Application of Raman Spectrometer

In partnership with IMA Ltd, ISI has developed a robust high performance spectrometer for use in gas pipelines. This challenging application takes advantage of the high etendue of the spectrometer combined with a low noise detector to measure the Raman signals of liquids from a distance of 2.5 m. The instrument was built within a weather proof enclosure for application in the field.

In order to recover enough photons to return the spectra from the samples a large recovering aperture was required, increasing the system etendue. This restricted the use of conventional Czerny Turner systems . However the ISI spectrometer recovered excellent spectra with a high level of spectral resolution < 4 cm^{-1}. The specifications for the instrument are given in Table 1.

Parameter	Specification
Operating wavelength	785 nm
Laser power	500 mW
Laser divergence	4 mrad
Resolution	4 cm^{-1}
Range	150 – 2700 cm^{-1}
Detector QE	70 % (@785 nm)
Dark noise	0.04 e/s
Receiving aperture	75 mm (diameter)

The instrument measured liquid samples of MEG, TEG, Methanol, and Xylene. The depth of the liquids was typically 20 mm but measurements were also made when less than 2 mm of liquid present.

The resulting spectra for each of these species are presented below.

The first liquid **examined** was xylene.

Figure 1 shows the returned measurement for a 20 mm, < 2 mm sample as well as the raw spectra gathered from the bottom of the pipe when no liquid is present.

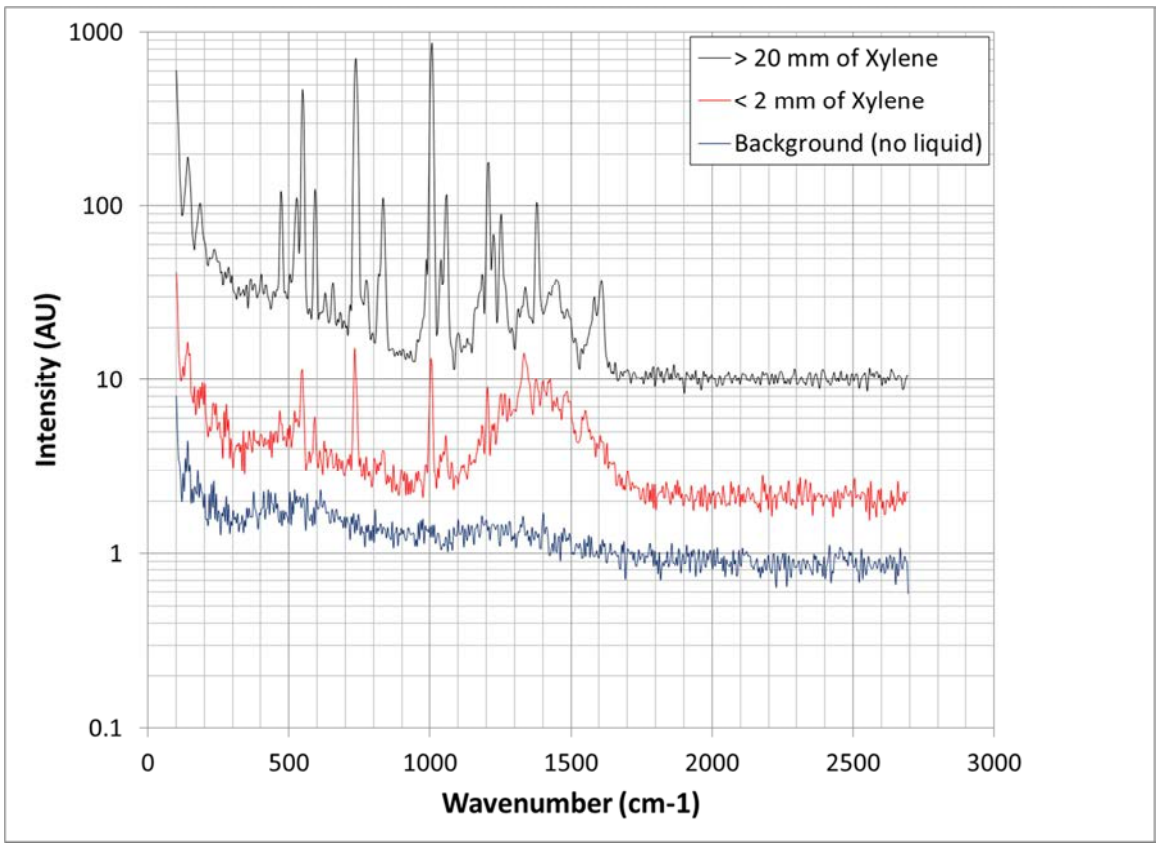

Figure 1 *Xylene spectra: Black line = 20 mm of Xylene; Red line = < 2 mm of Xylene; Blue line = no liquid present*

The complete Xylene spectra is observed with multiple peaks being present when 20 mm of liquid is intercepted by the instrument. But even when only a 2 mm is used clear peaks can still be determined. Figure 2 shows spectra gathered for Methanol. The 20 mm sample of Methanol returns the clear Raman spectra expected. As with the Xylene peaks are sobered in the 2mm sample.

