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Lube-Tech: Base number analysis by FTIR spectroscopy

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How natural gas engines will assist the transition to a greener power grid

David Tsui *and* ***Sushmita Dutta****, Project Managers for Kline & Co.'s Energy Division*

Natural gas engines, or perhaps we should call them Swiss Army Engines, are the multitool for power generation that can work alongside wind and solar to provide a reliable power grid for our future. Unlike other fossil fuels, natural gas has a lower carbon footprint than traditional coal or oil fossil fuels, and the natural gas engine allows for rapid stop/starts, which helps it complement renewable energy such as wind and solar.

CO_2 Emissions by Energy Source

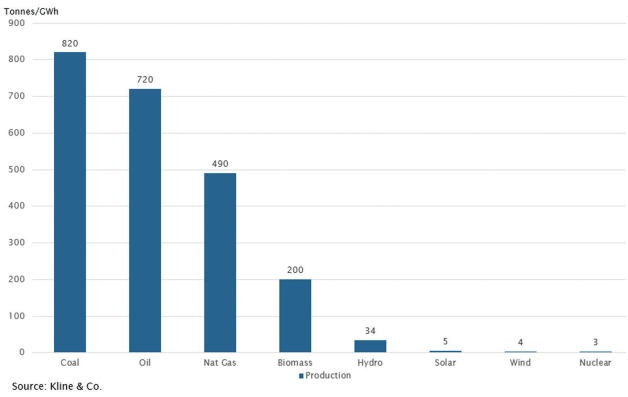


Figure 1: *CO_2 emissions by energy source*

Natural gas engines were designed to burn traditional natural gas fossil fuels; however, these engines can be readily adapted to burn renewable and other sources of fuel as well, such as:

- **Green hydrogen**: Green hydrogen is produced via the electrolysis of water; the electricity used for electrolysis must be derived from renewable sources for it to be "green."
- **Biogases**: These include digester gas, landfill gas, sewage gas, and other similar gases which are produced from the anaerobic decomposition of organic matter such as livestock manure and food processing waste. Such alternative gases are composed mostly of methane and carbon dioxide, along with other gases such as nitrogen, oxygen, and hydrogen sulphide.
- **Coal gas**: Coal gas is formed by destructive distillation of coal and consists mainly of hydrogen, methane, and carbon monoxide.
- **Producer gas**: The burning of coke in limited air results in producer gas, which is a mixture of carbon monoxide, nitrogen, carbon dioxide, and hydrogen.
- **Water gas**: The red-hot coke, when treated with steam, yields carbon monoxide and hydrogen, a mixture known as water gas.

Due to environmental concerns, governments across the globe are encouraging the use of cleaner-burning fuels, such as natural gas and manufactured gases, instead of other fossil fuels such as coal. For example, in the United States, according to the U.S. Energy Information Administration (EIA), 257 billion cubic feet of landfill gas were collected at 336 landfills in the country in 2019. This landfill gas was used to generate 10.5 billion kilowatt-hours (kWh) of electricity in the same year. Furthermore, according to EIA, 25 large dairies and livestock operations in the country produced 224 million kWh (or 0.2 billion kWh) of electricity from biogas in 2019.

China, on the other hand, with rich coal reserves, is investing in coal-bed gas. The country is the world's largest coal producer as well as consumer. The coal-bed gas power generation has witnessed significant growth, with government support for its use as an approach for air pollution elimination and energy conservation.

Green hydrogen or renewable hydrogen is the new buzzword in the energy sector. In 2020, the European Union announced its aim to become climate-neutral by 2050, which means an economy with net-zero carbon emissions. This ambitious plan is likely to be facilitated by the creation of a hydrogen economy. Thus, green hydrogen is more than just a buzzword; in fact, it is a real concept that is currently being put to implementation and can potentially transform the energy sector. After Russia's recent invasion of Ukraine, the European Commission unveiled REPowerEU, which has doubled the EU hydrogen targets for 2030. It now sits at 10 million tons of renewable hydrogen to be produced annually, along with an additional 10 million tons to be imported.

The usage of green hydrogen is currently in a nascent stage, but it is being viewed as the gas engine fuel of the future. Hydrogen is used in two ways in natural gas engines: as a dual fuel combination of hydrogen and natural gas or pure hydrogen. INNIO and HanseWerk AG have started field testing a 1-MW gas engine that can operate either with 100% natural gas or with variable hydrogen-natural gas mixtures up to 100% hydrogen. Other gas engine manufacturers are also developing engines for 100% hydrogen. INNIO's current 2022 Jenbacher line of natural gas engines is capable of operating on up to 25% green hydrogen and can be fully converted to 100% hydrogen.

This ability to utilise multiple fuel sources will enable nations to utilise renewable gaseous fuel, helping combat climate change by controlling greenhouse gas emissions. In addition, the flexible fuel sourcing will also allow nations to change sources of fuel quickly should there be supply chain disruptions like the ones we've observed recently.

Natural gas and liquified natural gas (LNG) supplies have been subject to global disruptions as the Russian/Ukraine war forces Europe to turn to alternate sources of natural gas and LNG, which will drive shortages in other regions as Europe bids up prices. This could drive changes in the type of natural gas engine oil (NGEO) consumed as the natural gas supply chain is altered and engines start to see more variable sources of fuel.

Despite the disruptions, natural gas will continue to be utilised as a transitional fuel source to help the world shift toward fully renewable energy. Europe has confirmed this continued usage of natural gas, with the European Union voting in favour of calling natural gas a "green" or "sustainable" source of energy despite some pushback. The caveat is that by 2035, a further transition toward biogas or green hydrogen will be required. This will phase out traditional natural gas use in parts of Europe. It's a good sign that natural gas power generation units will have a solid future, as power generation plants can continue to operate -- though they may require an OEM conversion kit should they seek to utilise green hydrogen. Kline expects global gas consumption to remain strong as global economies recover from 2020 declines caused by pandemic-related shutdowns.

