



Heavy Oil

Industry: Oils and Gas
Product: NR800

New Refinery Applications

Applications of FT-NIR to gasoline and diesel blending and the economic benefits are well known in the industry¹. With the introduction of the Yokogawa InfraSpec NR800 it is possible to develop new applications for samples that formerly could not be measured by on-line NIR instruments. The InfraSpec NR800 has a much higher light throughput than previous on-line FT-NIR instruments. Measurements on crude oil, atmospheric residues, heavy oils and lubes are now possible. In this note, we review a typical application for dark heavy heater oil.

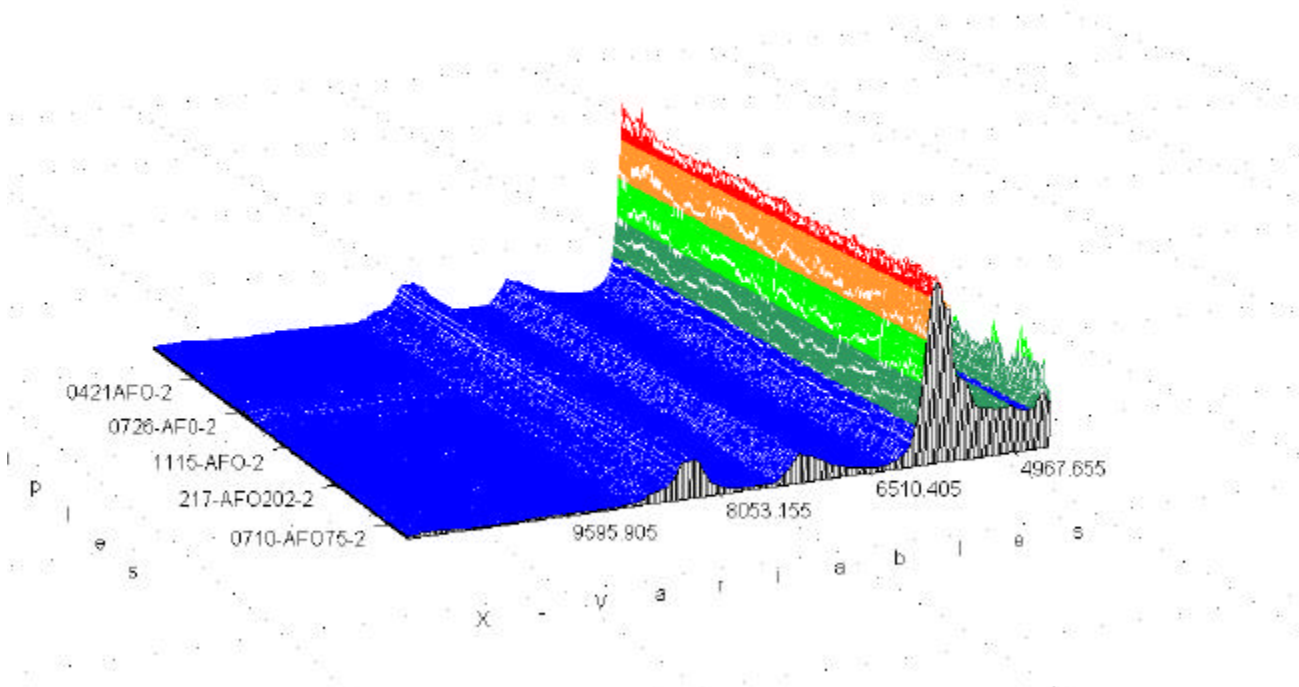


Figure 1: 3-D Spectra of Heater Oil Samples

Figure one shows a 3-D depiction of a large database of dark heater oil samples. Two portions of the spectra were used to form the calibration, 5400 – 4783 cm⁻¹ and 6048 – 8794 cm⁻¹. The predicted vs. measured plots in Figures 2 and 3, show the performance of calibrations for distillation points at 50% off and 90% off.

