4IR EXCLUSIVE UNTAPPED NEW DATA FOR ADVANCE PROCESS CONTROL OPTIMIZATION, FOR TRADITIONAL AND RENEWABLE ENERGY IS DRIVING PROFITABILITY ACROSS INDUSTRIES.

ABOUT THE COMPANY

Introducing 4IR Solutions, a 2020 spin-off from Aspect Imaging LTD. (a medical MRI company). 4IR Solutions provides entirely exclusive data for Advanced Process Control Optimization measuring parameters and properties that have been - until now - entirely untapped. These parameters help drive further profitability in both traditional and renewable energy sectors. 4IR Solutions introduces its unique non-optical correlative OP-NMR (Online Process NMR) analyzer and its innovative AI-based auto calibration software suite: Model Gateway. 4IR Solutions line of analyzers are fully mature and operational since 2018, and has already gathered acclaim from multinationals for its "game-changer" role in boosting profit as well as being the "enabler" in the transition from fossil to renewable energy.

4IR technology is deployed in oil and gas, petrochemical and chemical plants around the world. Its CTO and CEO Mr. Tal Cohen is the architect and developer of the technology since its inception, and continues to be the main shareholder along with reputable investors from USA and Australia. Dr. Paul Giammatteo is its Chief Scientist and President of 4IR solutions inc. North America. Mr. Nir Dranov is an investment banker that joined the board of directors to support 4IR's growth.

ABOUT THE KEY MANAGEMENT

Mr. Tal Cohen CTO and CEO (left): *"4IR has over 6 technological patents and is finalizing its M&A acquisition of iModel Software LTD"*

Mr. Nir Dranov, Director *"Since the spin-off, 4IR's technology has been validated by multi-national top tier petrochemical companies and refineries in North America and Europe. Today, we have begun pilots with leading global process optimization players".*

"A joint venture between 4IR and a strategic partner focused on process optimization, will unleash an untapped multibillion 'Blue Ocean' market. The right collaboration can increase profitable sales by $400-$500M for both companies. "

Dr. Paul J. Giammatteo, Chief Scientist and President of 4IR North America

One of our customers, a large refinery in North America that installed our OP-NMR in 2018 shared with me, quote

"OP-NMR is mission critical to the operation of the refinery. Without it, we reduce capacity from 103mbpd to 96mbpd. According to our calculation, each OP-NMR unlocks an additional $50M profit every year. Its ROI is less than 3 months."

This testimony plus their booking of additional 3-5 OP-NMR units is the best testimony of our economical benefit to our customers.

ABOUT NET ZERO

Accelerating the Transition to Net Zero:
From Fossil Fuels to Renewable Sources

The oil and gas industry faces ever growing regulatory challenges, as current standards limit eCO_2 thresholds and this requirement will only continue to increase.

Further regulation demands that 5-15% of total fuel to be comprised of renewable fuels. Achieving this requirement is made more complex by the significant variable characteristics of large range of raw materials. For example with Biodiesel (B100), the production of diesel-based fuels includes sources such as plant-based oils (soy, corn, coconut, palm, canola, etc.), animal-based oils (chicken, beef, etc.), aquatic based oils (fish, krill, algae) and recyclable resources (used cooking oils, food processing, etc.).

With 4IR's OP-NMR online analyzer, the multi-step conversion processes are uniquely monitored and controlled in real time, leading to production efficiency, process optimization and product quality gains. With optimized production due to advanced measurement and analysis technologies, emission reduction can be supported through the entire refinery.

Furthermore, blending traditional fuels with renewable resources can be efficiently conducted due to real-time measurement and analysis throughout the production process. This high level of continuous manufacturing control ensures high efficiency as well as both the desired quality of the final fuel and the required CO2 emission targets.

At-line Lab Process NMR Analyzer

AI-60 OP-NMR: Online Process NMR Analyzer

INCREASING EFFICIENCY, SAFETY, AND CONTROLLABILITY IN REFINERIES WITH REAL-TIME CRUDE FEEDSTOCK ANALYSIS
Understanding the Hidden Loss:
The Impact of Crude Oil Variability on Profit Margins

The refining process of crude oil, a complex and intricate operation, hinges significantly on the detailed understanding of the oil's properties and composition. Each refinery process unit's efficiency, output quality, energy usage, and safety are directly linked to the fundamental quality of the crude oil feeds including the distillation profile, cut points, API gravity, aromatic content, asphaltenes, Total Acid Number (TAN), sulfur content, etc., which define the operational parameters and constraints of the refinery units.

