20 – 30 °C)“

Hint:

-) *This table is only an example; The density values are dependent on the oil and kerosene used. A different polynomial must therefore be developed for each product.*

°C	2% Kerosene	4% Kerosene	6% Kerosene	8% Kerosene	10% Kerosene
20	0.9679	0.9644	0.9610	0.9575	0.9540
22	0.9665	0.9630	0.9595	0.9560	0.9526
24	0.9650	0.9615	0.9581	0.9546	0.9511
26	0.9636	0.9601	0.9566	0.9532	0.9497
28	0.9621	0.9586	0.9552	0.9517	0.9483
30	0.9607	0.9572	0.9537	0.9503	0.9468