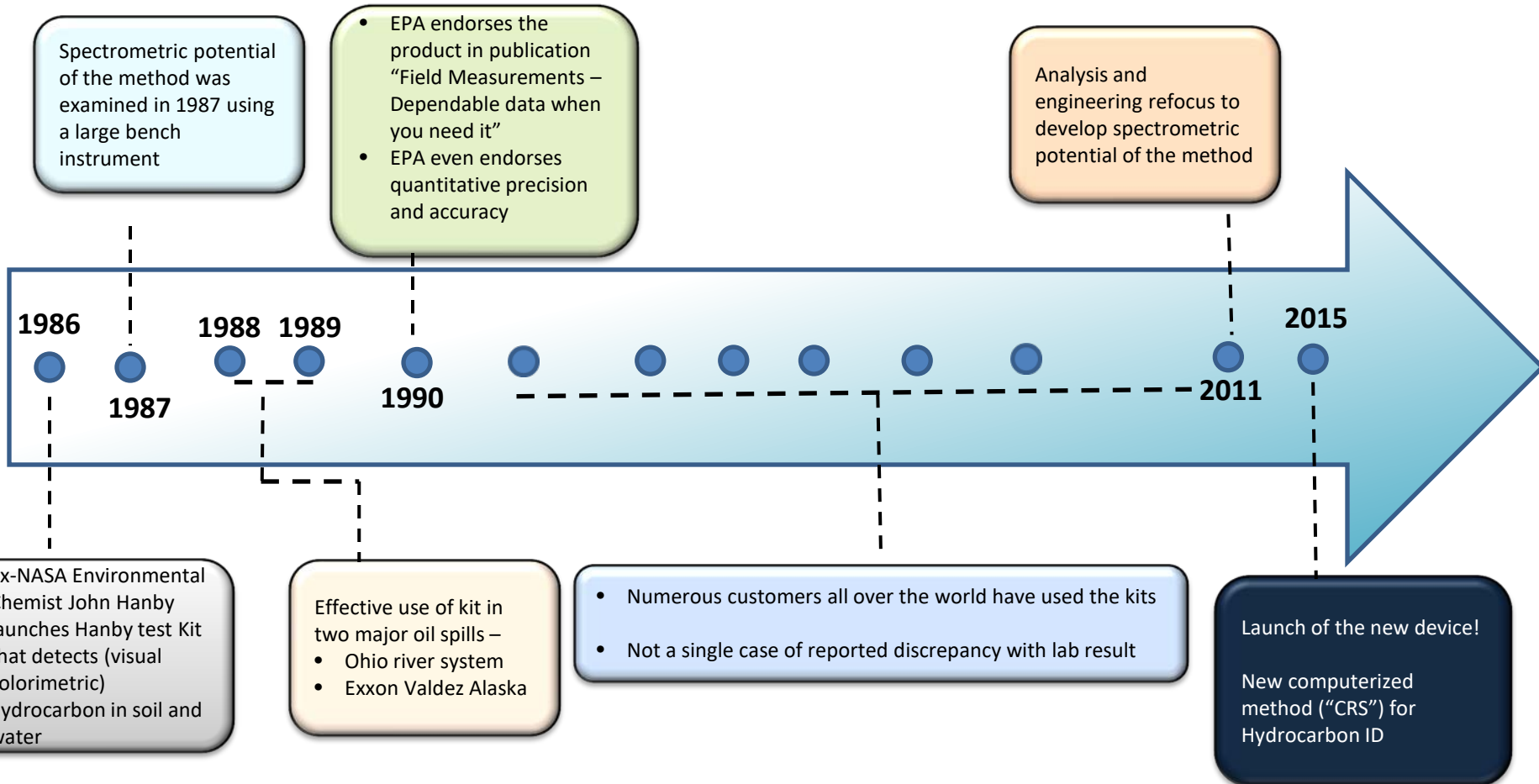# Hanby Chemical Reaction Spectrophotometry for Hydrocarbon DNA Analysis
&
ELMN8 Fire As A New Fire Fighting Agent

Charles D. Fator – *President & CEO*
Hanby Environmental - Hanby PetroAnalysis

James "Randy" Cook – *Owner & President*
Jessica Innocenti – *Human Resources & Certified Lab Tech*
OMG Solutions

Hanby story: "For Accurate Field Analysis"

Spectrometric potential of the method was examined in 1987 using a large bench instrument

- EPA endorses the product in publication "Field Measurements – Dependable data when you need it"
- EPA even endorses quantitative precision and accuracy

Analysis and engineering refocus to develop spectrometric potential of the method

1986

1988 1989

1987

1990

2015

2011

Ex-NASA Environmental Chemist John Hanby launches Hanby test Kit that detects (visual colorimetric) hydrocarbon in soil and water

Effective use of kit in two major oil spills –
- Ohio river system
- Exxon Valdez Alaska

- Numerous customers all over the world have used the kits
- Not a single case of reported discrepancy with lab result

Launch of the new device!

New computerized method ("CRS") for Hydrocarbon ID

New Technology for Hydrocarbon DNA Analysis & Fire Fighting Agent ELMN8
CUPA , Anaheim, CA 2/25-29/2019

Hanby Environmental
For Accurate Field Analysis

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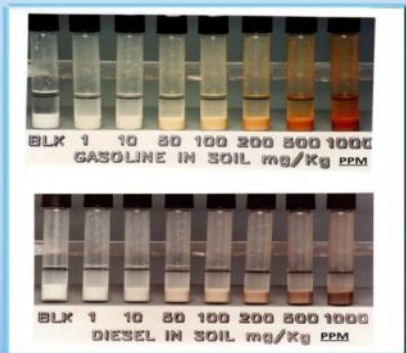# Hanby Environmental's TPH Field Test Kits

EVALUATIONS OF FIELD

The Hanby Test Kits and the visual methods of analysis are currently recognized by the U.S. EPA as a reliable field screening method for TPH in environmental matrices (EPA 1993)

The visual method of analysis, although subjective, was found to be reliable for identification of TPH contamination and for estimating concentration within an order of magnitude of the expected or certified value. (US Army Corps of Engineers 2000)

The Hanby Test Kit achieves selection limits of 1.0 mg/kg for soil and .10 mg/L for water. The typical range of the test is 1.0 to 1,000 mg/kg for soil and .10 to 20 mg/L for water. - clu-in.org

"The development of a field method for the analysis of organic contaminants at sub-part-per-million levels in water has proved to be a valuable tool in the establishment and the sampling of the groundwater monitoring wells." (Hydrocarbon Contaminated Soils & Goundwater, Vol 1, Pub.1991)

BLK 1 10 50 100 200 500 1000
GASOLINE IN SOIL mg/Kg PPM

BLK 1 10 50 100 200 500 1000
DIESEL IN SOIL mg/Kg PPM

www.HanbyEnvironmental.com

TECHNICAL PUBLICATIONS & CITATIONS

Books:

1. Hydrocarbon Contaminated Soils and Groundwater, Chap. 9, "A New Method for the Detection and Measurement of Aromatic Compounds in Water", Lewis Publ., 1991.