Figure 1: For custody transfer verification, detailed distillation profile is the core property to me measured by on-line analyzer

Despite the importance of these properties, refineries often operate on approximate estimations or outdated analyses, due to several challenging factors:

1. **Time-Induced Variability:** Properties of crude oil, even from consistent sources, vary and fluctuate over time due to natural changes and also due to slow degradation.

2. **Alteration During Transportation:** The process of transporting crude oil via pipelines, tankers, and storage tanks often leads to the mixing of various crude types, altering the original properties.

3. **Uncertainty with Opportunity Crudes:** These economically attractive crude types often lack detailed and reliable assays to accurately determine their properties.

The prevalent method to counter these challenges is manual laboratory testing. However, this method falls short due to its infrequent nature, time delays in obtaining results (the time lag between the sample grabbing and its analysis completion), incomplete data, data reliability and cost.

This lack of real-time, comprehensive analysis significantly hampers the effectiveness of refinery planning, control, and optimization software, leading to underperformance in efficiency and on-spec product quality. This, in turn, results in substantial revenue and profit losses, and forces the refinery to operate far away from its operation constraint to ensure acceptable safety and reliability levels within the refining process.
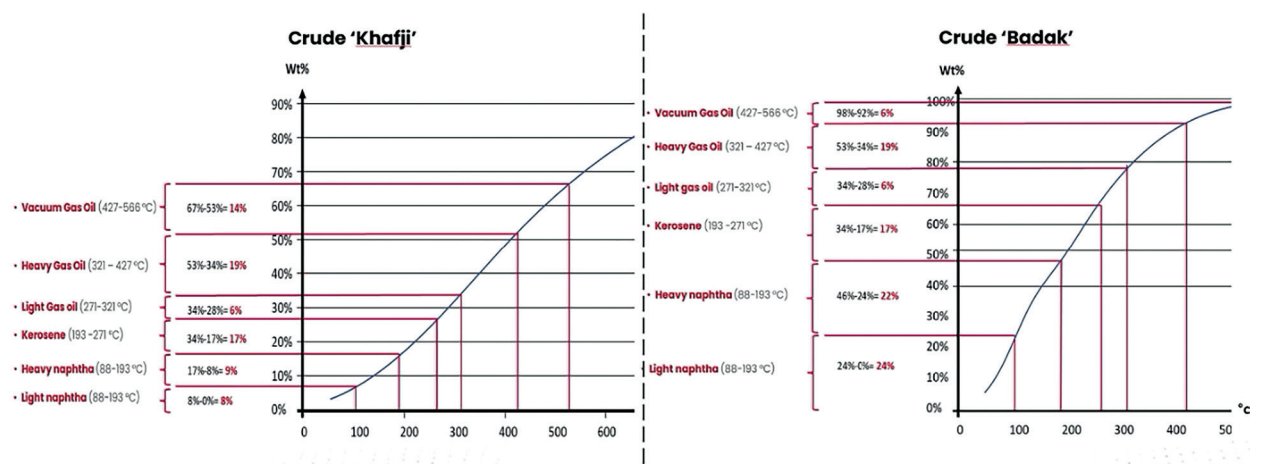
The Transformative Power of Real-Time Crude Analysis in Refinery Operations

Adopting real-time analysis of crude oil provides multiple operational and strategic benefits: revolutionizing refinery practices:

a. Crude Custody Transfer Verification: With real-time, on-line crude analysis, refineries can immediately confirm the quality and properties of incoming crude, ensuring compliance with purchase agreements and effective execution of production plans made months in advance. Continuously monitoring critical quality enhances refinery unit reliability and reduces operational costs. Continuous real-time incoming crude analysis enables the refinery to safely expand the range of usable crude sources, including Opportunity Crudes, without introducing operational risk, leveraging performance economic benefits.

b. Enhanced Safety and Utilization Through Proactive Upset Prevention: Continuous, real-time monitoring of crude feedstock allows for proactive prevention of operational disruptions in Crude Distillation Units (CDUs). By identifying composition deviations that could cause upsets such as tray flooding, refineries can proactively mitigate these risks. Furthermore, real-time analysis allows for the fine-tuning of unit operational and Advance Process Control variables (heat, pressure, flow, mix ratios) according to true, real-time composition of the crude feed, leading to enhanced process efficiency and improved sustainability, resulting in reduced material waste, enhanced throughput, reduced re-runs from off-spec rundown streams, and lower carbon emissions.

