Motor Oil Analysis

It is helpful when investigating the composition and source of pollution that possible contributors have been sufficiently characterized. Hence, there is a motivation for analyzing various oils, fuels, *et cetera*. Patrick Ferree – under the guidance of Anita Johnson – prepared samples of motor oil via atomization onto Teflon filters, and analyzed these samples using a Fourier transform Inferred Spectrometer (FTIR). The atomizing process is illustrated in the following simplified schematic:

Motor oil (in Pyrex bottle) → Atomizer → Teflon filter → Controller → Pump

The actual construction was slightly more involved. On the day of atomization, Janin, Anita, and Patrick arranged the plumbing such that the atomized sample was directed both onto Teflon filters, as well as to an Aerosol Mass Spectrometer (AMS). This required that flow be low enough for the AMS, but high enough to deposit a detectable mass of sample on the Teflon filters. The trouble was that motor oil does not atomize easily, and higher flow levels were required than predicted. Of the five samples collected for the FTIR analysis, only two had collected enough oil for any further analysis.

The Teflon filters were analyzed using the lab's FTIR. The IR spectra are shown in Figure 1 alongside spectra for fog oil and ship diesel atomized by Amanda and Anita at a different time. Each spectrum has been normalized to the maximum absorbance. In this case the intensity is not of interest, but rather only the individual spectral fingerprints. As expected, between 4000 and 1500 cm^{-1}, only signature peaks for alkanes are observed. The spectrum for each motor oil sample is essentially identical. The three observed peaks occur at 2851.84 cm^{-1}, 2920.96 cm^{-1}, and 2953.60 cm^{-1}. In general, these peaks do not provide unique information other than suggesting that alkane sp^2 C-H stretching is present.[1] However, a brief comparison is possible between the oils and the diesel. For both the fog oil and ship diesel, the maximum peak occurs at 2922.88 cm^{-1}, which is for all purposes the same as that seen in the motor oil. More interesting, though, is the ratio of peak intensities. One can see in Figure 1 that each substance has a particular ratio. For instance, consider the peaks occurring at 2851 cm^{-1} and 2920 cm^{-1}. Here motor oil and ship diesel both have a ratio of 0.81. However, a clear difference is observed between 2920/2953 cm^{-1}, where ship diesel has a ratio of 0.84 and motor oil shows a ratio of 0.64. This kind of observation is useful for drawing distinctions.

Patrick also checked for organonitrates and organosulfates by analyzing the spectra and looking for peaks at 860.9 cm^{-1}, 755 cm^{-1} and 1278.6 am^{-1}. There were no indications of peaks in these areas.

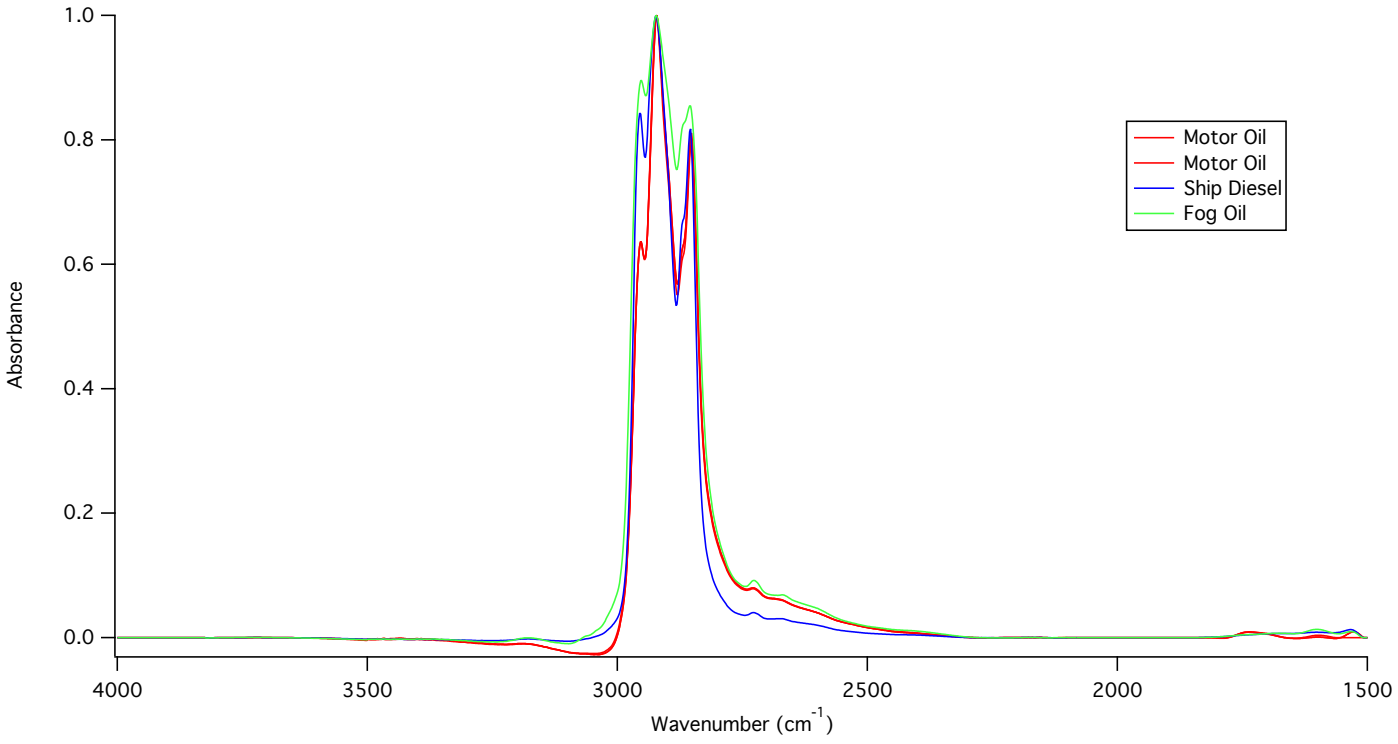

Figure 1.

[1]Pavia, Donald L. *et al*, *Introduction to Spectroscopy,* 3rd Edition, Thomson Learning, 2001.