Global natural gas production and consumption trends 2011 - 2021

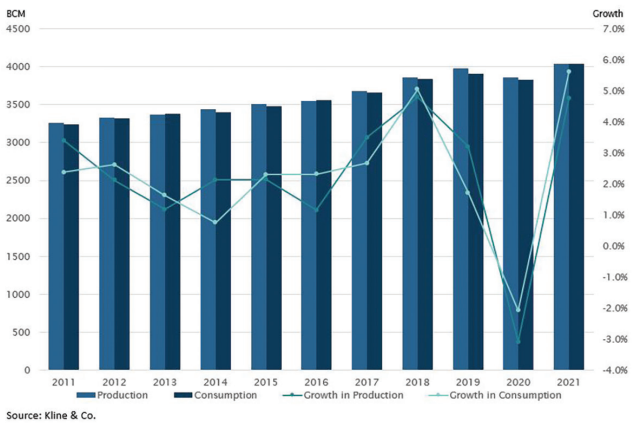


Figure 2: *Global natural gas production and consumption trends, 2011 to 2020*

According to bp's Statistical Review of World Energy 2021, there was robust growth in natural gas, with a jump of more than 60% in production and consumption between 2000 and 2019. As global economies recover from pandemic lockdowns, growth is expected to continue. However, the supply chain and sourcing for natural gas have been subject to dramatic shifts that began when Russia invaded Ukraine and the UN began to impose sanctions on Russian natural gas. The EU has also implemented

changes in its sourcing for natural gas and halted Russia's Nord Stream 2 gas pipeline. In response, Russia's Gazprom is limiting natural gas through the Nord Stream 1 pipeline to 20%, just as European energy consumption hit record levels, with natural gas being burned to meet electricity demand from a historic heatwave which caused temperature spikes of more than 104°F (40°C) in some countries in July 2022. This is hindering Europe's plans to maximise its gas stores before winter should Russia completely cut Europe off from natural gas.

The rapid strategy shift away from Russian-sourced natural gas, which had supplied 40% of Europe's demand with more planned as Nord Stream 2 was to come online, has caused Europe to tap into other sources, including LNG imports. In 2021, 45% of European LNG imports were sourced from the U.S., and another 20% was sourced from Qatar. This shift helped drive up prices and will likely cause supply shortages for poorer nations[1].

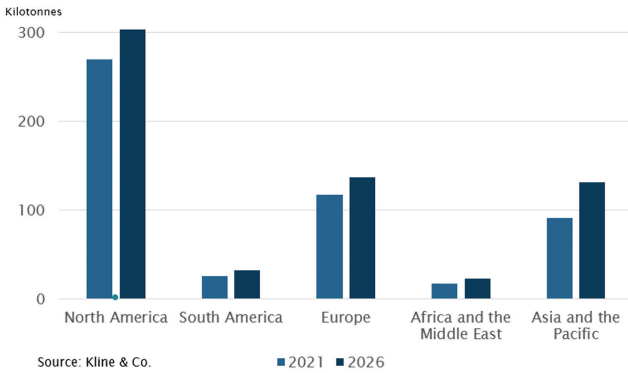
According to Kline's recently published *Natural Gas Engine Oils: Global Market Analysis and Opportunities* study, the change in gas sourcing will help drive growth in new pipelines and liquefication and gasification facilities, as well as expedited investment in renewable gases such as green hydrogen and bio or landfill gas. This, in turn, is likely to drive demand for NGEO more suited to handle various fuel sources that could include a mix of hydrogen and gas or sour gases from landfills.

North America remains the strongest market for NGEO utilised in both power generation and in mechanical drive to operate massive pipeline networks. Europe and Asia follow, with more growth seen in the Asia and the Pacific region, as these developing nations rapidly consume more energy. In the short/medium term, Kline projects growth in low-ash and medium-ash traditional NGEO demand.

In the longer term, Kline projects more use of medium-ash NGEO or new formulations designed for green fuels. These new products will likely be formulated to better handle a more variable Wobbe Index (WI) and greater levels of contaminants such as water.

NGEO demand, globally, is expected to exceed 500 kilotonnes by 2026 and grow at almost a 4% CAGR, with some regions outpacing others depending on gas availability and government infrastructure plans. Germany, for instance, is looking to retain three of its nuclear power generation plants, given the issues with Nord Stream gas from Russia, so its transition to natural gas will be slowed. However, other nations such as China are expected to see over 10% growth in NGEO demand. With continued heat waves and harsher weather, the demand for more power will only increase.

NGEO demand projection 2021 - 2026



For more information, check out Kline's Natural Gas Engine Oils: Global Market Analysis and Opportunities report. A comprehensive analysis of the global NGEO lubricants market in the wake of record natural gas prices and global turmoil, it focuses on key trends, developments, changes, challenges, and business opportunities.

https://klinegroup.com/the-eu-s-emerging-power-generation-scenario/

[1] For more information on the EU's emerging power generation scenario, check out Kline's blog here: https://klinegroup.com/the-eu-s-emerging-power-generation-scenario/

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Base number analysis by FTIR spectroscopy

***F.R. van de Voort**, McGill IR Group, McGill University, Montreal QC Canada*
***Daniel Furness**, Oil Analyst Lubetech Pty. Ltd. Coopers Plains QLD Australia*
***Sian Atherinos**, General Manager Lubetech Pty. Ltd., Coopers Plains QLD Australia*
***Michael Viset**, Hydrocarbon Consultant, Kellyville, NSW, Australia*

Overview

A practical stoichiometric fourier-transform infrared (FTIR) Base Number (BN) method was developed in collaboration with Lubetech Pty Ltd., (Australia) to produce ASTM D4739-similar BN results. Thirty-six oils were analyzed by FTIR and ASTM D4739 and demonstrated to match up well, the overall SD for accuracy between methods being ~± 1.0 BN over a range of 0-10 BN, with the within-oil FTIR analytical reproducibility being ~±0.50 BN. With samples prepared and reacted results are obtained in ~1 min and the method is adaptable to standard FTIRs equipped with a conventional flow cell. As structured, service laboratories can achieve significant savings in time and labour while reducing the environmental and maintenance footprint associated with titration. This method is also a more reliable alternative to on-site filter-based IR instruments employing oil-dependent correlational chemometric calibrations as the simple Beer's Law calibration devised is universal, independent of oil type/condition and targets the acid-base reaction.