2. Chemistry for the Protection of the Environment 1, Chap.13, "A New Method for the Detection and Measurement of Aromatic Compounds in Water", Plenum, 1991.

3. Chemistry for the Protection of the Environment 2, Chap. 43, "Use of a Portable, Fiber-Optics, CCD Spectrophotometer to Measure Friedel-Crafts Products in the Detection of Crude Oil, Fuel, and Solvent Contamination of Soil.", Plenum, 1996.

4. Monitoring and Remediation Technologies for Solid Wastes, Chap. 5.3, "Innovative, Field-Portable, Optical Fiber-Based Spectrophotometer for Detection and Monitoring Aromatics and Alkyl Halides", Plenum (in publ.)

5. Current Protocols in Field Analytical Chemistry, Chap.1, Volatile Organic Compounds, Unit 1J Reagent Chemistry, "The Hanby Method for Aromatic compounds", John Wiley, 97, 98, 99.

U. S. EPA Publications:

1. Field Measurements: Dependable Data When You Need It, EPA/530/UST-90-003, Sept. 1990.
2. Subsurface Characterization and Monitoring Techniques, EPA/625/R-93/003, May, 1993.
3. HNU-Hanby Environmental Test Kit, EPA/540/R-95/515, August, 1995
4. Superfund Innovative Technology Evaluation Program (SITE) Technology Profile, 9th ed. EPA/540/R-97/502, "Characterization and Monitoring Program", Hanby Environmental Laboratory Procedures, Inc. (Test Kits for Organic Contaminants in Soil and Water), pp.392-3, Dec., 1996.
5. Expedited Site Assessment Tools for Underground Storage Tank Sites, EPA 510-B-97-001, Chap.VI, "Field Analytical Methods for Petroleum Hydrocarbons; Colorimetric (Hanby) Test Kits, pps.VI 13-17, March, 1997.
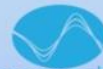
Hanby Environmental
info@hanbyenvironmental.com
www.HanbyEnvironmental.com

1772 West Sam Houston Parkway
Houston, TX 77043
Coypright, Hanby Enviromental, LLC 2012

877.806.0901 Toll Free
713.468.3898
713.468.3897 fax

Hanby Environmental
"For Accurate Field Analysis"

HANBY TPH TEST KITS
SOIL AND WATER

On-site Results in Minutes!

Hanby Environmental
For Accurate Field Analysis

MG Solutions
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Hanby Environmental's TPH Field Test Kits

Hanby Environmental — For Accurate Field Analysis

HANBY FIELD TEST KITS ARE:
A uniquely designed "mobile lab" that test for TPH in water & soil by using a precise scientific method to produce colors to identify contaminants, both qualitatively and quantitatively. Hanby test kits are designed to save time and money by significantly reducing the dependence on off-site lab analysis.

SOIL TEST KIT

USES FOR KITS:
The kits can be used for many various applications, for instance in phase 2 site assessments, to monitor the operating conditions of a remediation system, or to confirm that contaminated soils and/or groundwater has been or needs to be removed and to monitor locations to ensure compliance within approved guidelines as well as, applications such as, platform mud-logging, wire line reservoir fluid analysis, chemical identification of crude oils and more.

WHO USES THE KITS:
Environmental contractors and consultants, HazMat teams, remediation specialists, and even oil exploration geologists have been utilizing Hanby products at spill sites, underground storage tanks, pipeline leaks, remediation sites and Superfund sites.

"The immediacy of analysis is key."
- John Hanby, Inventor

www.HanbyEnvironmental.com

WATER TEST KIT

HANBY FIELD TEST KITS
Hanby Water Test Kits have been serving as dependable field analytical tools since 1987 to provide rapid, accurate data for fresh water and marine petroleum contamination. They have been published since 1990 by the U.S. EPA as a "Dependable data method" and have been evaluated and approved for field use by the EPA and State Agencies.

Hanby Field Kits have been utilized at the worlds most major oil spills, such as the Exxon Valdez, the Ashland oil tank spill, the Mega Borg, the Prestige and many others to provide sensitive precision data for clean up and remediation efforts.

Hanby Field Kits play a key role in monitoring the restoration of water and wetlands and in the determination of oil content in production water in offshore and onshore oil rigs.

SAVE TIME & MONEY
"Don't wait, add this wonderful cost effective tool to your business!"

ADVANTAGES OF OUR KIT:
Speed
(takes 5-10 min for a result)
Portability
(lightweight & rugged case can travel in back of truck & not be damaged)
Easy to use
(color is developed in response to the presence of a contaminant and the resulting color is matched to a color chart supplied in the kit)
Low cost per sample
(15 test in one kit & 15 tests per refill order)
Wide Range
(test for a broad range of petroleum related chemicals)
Accurate Results
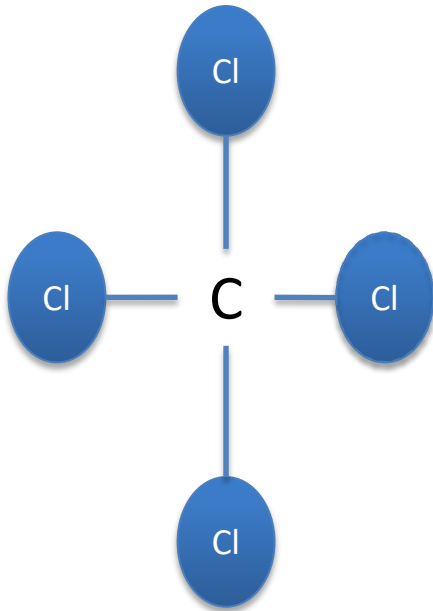*(results are scaled down in PPM – Parts per million)*

PETROLEUM DETECTION SPECIFICATIONS
The Hanby Test Kits provide analytical results for petroleum fuels and constituents, such as gasoline, diesel fuel, jet fuel, crude oil, motor oil, BTEX, and PAHs, as well as PCBs in soil and water samples.

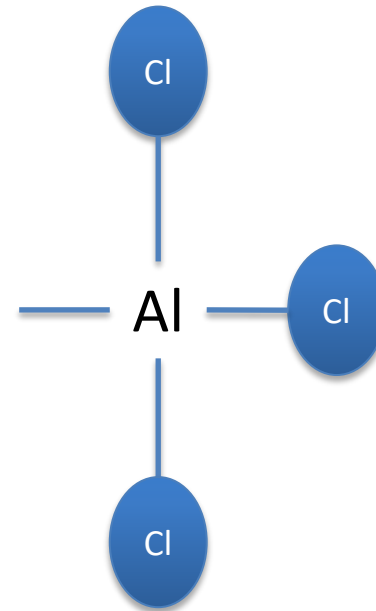*"Field Kits challenge fixed Labs in enviromental testing."*
- R & D

Bk 0.1 0.5 1.0 2.5 5.0 7.5 10.0 25.0 50.0
MC 252 (Deepwater Horizon) Crude Oil in Water, µL/L (PPM)
H.E.I.P., Inc.   7/4/10

