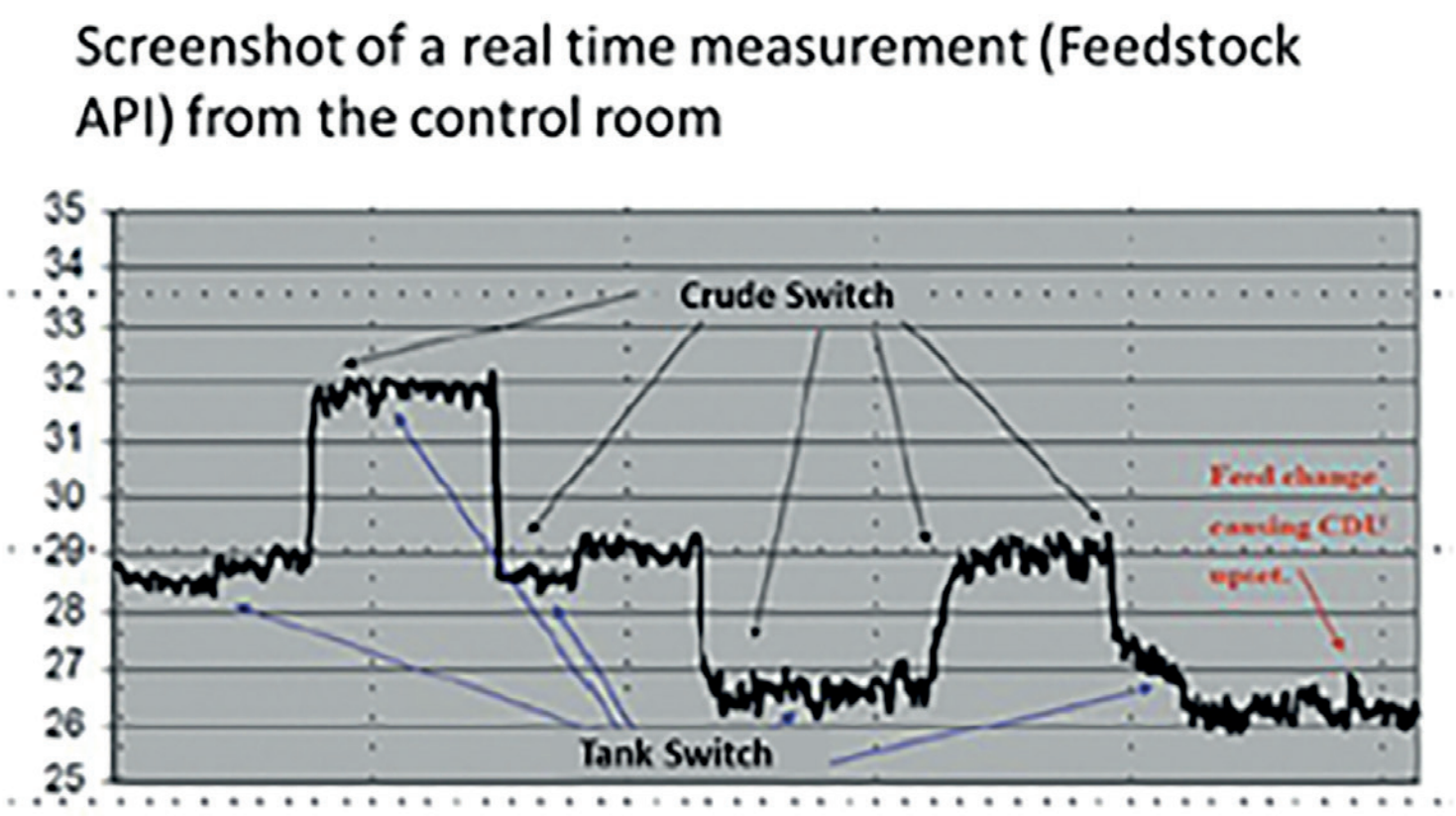
REAL-TIME CRUDE BLENDING TO IMPROVE REFINERY UTILIZATION AND MARGINS

Crude oil blending is a strategic process used in refineries to create a blend of different types of crude oils with varying properties. This is done to achieve specific desired characteristics of crude oil feed into the CDU and thus of the final refined products and optimize the refining process. Crude blending enabled refineries to optimize their operations, control product quality and consistency, improve yield optimization, and help environmental compliance.