Introduction

Potentiometric BN analysis is a determinative analytical procedure for in-service engine oils containing an acid neutralising base package. It is often carried out after FTIR condition monitoring/screening (ASTM E2412) or the more specific measure of oxidative acidic products accumulating (ASTM D7418) or base related spectral signals being lost; all indicative of the oil being potentially compromised. The McGill IR group has been at the forefront of developing automated *quantitative* methods for the analysis of in-service oils by FTIR spectroscopy with a focus on automated methods (1), including Acid Number (AN) and BN. More recently, an effort has been undertaken with Australian collaborators to develop manual methods (2) focusing initially on AN as reported here previously (3). Lubetech Pty Ltd, an independent oil analysis and condition monitoring company based in Brisbane, Australia (4) has a vested interest in BN determinations. Like many oil analysis and condition monitoring laboratories optimising analytical efficiency while minimising its environmental footprint is high on its list of priorities. With an Agilent 5500t FTIR available in-house and having been apprised of the benefits derived from earlier AN methodology, a collaborative project was undertaken to prototype a manual stoichiometric FTIR BN method. The concept behind the manual FTIR AN and BN methods is to produce ASTM-similar results without investing in more sophisticated fully automated systems (5), but still achieve superior analytical rates and minimise reagents/solvent usage. This approach was also seen as an option to

facilitate on-site lubricant analysis where reliable BN information is critical. Here it is common to use ASTM D7889-approved IR in-service fluid property condition monitoring instruments that also generate non-ASTM approved AN/BN estimates. These estimates are not part of the ASTM method per se and are not considered adequately reliable for this purpose, but are being used as no practical, better options have been available to date.

FTIR Spectroscopy and Calibration

The Agilent open-architecture TumblIR® accessory (nominal pathlength ~100 µm) for the 5500t FTIR Series is very convenient in terms of sample handling, requires minimal sample (~1.5 ml) to be prepared and only one or two drops for spectral analysis (Figure 1).

Figure 1: *Agilent 5500t TumblIR open architecture sample handling accessory*

Alternatively, any conventional FTIR spectrometer equipped with a ~100 µm transmission flow cell loaded by aspiration may also be used, albeit requiring more sample (~10 ml) to load and rinse out previous samples. What is unique about this BN method is that the calibration is based on a certified Conostan® 6 BN standard (6) which has all the characteristics of a lubricating oil and is simply diluted with mineral oil to produce a series of standards ranging from 0-6 BN (mg KOH/g) differing in 1.2 BN increments. The BN values are converted to apparent BN (BN_{App}) expressed as mg KOH/ml in keeping with the volumetric nature of spectroscopy.

Analytical Protocols

The BN sample analysis protocol is summarised in Figure 2, calibration following a similar route, trifluoroacetic acid (TFA) being used as the reagent for stoichiometric BN determination. Samples/standards (1.5 ml) are conveniently prepared and reacted in 2 ml self-capped plastic microfuge tubes.

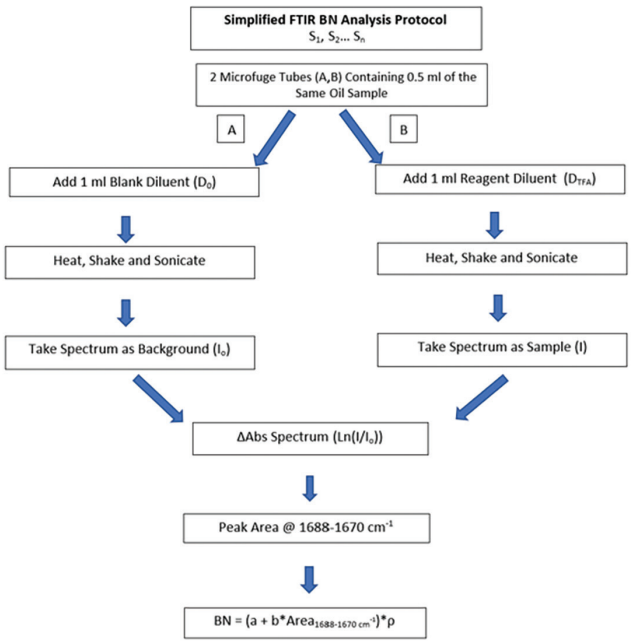

Figure 2: *Simplified split-sample BN analytical protocol*

If a standard transmission flow cell is used, 10 ml or more can be prepared in larger autosampler vials using the same oil:diluent ratios to load a new sample and wash out the previous one. In all cases sample preparation is based on split-sample analysis. For analysis two equivalent 0.5 ml aliquots are placed into two separate microfuge tubes, one treated with 1.0 ml of D_o and the other treated with 1 ml of D_{TFA}. The sample and diluent are not miscible but are thoroughly mixed and placed in a sonic bath to ensure the reaction/extraction is complete. Each split sample is scanned as a pair, D_o as the background spectrum (I_o) followed by D_{TFA} as the sample spectrum (I) to produce a differential absorbance spectrum ($\Delta Abs = Ln(I/I_o)$) which ratios out the common spectral features of the oil matrix and emphasises the spectral changes associated with the acid-base reaction.