Friedel-Crafts Reaction

$CCl_4 \rightarrow CCl_3$

$AlCl_3 \rightarrow AlCl_4$

Carbonium Ion CCl_3

$AlCl_4$

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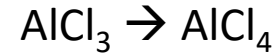
Friedel-Crafts Reaction

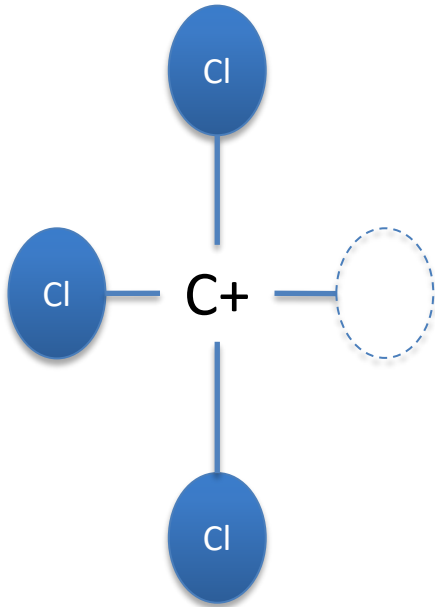Carbonium Ion –
Positive Charge (+)

Benzene – Negative
Charge (-)

Cl

Cl — C+ —

Cl

C_6H_6

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Friedel-Crafts Reaction

$AlCl_3 \rightarrow AlCl_4$

Carbonium Ion

AlCl₃
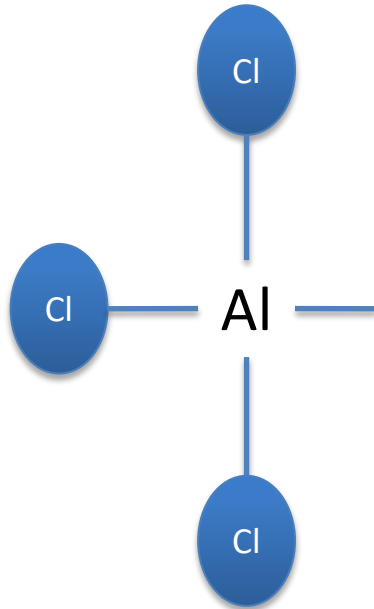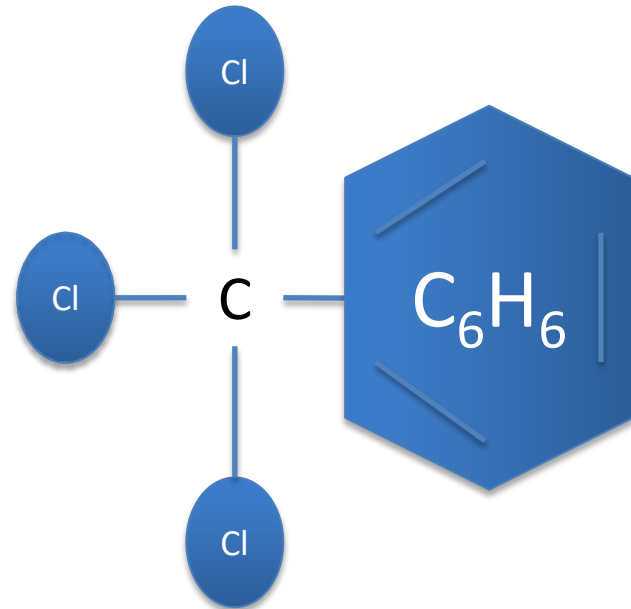
Friedel-Crafts Reaction

Benzene – Negative
Charge (-)

Carbonium Ion –
Positive Charge (+)

C_6H_6

Cl

$C+$

C_6H_6

Cl

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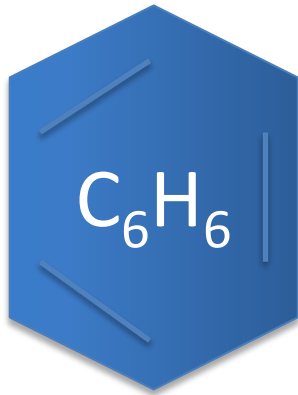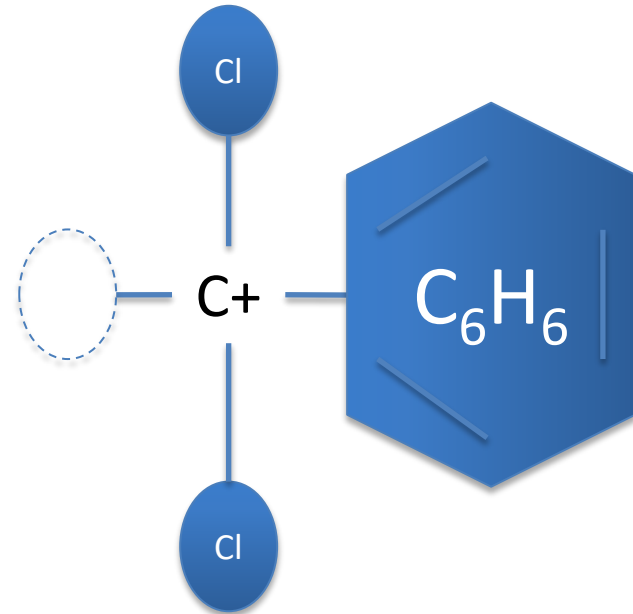
Friedel-Crafts Reaction
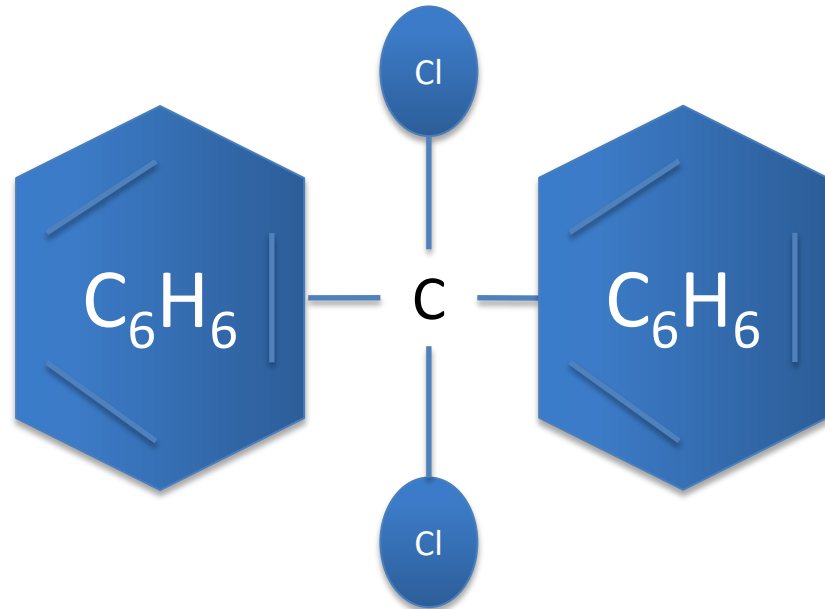
The Chromophore