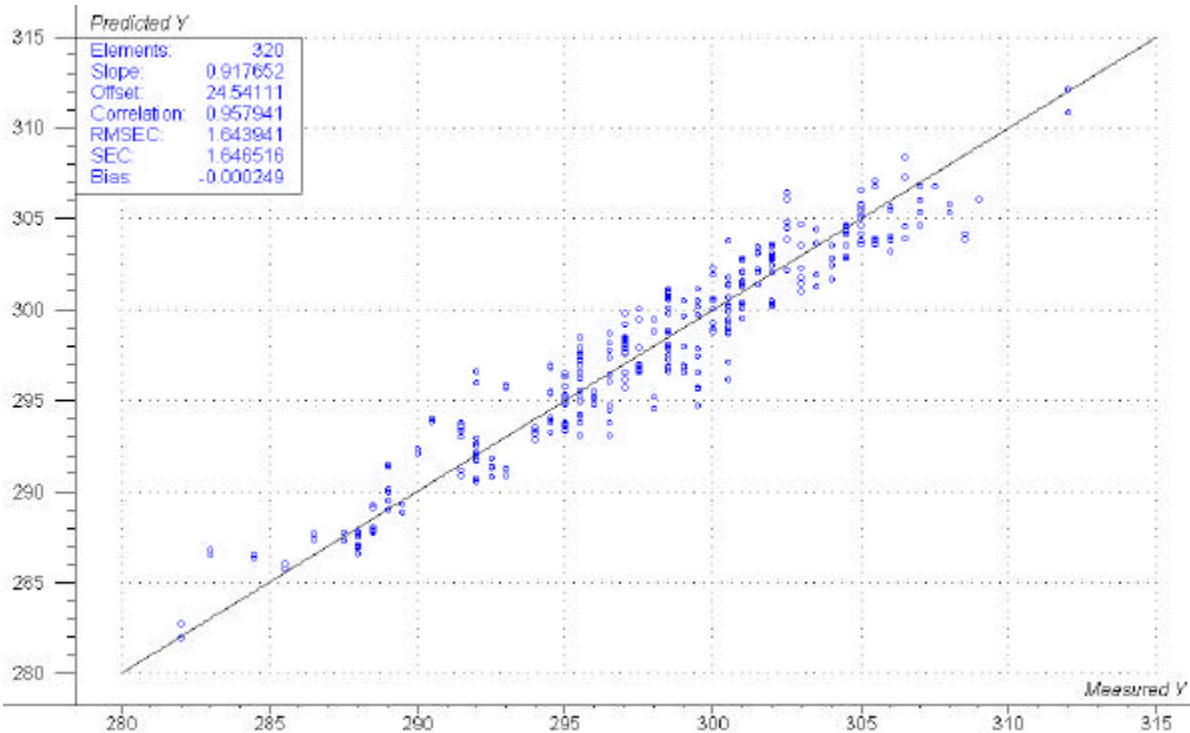


Figure 2: Calibration for 50% off Distillation point

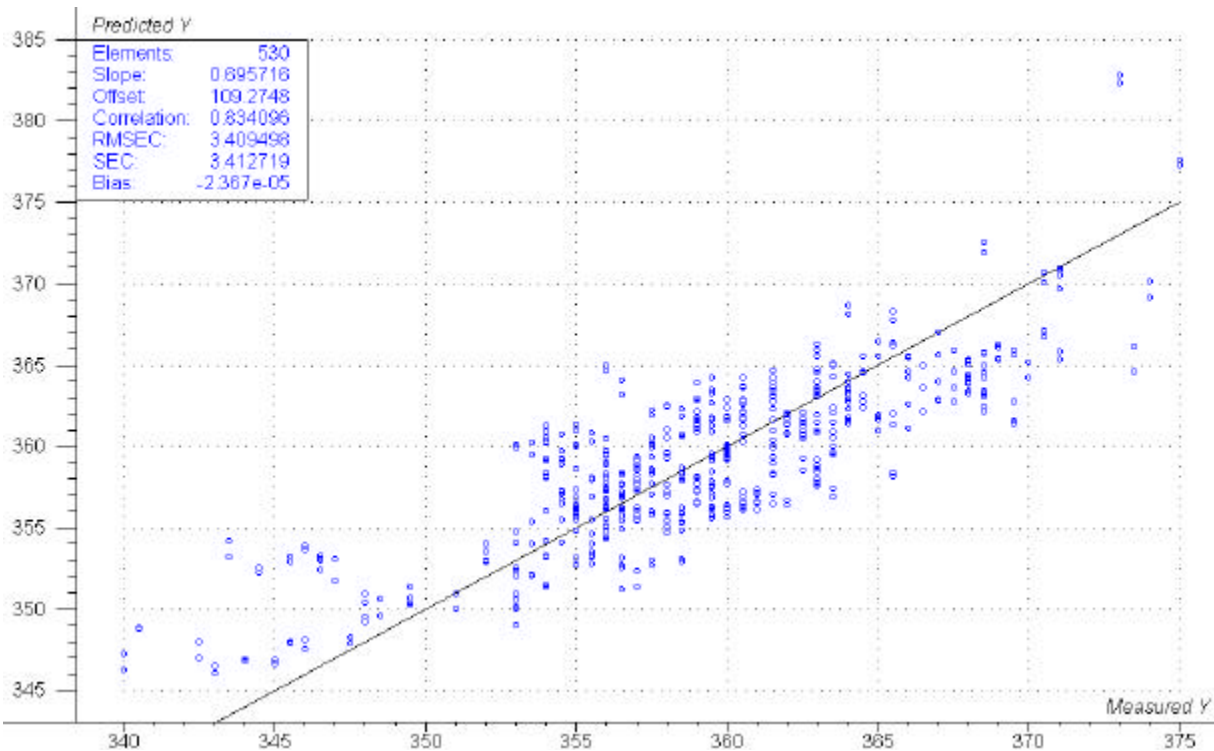


Figure 2: Calibration for 90% off Distillation point

Water in Methane

The RMSEC (Root Mean Square Error of Calibration) for these two calibrations are 1.64 °C and 3.4 °C respectively. RMSEC is a “1 σ ” measure of the difference between the values predicted by the calibration model and the actual measurements from the lab.

Using a “2 σ ” confidence interval, one might report the temperature at the 50% off point +/- 3.5 °C, and the temperature at the 90% off point +/- 6.8 °C. The accuracy, that is the agreement with lab data, includes the variability in the lab data used in the calibration. The repeatability of measurements by FT-NIR is typically much better than the accuracy because the run-to-run repeatability of the FT-NIR is dependent only on the ability of the spectrometer to produce the same spectrum for the same sample. For this application, the repeatability of the replicate measurements of the same sample was on the order of 0.4 °C for the 50% Off measurement.

Other Measurements