The calibration and analysis are based on the formation of the TFA salt (COO-) upon reacting with base, the signal change (area or peak height) being proportional to the BN_{App} of the sample.

Calibration and Performance

Spectroscopy and Calibration

Figure 3 presents typical ΔAbs calibration spectra obtained directly from the Agilent 5500t as well as typical calibration plot obtained from the Conostan® standard producing the following relation:

$$BN_{App} = 1.3163*Area_{1688\text{-}1670} - 0.1886 \quad [1]$$
$$R^2 = 0.9958 \qquad SD = \pm 0.151 \text{ BN}$$

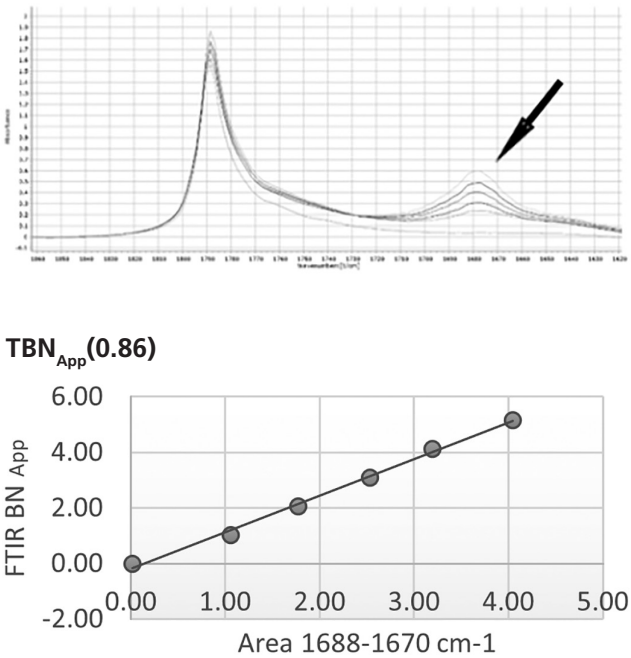

Figure 3: *FTIR Calibration spectra (top) and resulting calibration plot (bottom)*

Comparatively, the reproducibility of ASTM D4739 and FTIR BN for a new oil diluted with mineral oil were ±0.161 BN and ±0.139 BN, respectively. Thus, from a calibration standpoint, the performance of these two methods can be considered very similar for new oils. To some degree these results overstate the excellent performance of potentiometric titration when one compares the results of the 6 BN standard and a new Delvac new oil, both serially diluted with mineral oil. Both have clear-cut inflection points relative to those obtained for used oils (Figure 4) which are clearly less determinative than the standard and a new oil. It is well recognised that oil titrations can be problematic when oils are degraded and can foul the electrodes (7), a problem not encountered with FTIR.

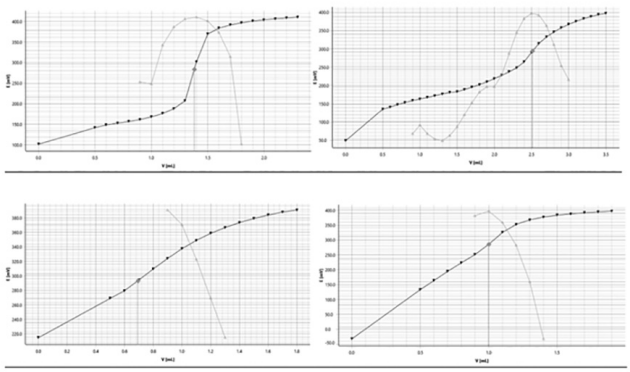

Figure 4: *Potentiometric titration plots of (a) 6 BN standard, (b) new Delvac oil, (c) used Delvac oil and (d) used Pegasus oil*

Sample Analysis

Thirty-six lubricants, a combination of new and used oils were analysed for BN by both methods, the comparative responses plotted in in Figure 5.

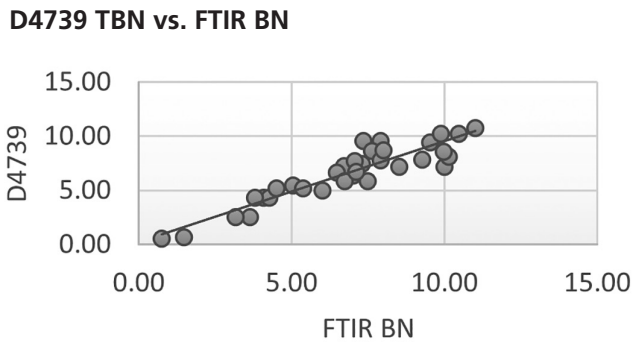

Figure 5: *Relationship between ASTM D4739 titration vs. FTIR BN*

The relationship between the two methods is:

$$ASTM\ D4739 = 0.9265*FTIR\ BN + 0.2678 \quad [4]$$
$$R^2 = 0.8493 \qquad SD = \pm 1.005$$

This indicates that one can measure to within ~±1.0 BN of what one would expect to determine by titration. Based on a more detailed comparative statistical assessment of the results and their stoichiometric basis, the FTIR BN determinations are very similar to those obtained by ASTM D4739 titration, hence the use of the term ASTM-similar.

Method Performance/Benefits

One of the more noteworthy consequences of this study is the close concurrence of the magnitude of the FTIR BN results to those of D4739 given that a substantially weaker acid (TFA) is used instead of HCl. This is attributed to the fact that the TFA concentration used is ~6X greater than the 0.10 N HCl used in D4739. It is likely that with a minor adjustment in the TFA concentration, the FTIR method can be structured to match the ASTM method more directly. This may be useful in the longer run if proven correct and standardised but is eminently workable as is, converting from one measure to the other using linear regression. As a reference method, D4739 has no accuracy specifications per se, but the within-method SDDr of ±0.503 BN obtained for the FTIR duplicates is very much in line with the reproducibility of ± 0.530 cited for a 10 BN certified standard (8) analysed by ASTM D4739.