Friedel-Crafts Reaction

The Chromophore
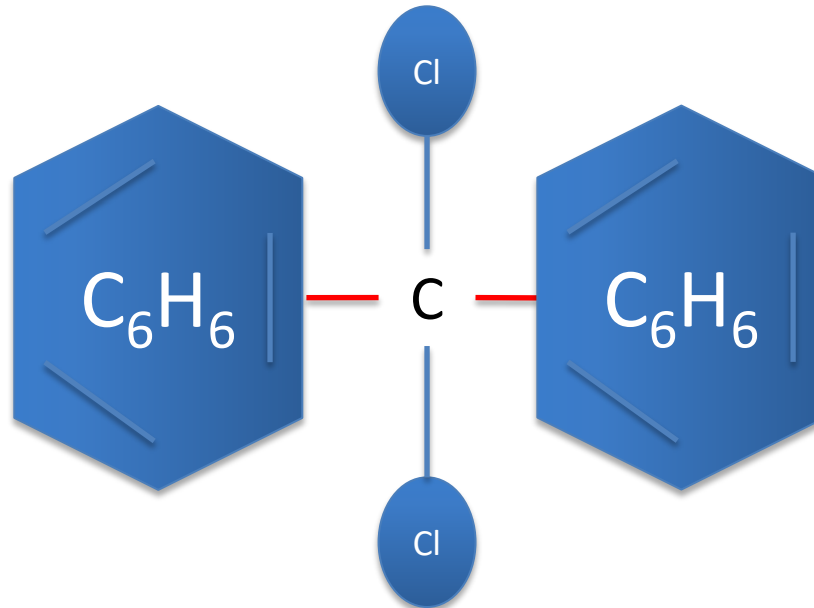
Next step

Hanby water / soil test kits –

Perhaps the fastest and simplest water and soil contamination (hydrocarbon) analysis since 1986
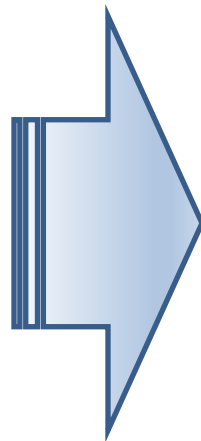
Hanby PetroAnalysis

Fingerprint Hydrocarbons With Our **Chemical Reaction Spectrophotometer HYDROCARBON ID**

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Similar looking kit, but step change in analysis / information

Water / Soil Kit

Visual

BLK 40 50 60 80 100 120

GASOLINE in Soil mg/Kg

Mobile App

2015: New Device – "Hydrocarbon ID"
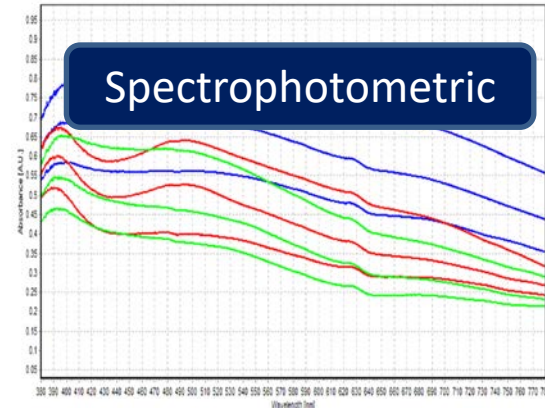
Spectrophotometric

FRONT & CENTER

Hanby Environmental

The Utilization of Strong Chemical Reactions to Enhance the Spectral Signature of Petroleum Substances Chemical Reaction Spectrophotometry

By: John D. Hanby

A new method for the spectral analysis of petroleum compounds in the environment is described that utilizes a combination of chemical (bond) energy and UV/vis light energy.

The correspondence of chemical bond energy levels (10^4-10^5 Cal/mol) with UV/visible frequencies (10^{14}-10^{15} cps) results in a robust spectral resonance that provides a new spectrophotometric technique for the qualitative and quantitative analysis of complex organic substances such as crude oils. Particularly strong spectral signals in the UV/vis region are produced by certain chemical reactions. This strong spectral energy is related to the electronic population inversion achieved in the course of these exothermic chemical reactions, which is in line with the definition of a chemical laser as "*a laser operating on a population inversion produced—directly or indirectly—in the course of an exothermic chemical reaction.*" [1]

The discovery of the analytical capability of this technique was made by the author shortly after he left a 10-year position as Environmental Health Lab Supervisor at NASA, JSC, Houston in 1985. One of the methods for the analysis of Space Shuttle drinking water was the visual determination of the disinfectant used, bromine, utilizing Nessler tubes. The significance of this new technique lies in the enhancement of the signal-to-noise ratio (SNR) resulting from the strong spectral signals achieved by specific chemical substances, particularly aromatics, that are present (3% to 30%) in crude oils and readily undergo the FC reactions. This is analogous to having relatively few "marker compounds" present in a complex substance that provide definitive identification of the substance. Crude oil, petroleum, is the most complex organic substance on the planet. This is understandable given that it is derived from the biota that have accumulated on the earth for about 100 million years and, through sedimentation and geological processes, has "cooked" at high temperature and pressure through this time. Accordingly, the precise, definitive analysis of the hundreds of components in petroleum, or "TPH," is the most daunting task facing environmental chemists. Hanby patented a field test kit for water and soil samples that utilized the discovery in 1991.

Spectrometry is based on the fact that certain electronic configurations in molecules undergo harmonic resonances with specific frequencies in the electromagnetic spectrum. These frequencies range from extremely powerful energies such as X-rays to relatively low-energy frequencies such as microwave and infrared (heat). Ultraviolet and visible (UV/vis) frequencies have precisely the frequencies that resonate with the electronic structures of molecules. This spectral resonance is captured by the field device, called "Hydrocarbon ID," and compared with a spectral library stored in the computer of the device. These bonds are composed of electron pairs that strongly resonate with UV/vis spectral energy especially when the newly formed products, called chromophores, are still in close contact (adsorbed) with the catalyst. The first publication concerning this new utilization of the relationship between spectral energy and chemical energy was first described by Hanby in the proceedings of an environmental conference held in Newport Beach, California in 1990.

[1]Gross, R.W. 1976. *Handbook of Chemical Lasers*. New York. John Wiley and Sons.

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CUPA , Anaheim, CA 2/25-29/2019

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Chemical Reaction Spectroscopy (CRS)

- The correspondence of **chemical bond energy levels** (10^4-10^5 Cal/mol) with **UV/visible frequencies** (10^{14}-10^{15}) **results in a robust spectral resonance** that provides a **new spectrophotometric technique** for the **qualitative** and **quantitative analysis** of **complex organic substances** such as crude oils. **Friedel-Crafts (FC) electrophilic alkylations exhibit particularly strong spectral signals in this region especially as the chromophores produced are briefly** adsorbed to the **strong Lewis acid catalyst, AlCl3**. This **strong spectral energy** is related to the **electronic population inversion** achieved in the course of these **exothermic chemical reactions, which is in line with the definition of a chemical laser** as, **"a laser operating on a population inversion produced-directly or indirectly- in the course of an exothermic chemical reaction"**. i

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Chemical Reaction Spectroscopy (CRS)

- The significance of this new technique lies in the **enhancement of the signal-to-noise ratio (SNR)** resulting from the **strong spectral signals** achieved by specific chemical substances, **particularly aromatics**, that are present **(3-30%) in crude oils** and readily undergo the FC reactions. This is **analogous** to having a **relatively few "marker compounds"** present in a **complex substance** that **provide definitive identification** of the substance. It can be thought of as **converse to the mass spectrometer analytical approach** in which the molecular components of a complex analyte are **further broken into ionized fragments**, which are then **sorted according** to their **mass/charge ratio**.

