Molecular Spectroscopy

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Precise FT-IR Spectroscopy Technique for Quality Control of Specialty Fats Using the PerkinElmer Frontier FT-MIR/NIR System

Introduction

In the process of refining crude palm oil (CPO) into refined, bleached and deodorized palm oil (RBDPO) for specialty fat production, the palm oil industry spends millions of Euros for chemicals needed in its quality control efforts of RBDPO. Due to its high chemical usage, the CPO industry faces enormous waste treatment costs. The quality control parameters in the manufacturing of specialty fats, such as Free Fatty acid (FFA), Iodine Value (IV), moisture and impurities (MI), Peroxide Value (PV), and slip melting point (SMP), not only consume many chemicals, they also harbor the potential to cause environmental issues if left untreated.

To help reduce those issues, PerkinElmer has developed a rapid FT-IR method using its Frontier™ FT-IR Infrared Spectrometer System. What follows is a report on how the Frontier FT-IR can provide an effective, environmental friendly solution that will save the palm oil industry both time and money.

For the Better

Experimental

Instrument Settings and Calibration Models Using Chemometrics

Oil blends of specialty fats were injected into BaF2 window liquid cell at 65 °C with Spectral resolution of 8 cm-1, 32 scan. PerkinElmer Frontier FT-IR was used for transmission measurement covering a range from 4000 - 400 cm-1 (Figure 1). Calibration models of FFA, IV, MI, PV and SMP were performed using PerkinElmer Spectrum Quant Advance Chemometric software.
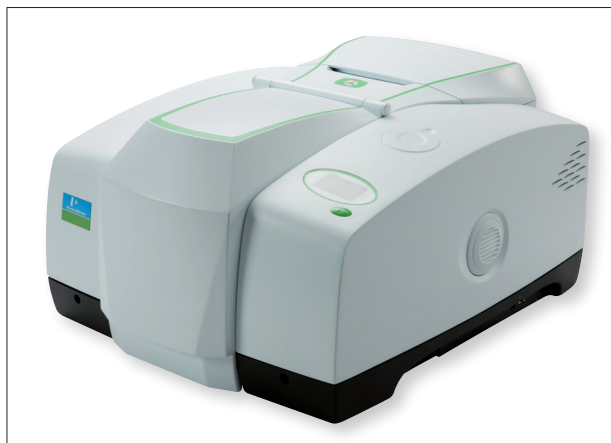

Figure 1. PerkinElmer Frontier MIR System.

Moisture (MI) of Palm Oil Blends - MPOB p 2.2 Method

Loss in mass undergone by the product on heating at below 130 °C.

Peroxide Value (PV) of Palm Oil Blends - MPOB p 2.3 Method

Quantity of those substances in the sample expressed in terms of active oxygen, which oxidizes Potassium Iodide under the condition specified in this method for specified amount of sample.

Iodine Value (IV) of Palm Oil Blends - MPOB p 2.6 Method

A measure of the unsaturated fatty acids and expressed in terms of the number of mg of iodine absorbed per 100 g of sample.

Free Fatty Acid (FFA) of Palm Oil Blends - MPOB p 2.7 Method

Number of miligrams of Potassium Hydroxide required neutralizing the fatty acid in 1g of sample