c. Enhanced Product Quality and Efficiency Through Real-time Feed Blend Alignment: Real-time monitoring at the discharge pumps of the crude feed tanks after the crude blending point enables refineries to optimize the actual feed to the first distillation unit. Real-time adjustment of the actual

The distillation profile, of the **LP expected** crude blend

The distillation profile, of the **actual** crude going into the CDU **before any OP-NMR optimization** (example)
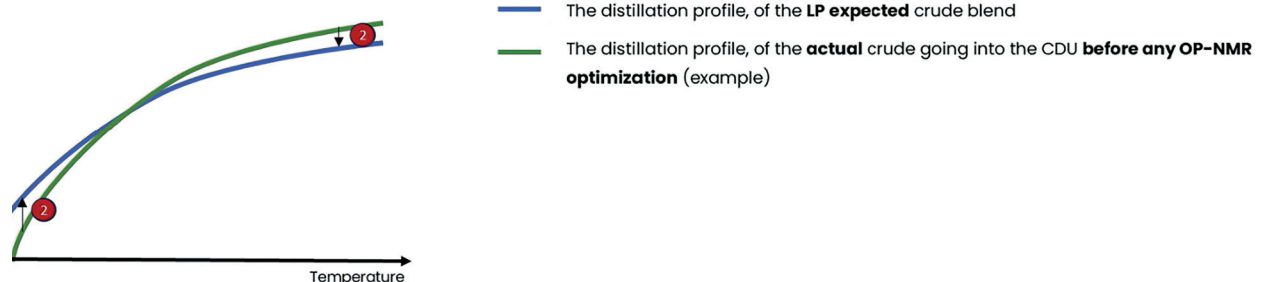
Figure 2: Continuous monitoring of the distillation profile of the blend crude enables real-time optimization

feed to the first distillation unit. Real-time adjustment of the actual crude feed to more consistently align to LP targets stabilizes CDUs and upgrading units, and improves rundown and product blending quality.

d. Comprehensive Operational Stabilization: Consistent crude feed control at the beginning of the refining process leads to stabilization throughout the entire refinery operation, enhancing overall efficiency and product consistency.

e. Dynamic, Plant-Wide Optimization: Continuous, real-time, feed forward crude feed analyses empowers refineries to adjust their production slate almost instantly in response to market opportunities, thus leveraging economic benefits and staying competitive.

Conservatively, real-time crude feed forward analyses will achieve up to 5% gains in operational efficiency and throughput with minimal off-spec product quality and re-work.

OP-NMR: The Optimal Technology for In-Depth Crude Oil Analysis

Given crude oil's opacity, traditional optical analysis technologies (like NIR, FT-IR) face significant limitations. In contrast, Nuclear Magnetic Resonance (NMR) technology, based on magnetic excitation of atomic nuclei, effectively bypasses these issues. On-line Process NMR (OP-NMR), a specialized variant of NMR, is tailor-made for continuous, on-line fluid analysis and stands out as a superior solution for comprehensive crude oil characterization.

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. Chemometrics transforms the spectrometric measurements into the critical crude oil and crude oil blend property measurements required for real-time control and optimization of a refinery.

Pros and cons of OP-NMR Spectroscopy:

Advantages:

- Non-optical spectroscopy
  - ➤ No dependency on transparency
- Linear and quantitative spectral response to the hydrogen content and molecular bonding environment of the sample.
- Robust Chemometric performance
- No spectral temperature dependency
- Water content does not interfere with spectral quality and is measurable and quantifiable
- Simplified sample preparation and handling

Disadvantages:

- Solids can't be observed
- Low sensitivity to impurities
- Sensitive to ferro-magnetic substances
- Non-Hydrogen containing molecules are not not observed