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Chemical Reaction Spectroscopy (CRS)

- Certainly the **most widely employed spectro-analytical technique employed** in the **analysis of formation fluids (crude oils)** in the **past few decades** has utilized **infrared (IR) and near infrared (NIR) frequencies** of the spectrum. **IR energies are 2-4 orders of magnitude less than UV/visible energies** and consequently do not have the penetrating and ionizing power to cause the chemical changes seen with the latter. The **lower frequencies of IR (heat) cause "bending", "wagging', "stretching", etc.** that describe the **movement of parts (moieties) of molecules** in relation to each other. As with **mass spectrometry, comprehensive** and **detailed interpretation** of these **spectrograms** is **far easier** to perform when analyzing **less complex substances than crude oils. Another greatly complicating factor in** the use of **IR frequencies**, particularly in the analysis of crude oil, is the **presence of large amounts of water** in the sample. **H2O** has **very strong absorbance** in the **infrared** and **therefore masks other IR absorbing compounds** that may be in the sample.

- i Gross, R.W. (1976) Handbook of Chemical Lasers, New York: John Wiley and Sons.

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ENERGY

Calories/mole 10^{12} 10^{11} 10^{10} 10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2

Electron volts 10^8 10^7 10^6 10^5 10^4 10^3 10^2 10 1 10^{-1} 10^{-2}

FREQUENCY

Cycles per second 10^{22} 10^{21} 10^{20} 10^{19} 10^{18} 10^{17} 10^{16} 10^{15} 10^{14} 10^{13} 10^{12}

WAVELENGTH

Centimeters 10^{-12} 10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2}

Microns (μ) 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10 10^2

Millimicrons (mμ) 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10 10^2 10^3 10^4 10^5

Ångstroms (Å) 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10 10^2 10^3 10^4 10^5 10^6

WAVE NUMBER

Centimeters^{-1} 10^{12} 10^{11} 10^{10} 10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2

RADIATION CLASSIFICATION

Cosmic rays
Gamma rays
X rays
For ultraviolet
Ultraviolet
Visible
Near infrared
Infrared
For infrared

The Electromagnetic Energy Spectrum

This table represents the correlation of various units of energy and the names ascribed to the different regions of radiation. Of particular interest in regard to Chemical Reaction Spectrophotometry (CRS) is the correspondence of the relatively narrow regions designated "ultraviolet" and "visible" with the "Calories/mole" units (indicated by the vertical line).

Calories/mole designates the energy content of the electronic bonds that are formed in chemical compounds. As is seen by the vertical line, the calories/mole range corresponding to UV and visible light is 10^5. The chromophores that are produced in CRS are compounds that have chemical bonds that are in this range. The robust spectral signals evident in CRS are inferred to be the result of the "photon/electron" resonance provided by this "chemical reaction/spectral" phenomenon.

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CRS: More than Spectrophotometry
(CRS: Chemical Reaction Spectrophotometry)

3 Wolfcamp crudes after CRS produce unique signature

However, typical all crudes produce similar "featureless" shape in this range

3 Tansill Yates crudes after CRS

✓ Chemical differences of crudes are amplified by CRS enabling "fingerprinting"

✓ Both qualitative and quantitative application

Seven spectrograms of two crude oils (Wolfcamp and Tansill Yates) are shown here. Six of the seven represent the unique absorption extending from ~320 nm to ~500 nm produced by Chemical Reaction Spectrophotometry (CRS). The seventh curve (indicated by the arrow) is typical of the rather featureless absorption spectrogram that is produced in this region by essentially all crude oils using regular UV/vis spectrophotometry. Friedel-Crafts reactions of the CRS method used on the crudes cause the formation of robust UV and visible *Chromophores*. The top three curves are three repetitions of scans of the Wolfcamp, and the bottom three are scans of the Tansill Yates. Instrument: Cary 5000

Original experiment using Cary 5000

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LEGALOIL.COM INFORMATION PAPER No. 2
FINGERPRINTING OIL
January 2004

Introduction

"Fingerprinting" oil is a process that refers to analytical chemistry techniques by which crude oil is defined into its components in such a way as to permit the identification of a particular sample of crude oil by the uniqueness of its composition.

Originally, star diagrams graphically depicting the relative quantities of specific aromatic compounds were used as oil fingerprints. Within one compartment of an oil field, star diagrams were usually identical since the oil composition is completely homogenized.
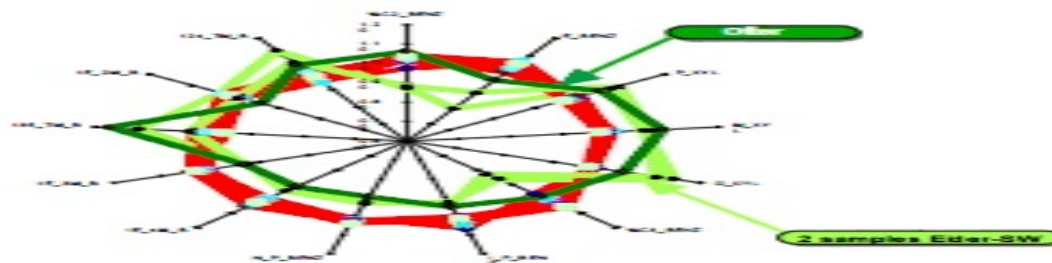

Figure 1-Star fingerprints of oil in Eider, Eider-SW and Otter fields. (source: Ganz, H.H., Hempton, M., Knowles, W., Van der Veen, F., and Kreulen, R., Integrated Reservoir Geochemistry: Finding Oil by Reconstructing Migration Pathways and Paleo Oil-Water-Contacts, *Society of Petroleum Engineers, Paper SPE 56896.*)

Purpose

The process of "fingerprinting" oil was developed to assist oil companies identify the source reservoirs from which oil is taken. When a new well intersects oil, for example, it is useful to know whether this is a new source of oil or the extension of a previously discovered source. In this manner the extent of a reservoir can be mapped and the size of the estimated.

The process came into further use in the economic exploitation of reservoirs by facilitating the commingling of oil from more than one reservoir through a common well. In such instances, reservoirs lie on top of each other and hence one well can pass through multiple reservoirs. Prior to the development of oil fingerprinting technology commingling of oil through a common well was not

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feasible, thus entailing a new well for each reservoir. Fingerprinting technology allows the oil from multiple wells to be commingled and the respective contributions identified by source and proportion.