One of the key benefits of the FTIR methodology is that it is a split-sample method, with both the calibration and analytical results being independent of oil-type as the common spectral elements of the oil are ratioed out and targets only the spectral changes specific to the acid-base reaction. The simple Beer's Law calibration devised is universal (e.g., independent of oil-type) and is readily assessed for performance (linearity and SD) and validated. This is significant because there are FTIRs and filter-based IRs that predict BN from neat oils using chemometrically-derived Library calibrations. These calibrations are based on spectral correlations of oils to their corresponding ASTM D4739 data and are strongly oil-type dependent and do not target a specific spectral signal derived from an acid-base reaction. Such calibrations cannot be readily validated nor can instrument performance be assessed; users being reliant on the claims made by the manufacturers. As such, the results obtained can be problematic to rely on, especially if the oil is not represented, identified properly, or topped up with another oil-type. This sort of uncertainty is avoided in this BN approach, as one derives and evaluate one's own calibration rather than relying on the manufacturer's assurance. To date there have been few options for on-site BN determination, however, access to ASTM-similar data provides substantially more confidence that the information generated is valid and reliable for critical machine reliability decisions.

Commercial Application

At Lubetech Pty Ltd, the manual FTIR BN method has replaced chemometrically derived BN values generated from the spectra of oils screened for in-service condition (ASTM E2412) but which was qualified in its accuracy. Interest in potentiometric titration, given its expense, has always been limited. The expense of this method versus its utility for most clients renders it commercially undesirable as most are looking for the cheapest, most reliable way to monitor the condition of their in-service oils. Additionally, modern oils have generally seen improvements in the BN stability and most clients are not seeing as dramatic drops in BN as they had been previously. Clients had been generally accepting of the fact that the previous FTIR TBN methods undertaken by most condition monitoring laboratories were not as accurate as D4739 but other results (viscosity, soot, wear results etc) were giving alternate indicators of the oil's condition. Being able to deliver ASTM quality data at a reasonable price has resulted in renewed interest in deterministic BN data. The independence of the stoichiometric method relative to oil type, formulation and condition is one of the distinct advantages over chemometric methods that are oil-type dependent. In the first instance, accuracy is obviously a primary factor, however, other

practical variables also play an important role in a method's success. Analytical time and the use of significant volumes of hazardous solvents/reagents are problematic for ASTM D4739, as is system maintenance.

The FTIR stoichiometric BN method is readily implemented at a substantially lower cost relative to potentiometric titration, in large part due to its generic nature, simplicity of sample preparation and straight-forward analytical protocol. In our laboratory the method has been implemented using generic software (SpectraGryph/Excel) to process the spectra collected and predict BN.

There is nothing to prevent FTIR manufacturers from packaging a turnkey version of the method for their own systems. Lubetech has been monitoring/tracking a wide range of client oils for some time, with BNs trending down with use/time, validating its diagnostic utility. Tracking oils in this manner is a cost-effective direct measure of oil degradation, with a significant number of clients now making stoichiometric FTIR BN a staple analysis. Thus the addition of this method to our analytical repertoire has not only been cost-efficient and an environmental plus, but has also provided users with value-added diagnostic information at a reasonable cost. Previous BN methods have been almost entirely replaced with the new method for clients at no further cost with far more accurate and environmentally-responsible results.

Conclusion

The FTIR BN method devised for the Agilent 5500t equipped with the TumblIR handling accessory provides for rapid and accurate determination of ASTM D4739 BN-similar results.

As structured the method can readily be adapted to conventional FTIRs equipped with a demountable flow cell, requiring only somewhat more sample to load and rinse. In both cases, sample preparation is straight-forward, requires minimal reagents/solvents and spectral analysis takes about one minute after the sample pairs have been prepared. In contrast, the titrimetric procedure takes between 30-45 minutes per sample and has a significant environmental/maintenance footprint. As a result of this collaborative development project, Lubetech Pty. Ltd. has implemented and provides FTIR BN as a cost effective, optional analysis.

A substantive data base is being built up to further refine the method as outlined here. As noted, the method may also serve for on-site use where quality BN data is required for critical machinery monitoring applications for which the Agilent 5500t is well suited, the analytical protocol simple enough to carry out in an on-site environment. Anyone interested in more detail can contact the authors directly or consult the pending issue of Lubrication Science (9).

Additional conceptional information is available in a comprehensive review related to the evolution of quantitative FTIR spectroscopy of lubricants, recently published in Tribology OnLine (10).

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News

HSE Committee:
The Committee held in September its third and last meeting of the year, where a strategic session on the priorities for 2023 and how to make the best out of the general meetings. The Committee also discussed how to continue and further increase its active collaboration with other associations in 2023 and keep its active involvement within ATIEL.

While the REACH revision and the CLP revision are still facing some delays (expected early 2023), the discussion on the various concepts are progressing. The Joint Research Centre published over the summer its technical report on Safe and Sustainable by Design (SSbD) and the European Commission opened a public consultation on better access to chemicals data for safety assessments and. In parallel, lithium salts are under threat to be classified category 1A (reproductive toxicants) after ECHA's Committee for Risk Assessment report. This means that the use of these lithium salts would now face stricter regulation. The HSE Committee will actively follow the developments of this new classification. In the meantime, the Biocides for metalworking fluids subgroup has also developed a position paper on their potential new classification.

Technical and Competition Committees:
The Technical and Competition Committees have met for the last time of the year in September 2022, with a dedicated session to strategy and defining the objectives for the coming years.

