Application Note AN-PAN-1052

Online process monitoring of octane number during catalytic reforming

Accurate analysis according to ASTM D2699 and ASTM D2700

In refineries, high octane products are desired since they are used to produce premium gasoline. This production is a highly hazardous operation which requires strict adherence to safety standards (IECEx) and constant monitoring of key process parameters, such as the octane number (ON). Providing dependable process data in a timely manner means that downstream process units (catalytic reformer) can be optimized quickly to increase profits while lowering operational costs.

This Process Application Note presents a way to closely monitor in «real-time» the octane number in fuels via near-infrared spectroscopy (NIRS) technology, which fits well within the international standards (American Society for Testing Materials «ASTM»). Online analysis of the octane number ensures simple, fast, and reliable results, allowing quick adjustments to the process for better quality products leading to higher profitability.

INTRODUCTION

The octane number is a key parameter measured in the petrochemical refining process which indicates the performance of commercial fuels (e.g. gasoline and jet fuels). It determines the tendency of the fuel to resist auto-igniting in the engine during combustion (knock resistance).

The octane number is measured based on the knocking resistance of two reference fuels: isooctane (C_8H_{18}) and n-heptane (C_7H_{16}). Iso-octane has a high resistance to knocking under harsh conditions and is therefore assigned an octane number of 100. Conversely, n-heptane has a low resistance to autoigniting, thus it is assigned an octane number of 0. Since the knocking resistance varies based on the operating conditions, there are two main types of octane numbers: Research Octane Number (RON) and Motor Octane Number (MON). The RON is measured under lower temperatures and speeds, and the MON is measured under high temperatures and speeds.

In refineries, high octane products are desired in order to produce premium gasoline. The refining process which produces high octane products is called catalytic reforming (Figure 1). Catalytic reforming converts heavy naphtha (a paraffin mixture with low octane rating) into a high-octane liquid product called «reformate» (a mixture of aromatics and iso-paraffins C7 to C10). Therefore, catalytic reforming has a significant impact on the profitability of a refinery.

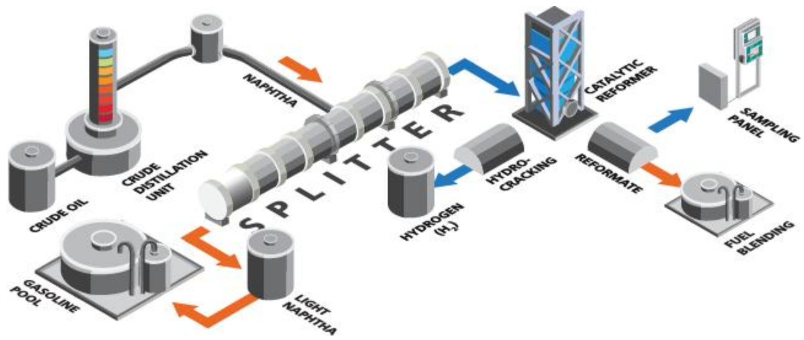

Figure 1. Detail of the catalytic reforming process of naphtha with stars noting suggested online near-infrared spectroscopy (NIRS) measuring points.

The octane numbers of the produced reformate must be constantly monitored to ensure high throughput along the refining process. Traditionally, RON values can be measured by two different methodologies: Inferred Octane Models (IOM) and laboratory octane engine analysis. However, these methodologies do not provide «real-time» results and require constant maintenance and human intervention to adapt to current operation conditions. Furthermore, calibration of the octane engine for RON > 100 (a common value for reformate) requires specific blends. These calibrations are not always available. Indeed, in refineries, octane engines are mostly used to analyze and qualify final blended products (gasoline), with RON values between 92–98.

«Real-time» analysis of the octane number in fuels can be performed online via near-infrared spectroscopy (NIRS) technology, which fits well within the international standards (ASTM) (Figure 2). However, the reformate samples contain solid particles in the stream which interfere with the measurements. Therefore, for reproducible and accurate measurements, a preconditioning panel is necessary to filter the samples and maintain a constant temperature to avoid fluctuations. Additionally, another advantage of using a preconditioning panel is that a sample take-off point can be implemented as well as a port for validation samples.

Metrohm NIRS Process Analyzers enable the comparison of «real-time» spectral data from the process to a primary method (Cooperative Fuel Research «CFR» testing) to create a simple, yet indispensable model for your process needs. Gain more control over production processes 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.

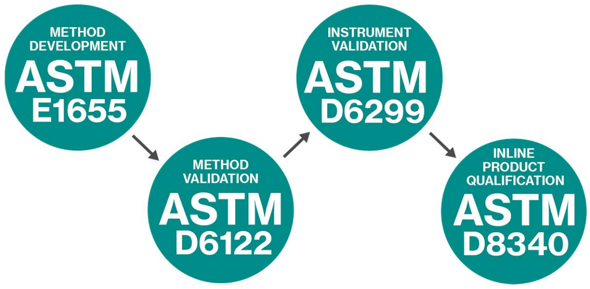

Figure 2. Different steps for the successful development of quantitative methods according to international standards.

APPLICATION

After samples are preconditioned, NIRS measurements are performed in a flow-through cell. The instruments used in refineries are certified as ATEX or Class 1 Div 1/2. They are either mounted in the plant where they will require positive air pressure, or in a pressurized shelter. The distance between the instrument or shelter and the sample points can be hundreds of meters apart. Every 30 seconds, RON and MON values are transmitted to the programmable logic controller (PLC) or distributed control system (DCS) depending on the communication protocol used.

Figure 3. The NIRS XDS Process Analyzer – MicroBundle from Metrohm Process Analytics.

Table 1. Key parameters and ranges

	RON	MON
SECV (Accuracy)	0.27	0.15
Precision	0.01	0.01
Range	90–107	80–100
Reference ASTM	D2699	D2700
ASTM Accuracy	± 0.9 (RON 103)	± 1.2 (MON 96)

FURTHER READING

Other related documents

Real-time inline predictions of jet fuel properties by NIRS

Inline monitoring of water content in naphtha fractions by NIRS

BENEFITS FOR NIRS IN PROCESS

- **Optimize product quality** (e.g., seasonal effects, crude swing) and **increase profit**
- Greater and faster **return on investment**
- Improved **product quality** and **manufacturing efficiency**
- **Detect process upsets** via automated analysis

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