Cold Filter Plugging Point, Pour Point, Viscosity, Flash Point, Density, Total Nitrogen and Sulfur can also be determined in some samples. Table 1 below shows the typical ranges and REMSEC for measurements that have been performed.

Sample Type	Parameter	Typical Range	RMSEC
Gas Oil	CFPP	-13 – 6 °C	1.75
	PP	-17 – 2 °C	1.99
	Viscosity	2.45 – 5.502 cSt	0.075
	FP	55 – 109 °C	3.02
	Density	0.8210 – 0.8400 g/cm ³	0.0005
Fuel Oil	Sulfur	0.0130 – 0.8590 wt%	0.099
	Total N	0.0205 – 0.02815 wt%	0.023
	Density	0.86935 – 0.93975 g/cm ³	0.00560

Table 1: FTNIR Measurements on Gas Oil and Fuel Oil

Conclusion

Measurement of the gas/oil ratio of live crude oils has been reportedⁱⁱ. A comparison of NIR to Mid-IR and Raman spectroscopy found that only NIR was suitable for measurement of API gravity on crude and atmospheric residueⁱⁱⁱ.

i Espinosa, A. et al, “On-line NIR Analysis and Advance Control improve Gasoline Blending,” *Oil and Gas Journal*, Oct. 17, 1994.

ii Mullins, O.C., Daigle, T., Crowell, C., Groenzin, H., and Joshi, N.B., “Gas-Oil Ratio of Live Crude Oils Determined by Near-Infrared Spectroscopy,” *Applied Spectroscopy*, Vol. 55, No. 2, 2001.

iii Chung, H., and Ku, M., “Comparison of Near-Infrared, Infrared, and Raman Spectroscopy for the Analysis of Heavy Petroleum Products,” *Applied Spectroscopy*, Vol. 54, No. 2, 2000.