Current practices in crude oil procurement and production planning

The blend composition is predetermined through linear programming (LP), considering estimated attributes of the accessible crude sources, production targets, and operational constraints. This approach is inherently less optimal, as the genuine attributes of individual crude sources and the resultant blended crude naturally deviate from the projected attributes. Relying on daily laboratory tests isn't sufficient to address this discrepancy.

In a new, high impact, approach for crude blending, real-time measurements of the blended crude properties are used to dynamically redefine the blend mix in real time. This method ensures that the properties of the actual CDU feedstock are as the LP expected, and provides several significant benefits to a refinery. These benefits include:

1. **Optimized Product Quality:** Real-time measurement of crude properties allows the refinery to adjust the blend mix instantly to meet product quality specifications. This ensures that the refined products consistently meet desired standards and market demands.

2. **Reduced Off-Spec Products:** With the ability to monitor and adjust the blend mix in real time, the refinery can avoid producing off-spec products that might require reprocessing or result in financial penalties.

3. **Improved Yield Optimization:** Real-time blending control enables refineries to maximize the yield of desired products. By adjusting the blend mix based on market conditions and process capabilities, the refinery can ensure the efficient use of feedstocks.

4. **Cost Efficiency:** The ability to adapt the blend mix in real time can help the refinery take advantage of fluctuations in crude oil prices. It allows for the use of cost-effective crudes while maintaining product quality.

5. **Process Efficiency:** Real-time adjustments in blend composition can optimize the performance of refinery processing units. This can lead to improved efficiency, reduced downtime, and lower energy consumption.

6. **Operational Flexibility:** Refineries often deal with changes in crude availability and market demands. Real-time blending control offers operational flexibility by quickly adapting to these changes without disruptions.

7. **Regulatory Compliance:** Crude oil properties can impact environmental emissions. Real-time adjustments in the blend mix can help the refinery meet regulatory requirements and emission standards more effectively.

8. **Reduced Lab Testing:** Traditional methods of determining crude properties and blend compositions involve extensive laboratory testing, which can be time-consuming. Real-time measurement reduces the need for such testing, allowing for faster decision-making.

9. **Enhanced Decision-Making:** Accurate real-time data on blend properties empowers refinery operators to make informed decisions promptly, reducing the risk of errors and optimizing operations.

10. **Mitigated Supply Chain Risks:** By adjusting the blend mix based on the characteristics of available crudes, the refinery can mitigate supply chain risks caused by changes in crude quality.

11. **Market Responsiveness:** Real-time blending control allows the refinery to respond rapidly to market trends and shifts in demand, producing products that are aligned with current market preferences.

12. **Advanced Analytics:** Real-time data from blending processes can be integrated into advanced analytics systems, enabling refineries to identify trends, patterns, and opportunities for further optimization.

In essence, the ability to measure and adjust crude blend properties in real time offers refineries a powerful tool to optimize their operations, improve product quality, reduce costs, and enhance their overall competitiveness in the market.

To implement this new approach of real-time crude blending, two major principles are required:

- Accurate On-line process analytics – knowing the crude oil and blend quality properties at any time and at any stage.