The economic savings available through wells designed for commingling could be as much as US$1 million US$ per well less expensive than conventional wells.[1] Fingerprinting Technology also provides information on the history of a particular crude oil accumulation and its original source. This information can be used to inform exploration came from and this information can increase the chances of exploration success.

In defining the size of a reservoir Fingerprinting Technology can help determine if the reservoir penetrated by a particular well is the same reservoir as has been penetrated by other well. Accumulated knowledge from the application of Fingerprinting Technology in region will assist in determining the size of the extent and volume of the field. Such information I also useful in planning the development of the field and specifically the number and location of wells required to drain the field.

In respect to oil theft, at its most basic level fingerprinting can be used to quickly distinguish between natural crude oil, kerosene and artificial products. A more detailed analysis can determine the source reservoir and therein test the bona fides of the person in possession.

Analysis

No common analysis basis or criteria for fingerprinting oil has yet been established among analysts. Therefore, analysis by different companies may (and probably will) produce a different fingerprint (or profile). However, such analyses will be internally consistent. SPDC currently uses 10 components as the basis for its analyses. Other companies may not only use a different number of criteria but may also use different criteria.

Experience

Chevron has the longest experience in fingerprinting oil. It has a laboratory in Lagos that conducts analysis. Shell routinely conducts analysis in Nigeria and the Netherlands. It is understood (but yet to be confirmed) that all major oil companies have developed fingerprinting technology.

Extent of Application

The extent of application and accuracy of fingerprinting technology is related to the size of the database used for comparison with the target sample. Individual companies are each building their own databases.

SPDC[2] currently has an 800 samples database from reservoirs plus samples from 40 trunk lines in Nigeria. This is likely the most extensive database yet developed by any company.

---

[1] Shell Bulletin Number 4
[2] SPDC — Shell Petroleum Development Company of Nigeria Limited

Fingerprinting Oil   2

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Companies could exchange oil samples to build up a national database. They would then test the samples to develop fingerprints based on their own proprietary analytical techniques. This would protect the analytical technology of each company.

A national "library" of reference samples could also be established. This would be cumbersome and have limited usage, as the national reference samples would have to be analysed using the technical process of the enquiring body analysing the target sample.

The most practical step would be for general agreement on the analytical process used to identify the oil source and the widespread adoption of that process. Of course there is the issue of proprietary rights and the competitive advantage of each company that has developed their own analytical processes thus far.

With the widespread use of an agreed analytical process, an international database of oil fingerprints could be developed. This would provide a quick and readily accessible register of known oil sources against which samples of suspect crude oil could be compared.

Limitations

Currently there is no commonality in the type and number of components used by various oil companies to identify crude oil.

Oil Spills: Oil that is spilt degrades and source identification is not accurate unless a sample is taken early in the spill.

Blending: There is a question as to whether the blending or mixing of crude oil that occurs in tankers when transporting crude oil will disguise the source of the individual crude oils. This is not dissimilar to the commingling that occurs when oil is transported through trunk lines or more than one well is tapped by a well (to be confirmed).

Conclusion

Fingerprinting technology has been developed by most of the large oil companies and is routinely being used to identify the source of crude oil to assist in tracing sources of oil spills, defining reservoir extents and volumes, commingling to facilitate extraction and transport of crude oil. It is also currently being used at the request of police in Nigeria to identify the cargoes of suspected oil thieves. The use of oil fingerprinting technology can be extended (and standardised) as an essential tool in identifying the source of suspected stolen oil.

References

1. Ganz, H.H., Le Varlet, X., Van der Veen, F.M., Keen, M.A. and Van den Bos, G.A.: Reservoir Geochemistry of Oil Fields in The Netherlands," *Proc. 18th*

International Meeting on Organic Geochemistry, Maastricht/The Netherlands (1997), **1**, 109.
2. Ganz, H.H., Hempton, M., Knowles, W., Van der Veen, F., and Kreulen, R., Integrated Reservoir Geochemistry: Finding Oil by Reconstructing Migration Pathways and Paleo Oil-Water-Contacts, *Society of Petroleum Engineers, Paper SPE 56896*.
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5. Shell Bulletin Number 4.

For more information on oil theft, see the Legaloil.com website at http://www.legaloil.com.