Summary

In summary, the implementation of real-time crude analysis, especially through advanced technologies like OP-NMR, marks a significant leap in refining operations. By addressing the challenges posed by the variability of crude oil, refineries can achieve optimal efficiency, heightened safety, and increased profitability, ensuring high-quality on-specification products and a strong market position. The analyser's unique capability to measure new untapped properties and measurements help drive further profitability in both traditional and renewable energy sectors.
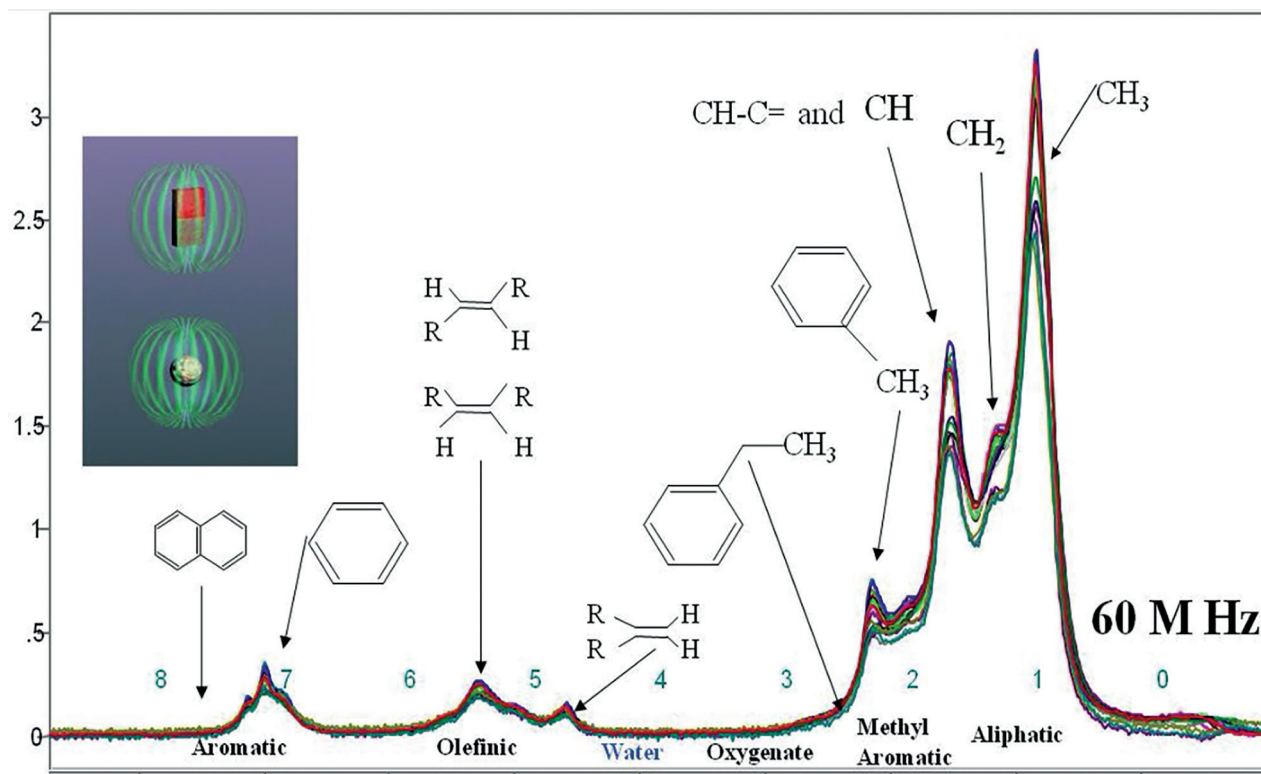

Figure 3: Typical OP-NMR Spectra of Crude Oil

Comparative table between analyzers:

Analyser Type	AI-60 Process NMR	NIR / FT-IR / RAMAN
Sensor Method	Magnetic (Similar to MRI)	Optical
Online Realtime Measurement	✓	✓
Dark & Opaque Crude Oil	✓	✗
Crude Oil	✓	✗
Gas Oil	✓	✗
Diesel Oil	✓	✗
Transparent	✓	✓
Kerosene	✓	✗
Naphtha	✓	✓

Figure 4: Typical OP-NMR generates exclusive raw data that is unachievable by optical analyzers, overcoming "blind spots" and for the first time enabling true "end-to-end" process control".

Analyzer: / Parameter:	Manual lab testing	Discrete Analyzers	Optical Correlative analyzers NIR/FTIR/RAMAN	4IR None-optical Correlative Analyzer OP-NMR	
Measurement accuracy	v	v	v	v	
Multi properties	v		v	v	
Immediacy		v	v	v	
Low maintenance				v	
Opaque fluids (i.e. Crude Oil)	v			v	Strategic edge

Figure 5: The OP-NMR is the only correlative analyzer applicable for dark/opaque fluids.

About the Author

Paul J. Giammatteo, Ph.D., Chief Science Officer and Vice President of Western Hemisphere Operations for 4IR Solutions, Ltd., brings 37+ years of industrial, technical, and business experience in applying analytical, at-line, and, on-line NMR Solutions to petroleum, petrochemical, chemical, pharmaceutical, biochemical, biotechnology R&D and manufacturing.

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