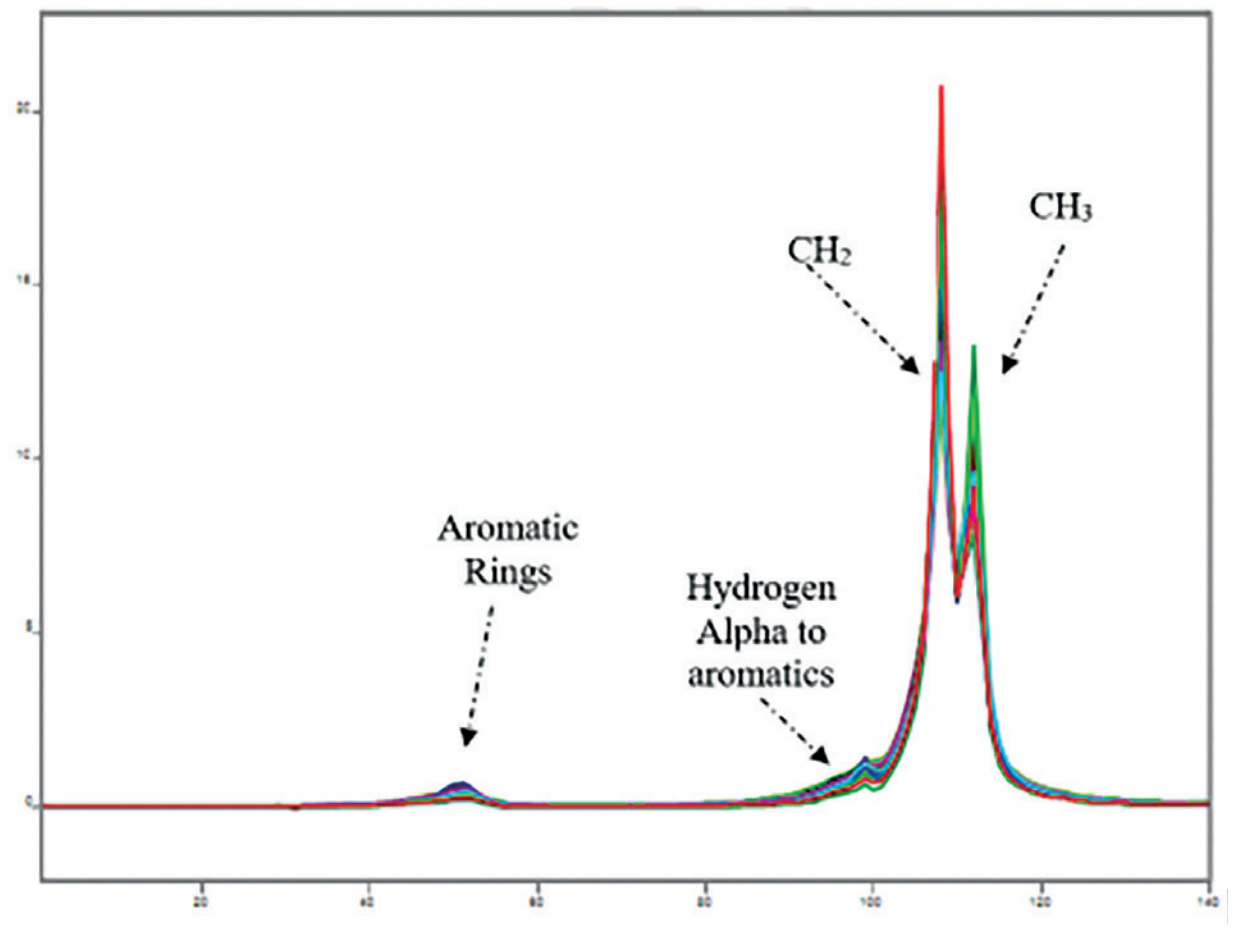


Figure 1: Typical OP-NMR Spectra of Crude Oils:

- Dynamic Simulation modeling - blending simulation models are commonly used to determine the required blend composition. Highest blending optimization can only be achieved by updating the simulation program with real time analytical data of the crude oil and blending quality properties.

On-line Process NMR (OP-NMR) technology distinguishes itself as the technology of choice for real-time crude oil analysis. Mainly due to its complete lack of sensitivity to the fluid opacity, which is the main constrains of optical-based technologies such as NIR and RAMAN. Additional advantages includes inherent linear modeling, which reduces the number of required samples to achieve high-accuracy modeling, no sensitivity to water existence and its low maintenance attributes.

The benefit of OP-NMR spectrometry lies in its linear correlation between hydrogen atoms of the molecules present in the crude oil, and the distinguished chemical shifts representing the chemical nature of its components. Chemo-metrics transforms the spectrometric measurements into physical properties which are characteristic for the crude oils and blends.

This technology provides real-time data and information about the physical and chemical properties (figure 2) of the blend in process. On-line adjustments and changes between blend components can be performed accordingly, until the proper required physical properties are achieved.

Incorporation of the latest generation of OP-NMR analyzer enables to increase the blending efficiency and accuracy of crude oils of different prices and qualities, and to reduce unnecessary giveaways. Efficient blending reduces the cost of the feedstock. It will significantly contribute to improve the refining margins, and the profitability of the entire refinery.

Crude Oil	Naphtha	Kerosene	Diesel Oil	LGO	HGO
API	Density	Density	Density	Density	Density
Distillation profile	Distillation profile	Distillation profile	Distillation profile	Distillation profile	Distillation profile
Aromaticity	RVP	Flashpoint	Cetane Index	Pour Point	Cloud point
Water in crude	Paraffins	Aromatics	Cloud Point	Cloud Point	Pour point
Pour Point	Naphthalene	Olefins	Viscosity	Flash point	Flash point
Sulfur	Aromatics	Naphthalene	Pour Point		
TBP	Hexanes	Freeze point	CFPP		
TAN	Benzene	Hydrogen-Content	Flash Point		
Asphaltene	FBP				

Figure 2 physical and chemical properties

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