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Aromatics – <u>Qualitative</u> <u>Fingerprint Identification</u> – By Spectral Curve
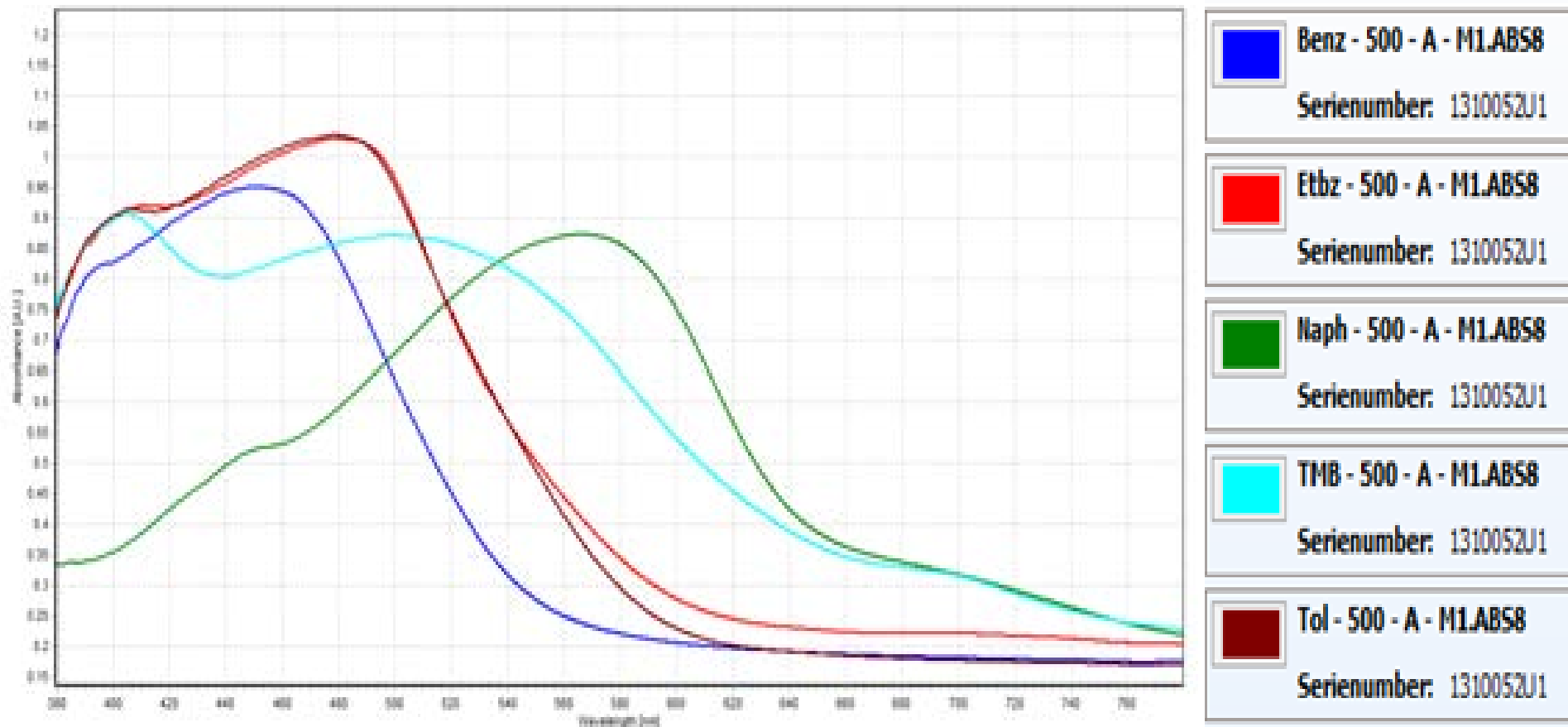
Aromatics – Quantitative Concentration – By Area Under Curve
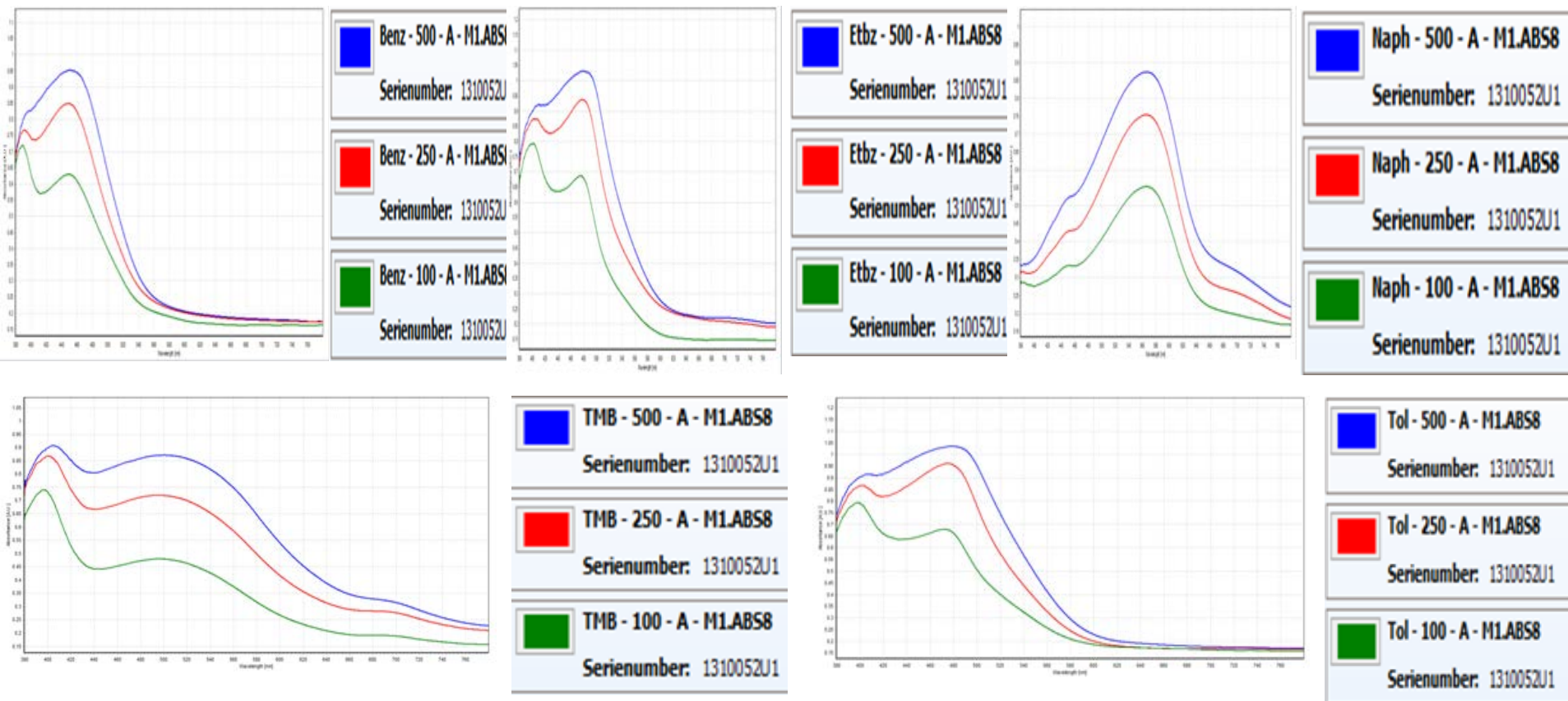
Three Crude Oils Comparison
Three Concentration Levels

Eleven Crude Oils Comparison
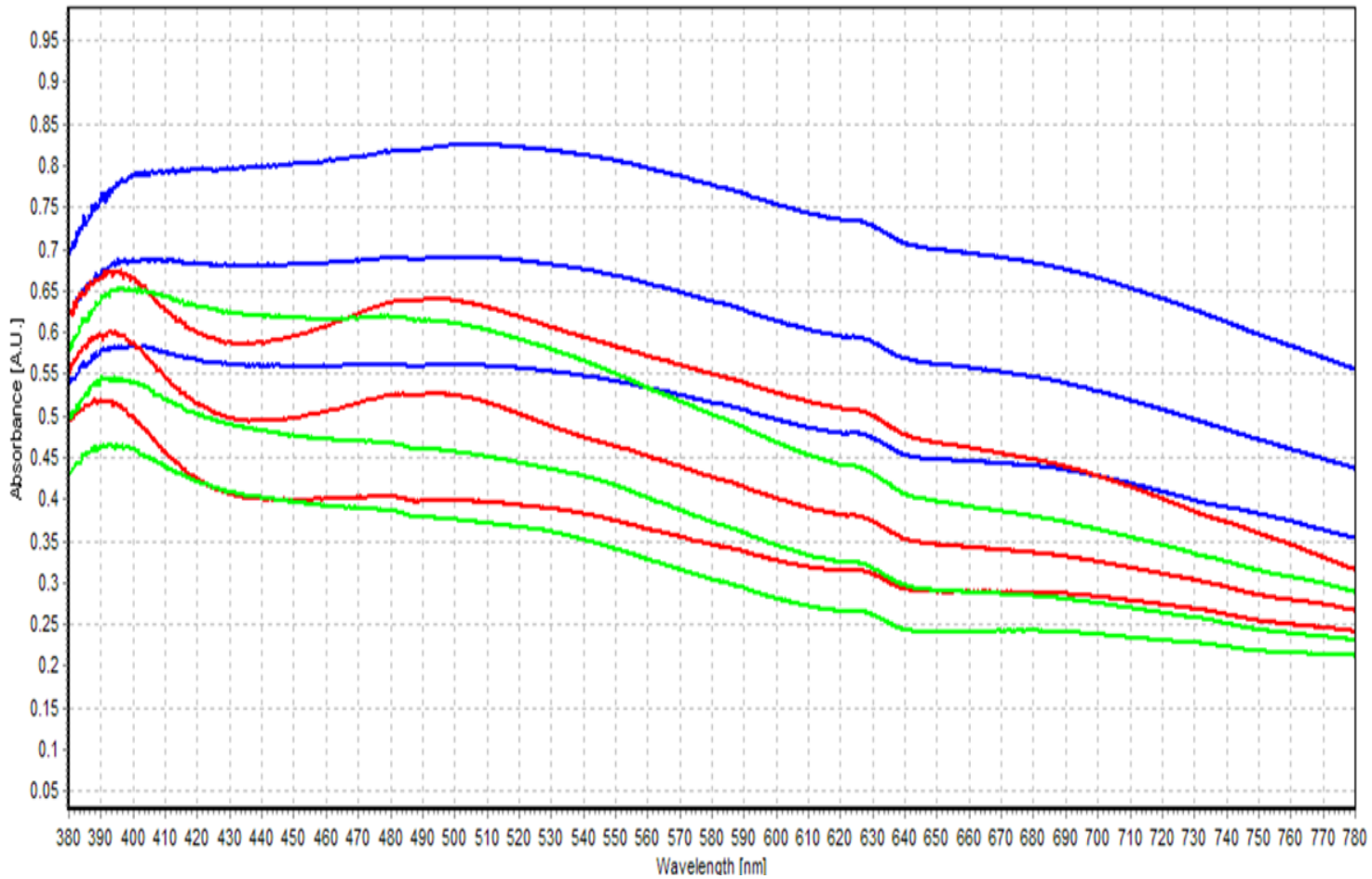
Legend:
- **Arab Lt - 1086 ppm - A - D** — Serienumber: 1402060U1 (blue)
- **Basra Light - 1000 ppm - A** — Serienumber: 1402060U1 (red)
- **Bryan Mound - 963 ppm -** — Serienumber: 1402060U1 (dark green)
- **Eagle Ford - 1000 ppm - A** — Serienumber: 1402060U1 (cyan)
- **GOM - 1151 ppm - A - D1** — Serienumber: 1402060U1 (green)
- **Louisiana - 764 ppm - A -** — Serienumber: 1402060U1 (yellow)
- **ORI - 500 ppm - A - D1 - 2** — Serienumber: 1402060U1 (magenta)
- **Penn Crude - 1000 ppm - A** — Serienumber: 1402060U1 (purple)
- **Quoa Iboe - 732 ppm - A -** — Serienumber: 1402060U1 (orange)
- **Sch - 873 ppm - A - D1 - 2** — Serienumber: 1402060U1 (black)
- **Venezula - 727 ppm - A - D** — Serienumber: 1402060U1 (gray)