In the meantime, they continue making progress on several cases, regarding misleading communications and issues on access to technical information. An OEM Bulletin was also circulated in September on Mercedes Evobus Blatt.

Over the last months, the Committees have been in contact with the European Commission's DG GROW and with National Type Approval authorities regarding relevant repair and maintenance information for fluids to be used in motor vehicles.

Finally, the Committees have been working on answering to the public consultation on the proposed prolongation of the Motor Vehicle Block Exemption Regulation (MVBER) and the draft amendments to the Supplementary Guidelines, for which the deadline was 30 September 2022.

Taxation Task Force:
The EU co-legislators are currently negotiating the revised Energy Taxation Directive that the European Commission published last year. This revised Directive is important for the lubricant sector to promote a level playing field in Europe.

Furthermore, related to UEIL's objective to prevent the inclusion of lubes under the Excise Movement and Control System (EMCS), certain EU Member States are concerned about increased fraud with lubes across Europe and are once again increasing the pressure to include lubes under EMCS. UEIL will continue its outreach to the EU Member States in the coming weeks to express its concern and will discuss with the European Commission the option of a definition of 'light lubes' that might be included under EMCS at the end of 2022.

The European Commission has also decided to reduce the quota on Group II to 75K tonnes in the first half of 2022 and 0 in the second half of 2022. UEIL is lobbying for a higher quota since the demand for Group II is higher than the supply in Europe, and because it is difficult to change from one producer to another for lubricant blenders. In addition, due to the EU sanctions on Russia, demand for Group II by European blenders has even increased in recent months. Therefore, UEIL hoped that the European Commission was willing to extend the transition phase on the current quota on Group II after June 2022, which has not happened yet. And the Member States are currently discussing an extension of the quota, which could take place at a later stage this year.

www.ueil.org

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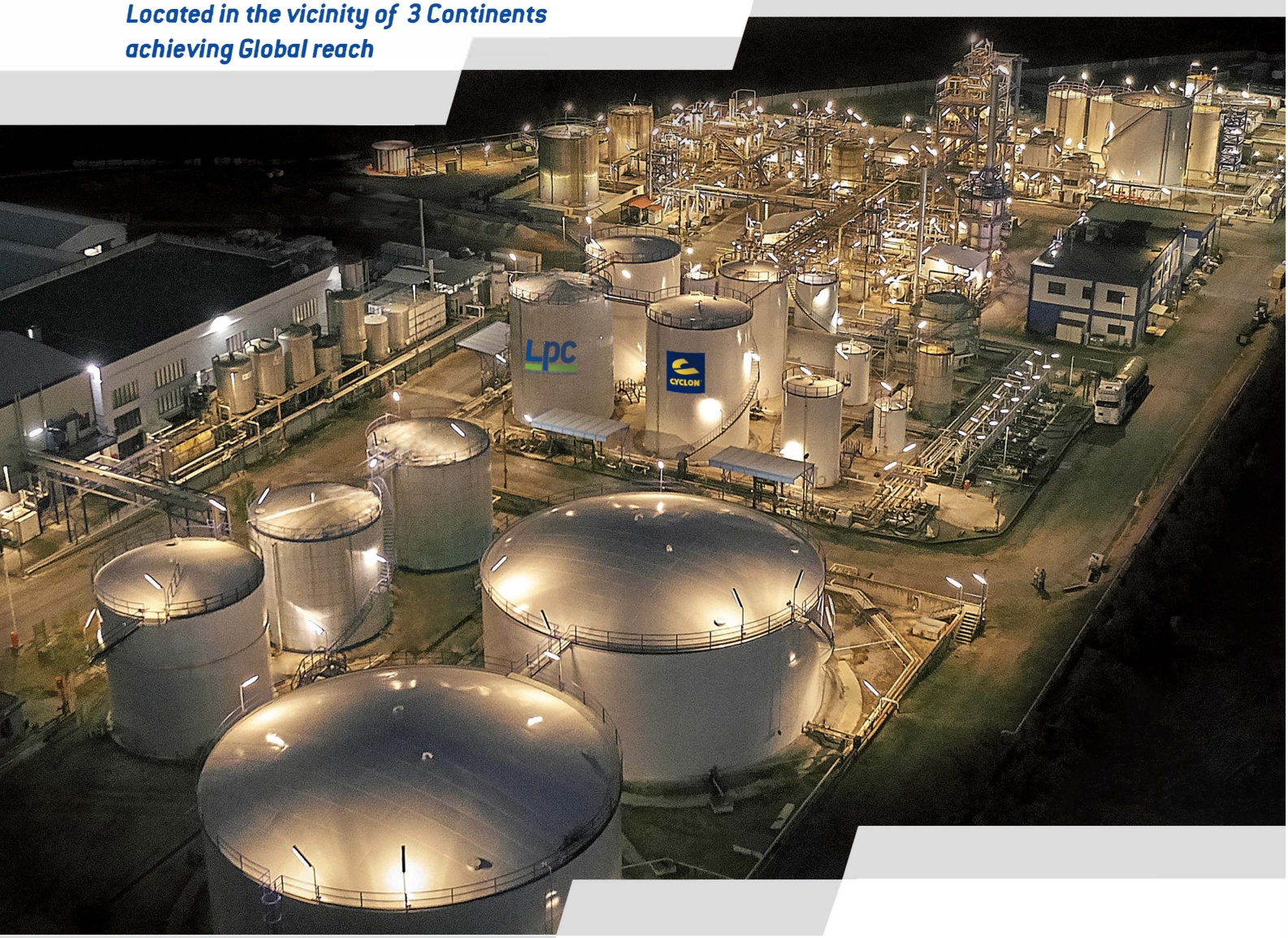

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2022 UEIL Annual Congress

19-21 October 2022 Athens, Greece

Driving innovation – the lubricant industry on the move

Europe's recovery requires the acceleration of the twin green and digital transitions, so that we build a more sustainable and resilient society and economy. These two trends present a unique opportunity to the lubricant industry – but we will only be able to capture the benefits if we take the right strategic decisions. For this reason, the theme for the 2022 UEIL Congress will be "Driving innovation – the lubricant industry on the move".

