

# Pearl™: New and Used Motor & Hydraulic Oils

The Pearl™ allows the quick, easy & highly repeatable IR spectral measurement of liquid samples.

**FTIR ABSORPTION SPECTROSCOPY** is an ideal analytical technique to characterise new, used and diluted motor oils, as well various other samples.



**Service oils**, like Castrol's Magnatec engine oil, are designed to minimise wear-and-tear in engines.

After a while, the oils **pick up elemental metals, soot and other contaminants** which turn the fresh yellow oil into a dark and worn black.

IR spectral analysis can help determine which contaminants are present, as well as what kind of **chemical degradation** occurs in the oil.

Traditionally, a vertically mounted cell was always the standard method of loading **viscous or sticky fluids**, which posed many problems including sample introduction and clean up.

However, The Pearl™ liquid transmission accessory is designed to make the IR spectral measurement of liquids **quick, easy and highly repeatable**.

## Equipment and Samples

The Pearl™ accessory (P/N **GS31000-B**) was used in conjunction with fully-wedged ZnSe windows in the Oyster Cell. Three different pathlengths were used; 25, 50 and 100 microns. See the part numbers in **Table 1**.

Pathlength	Part number
25 µm	GS31226
50 µm	GS31221
100 µm	GS31222

Table1: Pathlengths & part numbers used.

The **oil samples tested** included a fresh sample of Castrol Magnatec, as well as a used sample after **18 months of use** in a petrol engine.

Fresh Renolin CL37 and 68 oils were also analysed. The spectra were recorded with a **1 cm<sup>-1</sup> resolution**, using The Pearl™ coupled with an FTIR spectrometer.

## The Results

**Figure 1** shows three spectra for a **fresh sample** of Castrol Magnatec motor oil, recorded using three different pathlengths: **25, 50 and 100 µm**.

The absorbance **increases with increasing pathlengths** in the Oyster Cell, as can be expected.

It is worth noting that the oil samples had **not been diluted**, so they were at their maximum concentration during analysis. Despite this, the maximum absorbance in fingerprint region (500 – 1500 cm<sup>-1</sup>) **peaks at 2.5 for the 100 µm pathlength**.

This demonstrates that no dilution or sample preparation is needed to record the transmission spectrum of oil samples with **25, 50 or 100 µm pathlength** windows.

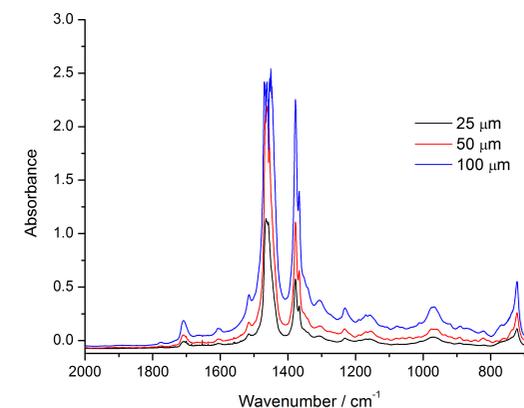


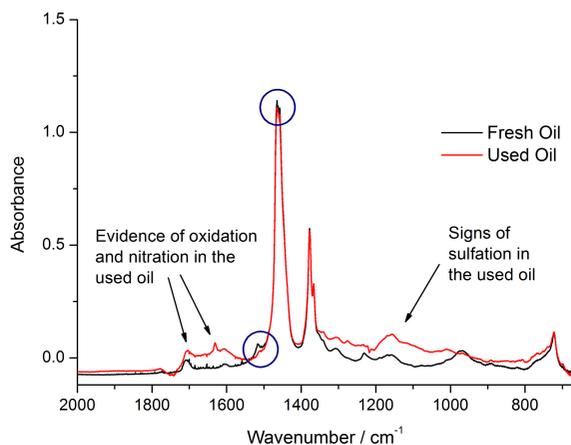
Figure 1: IR spectra of fresh Castrol Magnatec.

**Figure 2** compares the spectra of fresh and used Castrol Magnatec oil samples using a **25 µm pathlength**.

Very little sample, < **5 ml**, was needed to quickly differentiate the oils.

The used sample shows evidence that the oil has been **chemically altered** and that contaminants have been introduced.

Around  $1150\text{ cm}^{-1}$ , the **hallmark signs of sulfation** are visible, while the region of  $1600 - 1700\text{ cm}^{-1}$  shows evidence of oxidation and nitration in the oil.



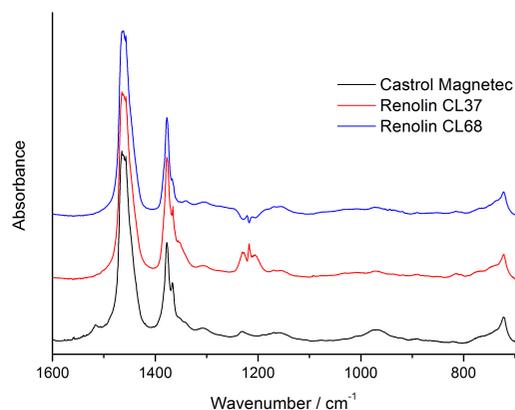
*Figure 2: A comparison of new & used Castrol Magnatecs.*

Conversely, there is a loss of relative signal intensity at  **$1500$  and  $1460\text{ cm}^{-1}$** .

This is marked by blue circles and indicates there is less of the original oil in the used sample.

**Figure 3** compares three different fresh oil samples measured using a  $25\text{ }\mu\text{m}$  pathlength, in black, red and blue, respectively:

- **Castrol Magnatec engine oil**
- **Renolin CL 37 hydraulic oil**
- **CL 68 hydraulic oil**



*Figure 3: A comparison of the three oils.*

Clearly, the oils share a similar aliphatic band at  **$1470\text{ cm}^{-1}$** , but their other molecular signatures are different.

### Conclusion

**FTIR spectroscopy** is a well-known tool for the characterisation of various samples.

This note highlights that **viscous oil samples** can be analysed **simply and quickly** using three different pathlengths in The Pearl™.

**Very little sample** was needed to differentiate the two oil samples.

Moreover, the used samples showed evidence that contaminants had been introduced over time through use and contact with machinery.

The subtle spectral signatures between different oils, whether fresh or used shed light on the chemistry of the samples.

A loss of signal intensity at certain frequencies indicated that the original oil sample had been **chemically degraded** through use in a car engine.

The fact that the maximum absorbance in the fingerprint region ( $500 - 1500\text{ cm}^{-1}$ ) peaked at 2.5 for the  $100\text{ }\mu\text{m}$  pathlength shows that a few drops of pure sample is enough to record top quality transmission spectra.

More in-depth studies to determine how quickly the oils degrade with use can easily be carried out using **The Specac Pearl™**.

Email [sales@specac.com](mailto:sales@specac.com) or visit [www.specac.com](http://www.specac.com)