Slip Melting Point (SMP) of Palm Oil Blends - MPOB p 4.2 Method

The temperature at which a column of fat is tempered under specified conditions and then heated in the water bath under controlled heating rate until the fat column melts partially and slips up the capillary tube.
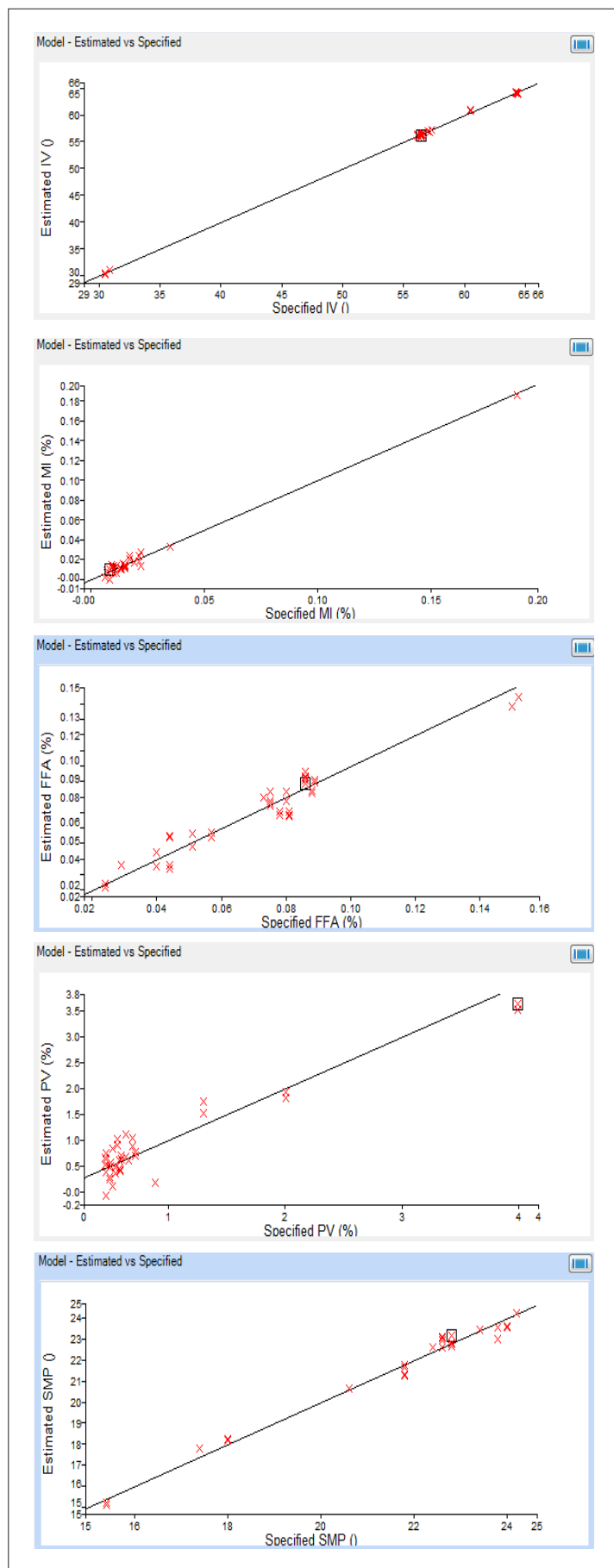
Results

Figure 2. Calibration Models for Specialty Fats-IV, MI, FFA, PV & SMP.

The calibration involves scanning the sample in heated liquid cell and is a fast method to determine minute amounts of above mentioned parameters in specialty fats (Figure 2). The FT-IR spectrum in Mid-IR region ensures better and more precise quantitative predictions compared to conventional Near-IR measurements due to strong IR peak absorption in Mid-IR region.

PerkinElmer Frontier FT-IR system features:

- Preset calibrations or only requiring calibration fine-tuning on site with ready method settings for quick start
- Heatable liquid cell for transmission measurement of the oil samples
- Preheater to warm up samples to required temperature to reduce waiting time
- Absolute virtual instrument (AVI) (Figure 3) technology for
  - Improve calibration transfer between instruments
  - Accurate wavelength calibrations with all accessories

Conclusion

The PerkinElmer Frontier FT-IR system offers an alternative rapid method to the wet chemistry reference methods for downstream palm oil-based end products. The PerkinElmer Frontier FT-IR system can be preset with FFA, IV, Moisture, PV and SMP calibrations with Absolute Virtual Instrument (AVI) proprietary intellectual property of PerkinElmer Frontier FT-IR system. This eliminates routine re-calibration problems with traditional dispersive Near-IR technology traditionally used in the palm oil industry.

