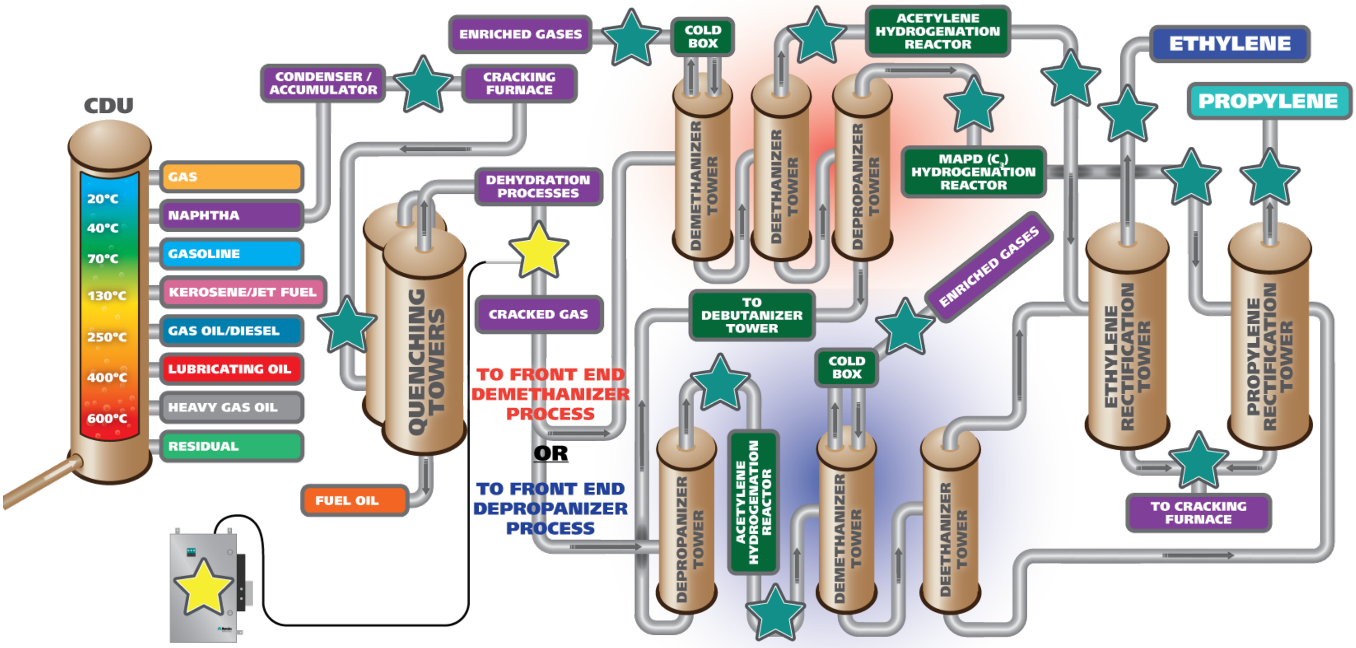
Process Application Note AN-PAN-1047

Inline monitoring of water content in naphtha fractions by NIRS

Crude oil, which consists of at least 500 different components, is processed by fractionation and refining to produce liquefied gas, gasoline, diesel, heating fuel, and lubricants as well as a large variety of other products. As the «lubricant» of the global economy, it covers approximately 33% of our energy demand (2017) and is used in the chemical industry for the production of plastics, textiles, dyes, cosmetics, fertilizers, detergents, building materials, and pharmaceuticals.

The crude oil is desalted, then separated into several intermediate materials via atmospheric or crude distillation unit (distillation tower, CDU), depending on boiling temperature. The quality of fractions from the CDU need to be continuously monitored. To satisfy high demand for gasoline, the heavier sidecuts from the CDU are reformed and resolved to increase the light intermediate materials, thus increasing the gasoline fraction. The overhead distillate fraction naphtha (a mixture of C_5 to C_{10} hydrocarbons) is produced from relatively light components and is supplied to ethylene plants as a raw material.