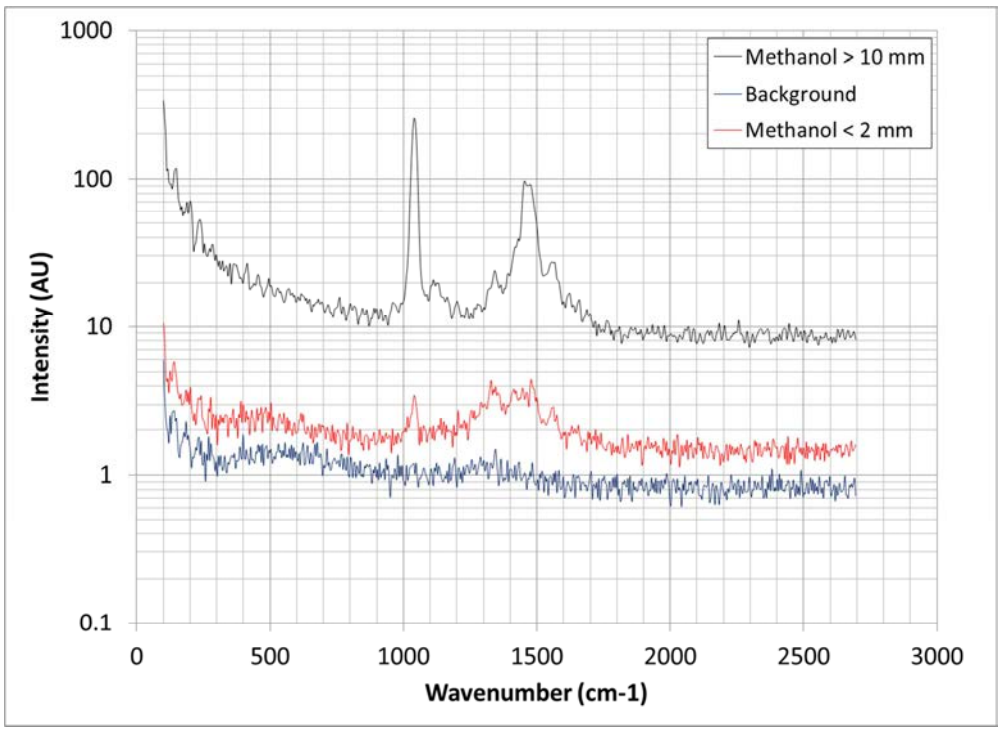

Figure 2 Methanol *spectra: Black line = 20 mm of Methanol; Red line = < 2 mm of Methanol; Blue line = no liquid present*

Figure 3 shows the Raman spectra for triethylene glycol (**TEG**), and ethylene glycol (**MEG**), chemicals common used to remove moisture from a gas stream. There raman spectra are very similar as expected but some differences can be clearly observed between the two liquids.