For palm oil refinery and downstream application players with heavy analysis workloads or high sample throughput, the PerkinElmer Frontier FT-IR system provides multiple parameters analysis results simultaneously and offers the best solution to your palm oil needs.
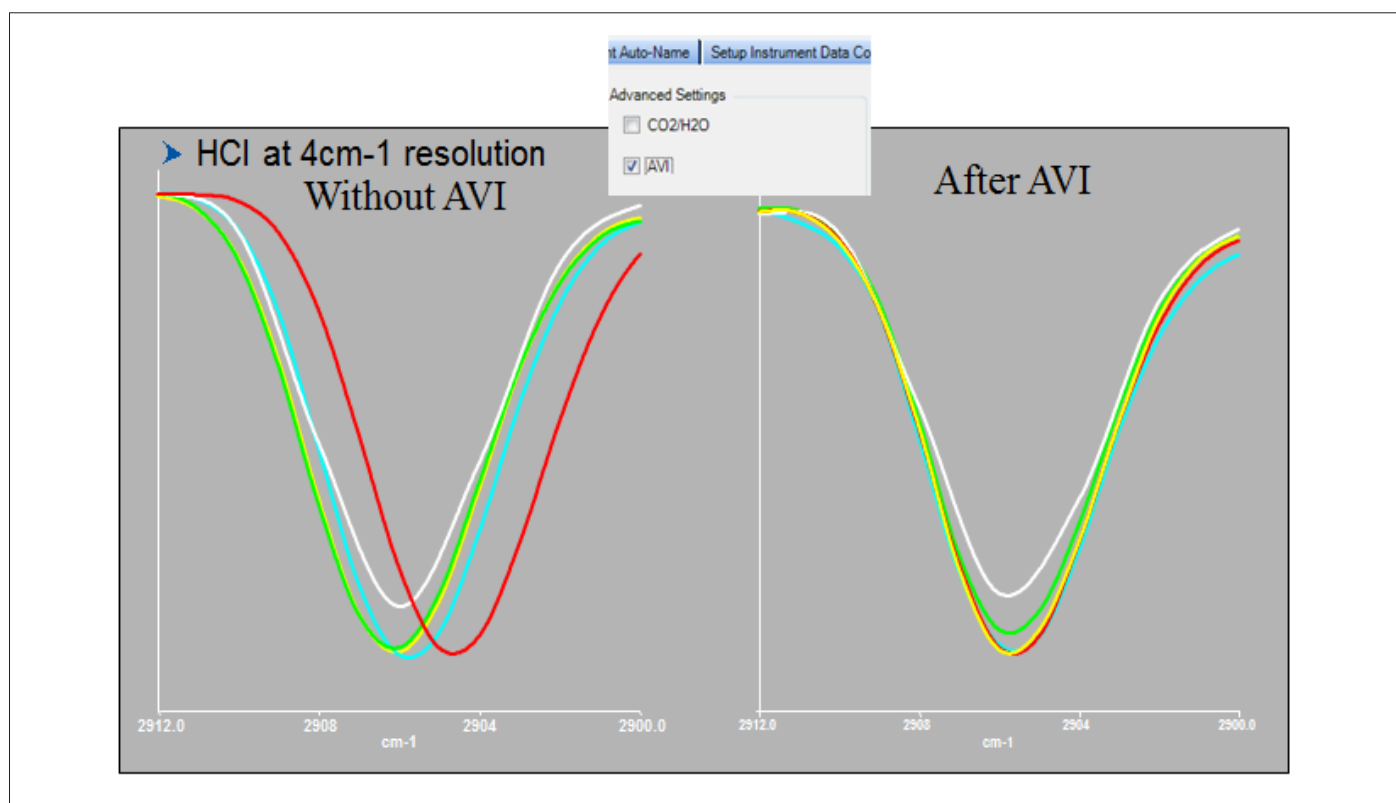

Figure 3. AVI correcting differences between instruments.