Detail of refining, cracking, and separation processes focusing on naphtha gas stream with stars noting suggested NIR measuring points.

The CDU must operate efficiently at all times, however the crude feed is full of impurities which cause corrosion and fouling in the refining process. Operating conditions that also influence corrosion and fouling include temperature of the crude column overhead, crude, and reflux, as well as the water wash and overhead vapor water content. Water absorbs the acids and amines (see **AN-PAN-1001** for more information), and when it vaporizes as reflux flowing down the column, heated salts are deposited. These salts accumulate, causing a higher pressure drop, resulting in a loss of efficiency and profit.

Determining the water content of crude oil, refined petroleum products, fuels, biofuels, lubricants, and other products is important for maintaining quality control, meeting trade specifications, protecting financial value, and enhancing process optimization. Knowing accurate water content in hydrocarbons enables the refinery to take steps to reduce risks from corrosion, safety problems, and infrastructure damage which can be caused from unwanted water content levels. Generally the determination of water content in naphtha fractions is performed with a reference method (also provided by Metrohm) which requires several reagents.

Keywords: water content, moisture, CDU, refining, petrochemicals, NIR, spectroscopy, chemical free, XDS, ATEX

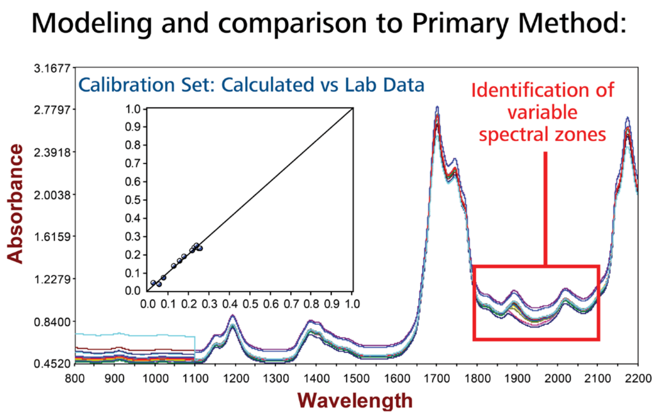
A safer, faster way to monitor the water content in CDU overhead fractions is inline with reagent-free near-infrared spectroscopy (NIRS). Spectroscopy offers numerous advantages over many wet-chemical analytical methods. NIRS is economical and fast, enabling qualitative and quantitative analyses that are noninvasive and nondestructive. A diverse range of parameters can be determined simultaneously in seconds from just one analysis. NIRS is an indispensable analysis technique that can be used along the entire production chain – from incoming materials to processing to the quality control of finished products.

Our NIRS process analyzers enable comparison of real-time spectral data from the process to the primary method to create a simple, yet indispensable model for your process needs. Gain more control over your production with a Metrohm Process Analytics NIRS XDS system configured for applications in **ATEX** zones, capable of monitoring **up to 9 process points** with the multiplexer option.

Application: Sample is measured in 2 mm pathlength flow cell after the drying phase. Wavelength range used: 1800–2100 nm. ATEX analyzer is recommended for explosion-proof areas.

Typical Range: 0–0.3 w% H_2O

Remarks: A reference method (such as Metrohm Karl Fischer titration) must still exist as a check method. An appropriate range of samples covering the process variability should be analyzed by both methods to build an accurate NIR model. Correlations are made to process specifications.



(L) Data correlation between primary method and NIR model illustrating how accurate the correlation is between methods.
*(R) NIRS XDS Process Analyzer configured for applications in **ATEX** areas.*

International Standards (petrochemicals):

- **Standard-compliant fuel analysis**
- **Standard-compliant biofuel analysis**
- **Standard-compliant lubricant analysis**

Related Application Notes:

- **AN-NIR-025** Real-time inline predictions of jet fuel properties by NIRS
- **AN-NIR-022** Analysis of petroleum products (e.g. cetane index, TAN, aromatic hydrocarbons and sulfur)

More information about NIRS applications related to the refining process:

- **NIRS for optimizing refinery processes**
- **Ethylene Cracking (Metrohm USA)**

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