From October 19 to October 21 in the beautiful city of Athens, Greece, we will explore the topic of innovation along different stages of the value chain, with the aim of understanding the regulatory environment and the tools at hand – as well as being inspired by success stories and case studies presented by the brightest European lubricant manufactures.

Wednesday 19 October 2022	
Registrations at the Divani Caravel Hotel (Congress Hotel) UEIL Board of Directors Meeting	10.00 – 16.30 09.30 – 12.30
Pre-conference interactive course ***How to talk to your customer before they're ready to buy*** Plan. Grow. Do	10:00 – 13:00
Welcome coffee	13.00 – 14.30
UEIL General Assembly	13.30 – 15.30
Pre-conference seminar ***Future scenarios and business model evolution for the lubricant industry: From reaction to anticipation*** Sponsored by Kline Consulting	16.00 – 18.00
Cocktail reception at Divani Caravel (Congress Hotel)	18.00 – 19.30
UEIL Welcome Dinner at Divani Caravel (Congress Hotel) Dress code: business casual	19.30 – 22.00
Thursday 20 October 2022 ***Moderated by: David Wright, Lube Media / UKLA***	
Registrations at Divani Caravel (Congress Hotel) *Partner Programme (tbc)*	08.30 – 17.30 *09.00 – 17.00*
Welcome Coffee *Sponsored by ILMA*	08.30 – 09.30
Opening session	09.30 – 10.30
Welcome Valentina Serra-Holm, President, UEIL	09.30 – 09.50
Introductory speech: The lubricant market in Greece Miltiadis Bantis, LPC	09.50 – 10.10
Keynote speech: Industry 5.0 Martin Heumer, European Commission	10.10 – 10.40
Coffee break *Sponsored by ABN Resource*	10.40 – 11.10
Session 1: Innovation in raw materials	11.10 – 12.20
Top-Tier, Carbon Neutral Base Oils: The Best Route to Lowering Your Carbon Footprint Bill Downey, Novvi	11.10 – 11.35
Success in Sustainability Mark Miller, Biosynthetic Technologies	11.35 – 12.00

Panel discussion Bill Downey and Mark Miller will be joined by Elisa Swanson-Parbäck, Perstorp	12.00 – 12.20
Session 2: Innovation in R&D and product development	12.20 – 13.30
The answer is innovation Andreas Dodos, Eldon's	12.20 – 12.45
SME Innovation Challenges in a Regulatory World Nick Clague, Technical Director, Vickers Oils	12.45 – 13.10
Panel discussion Andreas Dodos and Nick Clague will be joined by Sofia Öberg, 2Probity	13.10 – 13.30
Lunch Break ***Lunch & Learn: "Innovate sustainably: Driving further success with bio-based additives"*** *– sponsored by Ingevity*	13.30 – 14.40
Session 3: Innovation in production and supply	14.40 – 15.45
Carbon Neutral Blending – A Sustainable Future for the Lubricant Industry Alex Ball, Blendtek	14.40 – 15.05
Remote stock monitoring and management Sylvia Kerscher, FoxInsights **Panel discussion** *Speakers tbc*	15.05 – 15.30 15.30 – 15.50
Coffee break *Sponsored by Zeller + Gmelin*	15.50 – 16.20
Session 4: Innovation in sales	16.20 – 17.15
Selling how your buyer wants to buy Steve Knapp, Plan. Grow. Do.	16.20 – 16.45
E-commerce: Applying tactical and strategic lenses Yana Wilkinson, Kline Consulting **Panel discussion** Steve Knapp and Yana Wilkinson will be joined by Valentina Serra-Holm, UEIL	16.45 – 17.10 17.10 – 17.30
Gala Dinner, Eleon-Loft Athens Dress code: Business elegant *Sponsored by LPC*	19.00 – 23.30 Leave from the Congress Hotel at 18:45.

Friday 21 October 2022

Moderated by: Thomas Norrby, Nynas

Networking coffee *Sponsored by FUCHS HELLAS SA*	09.00 – 10.00
Session 5: The lubricant industry's sustainability journey	10.00 – 11.00
EU's green transition *Speaker tbc* **UEIL's sustainability journey** John Eastwood, Cargill & UEIL Sustainability Committee	10.00 – 10.30 10.30 – 11.00
Coffee break *Sponsored by SIP*	11.00 – 11.30
Session 6: How is the lubricant industry adding value to society?	11.30 – 12.20
Panel discussion Holly Alfano, ILMA; Jacquie Berryman, ATC; Marco Digioia, ATIEL; Valentina Serra-Holm, UEIL.	11.30 – 12.20
Closing session	12.20 – 12.30
Closing remarks Valentina Serra-Holm, President, UEIL	12.20 – 12.30
Lunch break *Sponsored by FUCHS HELLAS SA*	12.30 – 13.30

Please note that the programme may be subject to modifications and it will be updated continuously up to the congress.

Legislative update on the Fit for 55, the Carbon Border Adjustment and the ETS

The Fit for 55 package is a set of EU legislative measures aiming to reduce net greenhouse gas emissions by at least 55% by 2030. It covers a wide range of policy areas like energy or transport. Among these measures, two files are particularly important for energy-intensive industries implemented on the European ground: the revision of the EU Emission Trading System (EU ETS) and the Carbon Border Adjustment Mechanism (CBAM). The European Parliament has adopted its reports on both files during a Plenary session in Brussels on 22 June 2022 and has begun interinstitutional ('trilogue') negotiations with the Council of Member States and the European Commission to agree on final legal acts. This process can be expected to last around six to nine months.