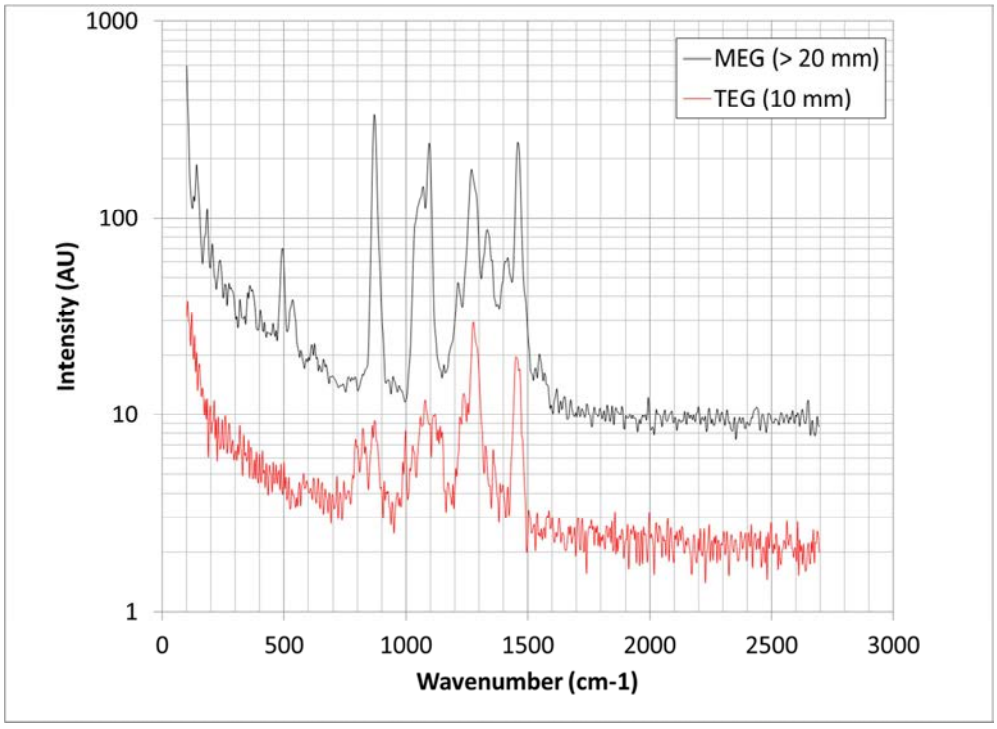

Figure 3 *Black line = 20 mm of ethylene glycol (MEG); Red line =* triethylene glycol *(TEG)*

In addition to these pure liquids Raman spectra has also been taken of a couple of more household items. Notably Vodka and an adhesive remover. From the spectra as expected the Vodka clearly shows peaks indicative of alcohol. The adhesive remover shows multiple peaks demonstrating that is a has a relative complex structure.

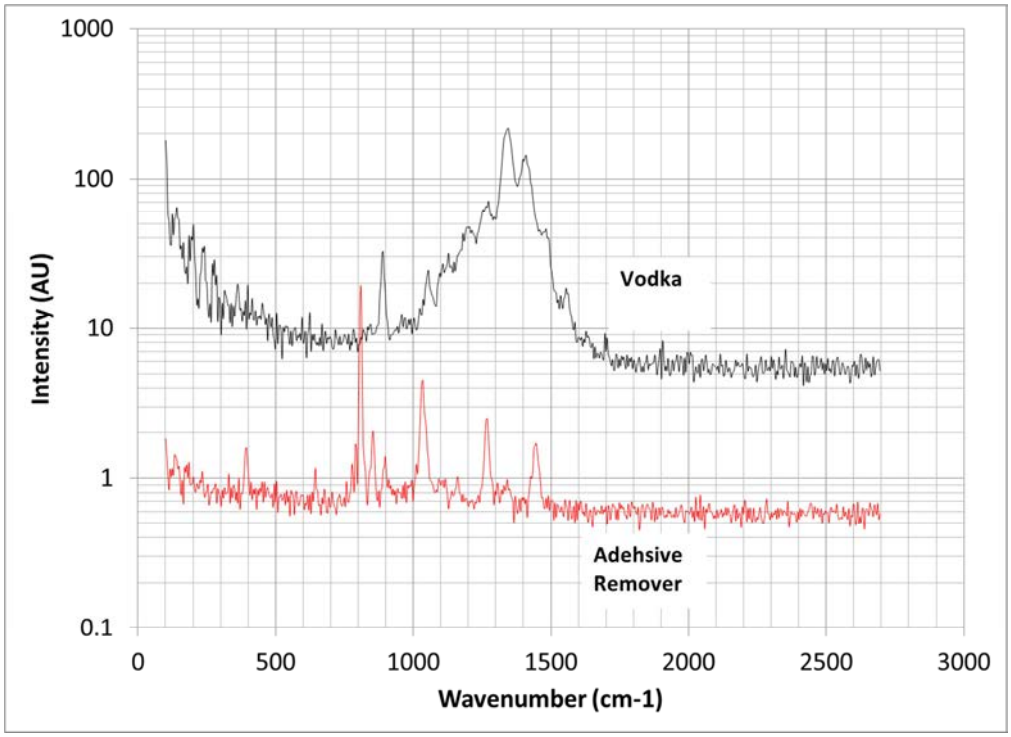

Figure 4 *Black line = Vodka; Red line sample of adhesive remover*