EU Emission Trading System (EU ETS)
The EU ETS sets a cap on the total amount of certain greenhouse gases (CO_2 emitted from electricity and heat generation, energy-intensive sectors, and commercial aviation; N_2O, and PFCs) that can be emitted by the installations covered by the system. Its revision aims to provide predictable, robust, and fair rules to address the risk of carbon leakage.

Carbon Border Adjustment Mechanism (CBAM)
It particularly aims to impose a carbon price on imports of a targeted selection of products. Initially, cement, iron and steel, aluminium, fertilisers, and electricity would fall under the scheme. The CBAM is highly linked with the revision of the EU ETS, as the level of the levy will depend on the price of emission allowances in the EU ETS.

https://ec.europa.eu/clima/eu-action/european-green-deal/delivering-european-green-deal_en

https://oeil.secure.europarl.europa.eu/oeil

REACH update

With the EU entangled in a growing energy crisis since Russian's invasion of Ukraine, advocating for regeneration of waste oils appears all the more important and timely. The current situation shows that we need to do more with the resources we have available and accelerate the energy transition, as the EU cannot continue to be dependent on import of primary raw materials.

Amidst the uncertain context which deeply worries and affects both industries and consumers, waste oils regeneration is part of the solution. Our regeneration activities, which are not only in sync with the circular economy but also performed on the European soil, can help reduce the EU's dependence on imports of primary resources from third countries while reducing CO_2 emissions strengthening domestic jobs and the economy. GEIR will therefore be engaging with policy-makers and like-minded actors to carry these messages forward for appropriate and informed action, particularly in view of the discussion at political level on the revised Waste Framework Directive in the coming months.

Given the critical situation that we are experiencing today, it is paramount that the EU recognises the important role that our industry plays in the promotion of a circular economy and in the energy independency of the EU. This essential role must be consistently recognised across EU legislation, thereby giving more space to GEIR to be heard and contribute to resolve today's energy and climate challenges.

www.geir-rerefining.org

Greece

***Papadelis Christoforos**, Marketing Manager of LPC (Lubricants & Petroleum Corporation)*

The lubricants industry is playing a significant role on the path to sustainable development, and Greece is among the countries within Europe undertaking initiatives in this direction.

The Greek lubricant market has long been established as a key player in the Balkans, demonstrating a continuous growing footprint in the European lubricant landscape. Its lube oil base-stock production capabilities form the basis for this development and allow not only to support local finished lubricants needs but also to export significant quantities abroad. The production of lubricants in Greece depends mainly on two refineries, the Motor Oil Hellas crude oil refinery, producing Group I base oils, and the LPC re-refinery, producing Group I+ re-refined base oil, reaching an annual production capacity of more than 250.000MT.

After the impact of the COVID-19 pandemic on the lubricants value chain, the Greek lubricant market has shown a gradual recovery. In 2021, the market was estimated at 70mln Lt and is expected to grow due to the economy and transport regeneration combined with an increase in industrial production. The Automotive segment constitutes the largest share, 44% in 2021, while the Industrial & Marine segment 19% and 37% of the domestic market, respectively. There is also a growing grease market, accounting for approximately 2mln Lt in 2021.

The global trend for synthetic/semi-synthetic oils, driven by stringent emissions and fuel economy norms, is also evident in Greece and is growing by more than 4% within five years. Mineral origin lubricant oils remain a leader in the category but still face a declining contribution trend.

Aligning with the European Commission 'Fit for 55' package, an extensive range of policies and reform measures have been adopted at the national level.

To achieve sustainable development objectives, the legal framework fosters the transition to a low-carbon future, sustainable consumption and production patterns.

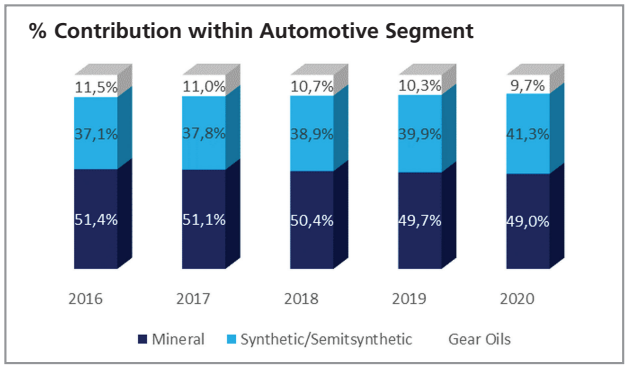

***Figure 1:** Oil category % contribution within the automotive segment*

In the lubricants category, Greece is a benchmark for best practices. In managing waste oils, Greece remains at the top of Europe, exceeding the national targets for recycling since 2015. In 2021, 71%wt of the waste lubricating oils produced in Greece were collected, and 100%wt of these regenerated. The set of mandatory green public procurement (GPP) criteria and targets for lubricants is another example of the move towards a sustainable future.

Thanks to its re-refinery, LPC is one of the reasons for the excellent performance of the Greek EPR system. It has introduced the best available regeneration techniques, including combined techniques of thin film evaporator (TFE) and catalytic hydrotreatment. And it is also the only company in Greece that produces "Bright stock" - the heavy mineral oil fraction - coupling propane extraction with catalytic hydrotreatment. Not only does it allow the achievement of high yields and advanced base oil quality, but it contributes to reducing the carbon footprint of final products.

Greece's lubricant oils industry bears the advantages of Greece's strategic location and compliance with the EU regulatory environment. At the same time, the industry has developed a great refining infrastructure and is continuously building its profile as a credible exporting partner.

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