Axis labels: Scope [ADC Counts] vs Wavelength [nm]

Sample Eleven Crude at Multiple Concentration Levels
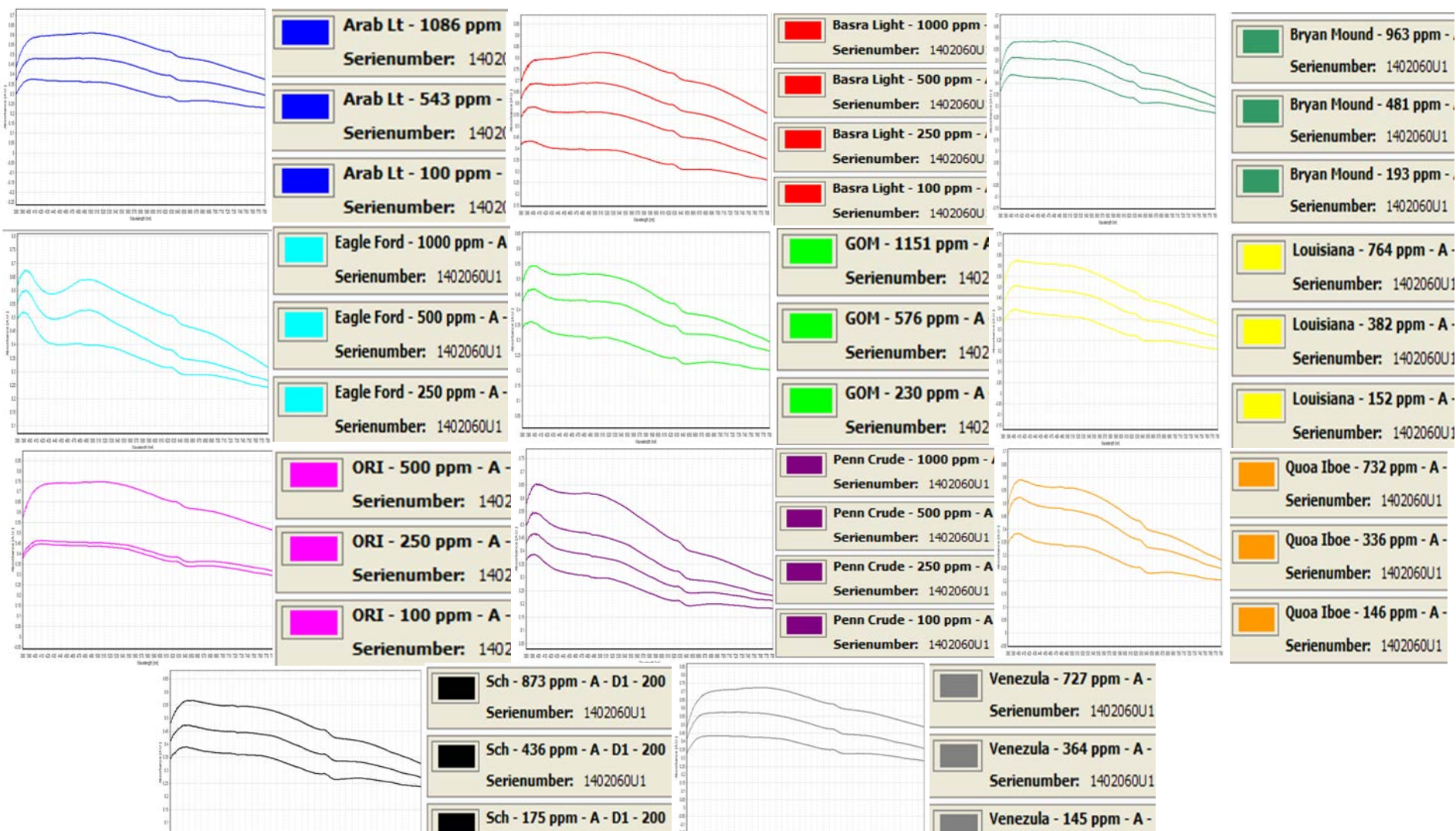
Identification of Spectrograms according to Amount (mg) of Analyte

These are spectrograms taken, using the Hanby CRS method, of two analytes (Eagle Ford Oil and Toluene). The legend on the right side indicates the substances and spectrogram (from top to bottom, 1-9). The number of the spectrogram (1-9) is referenced at 500 nm (top to bottom) in Table 1. Table 2 indicates amounts of substances used in the preparation for the CRS procedure.

	Table 1		Table 2 (mg of Analyte)		
Spectrogram Number	Spectrogram Color	Analytes	Eagle Ford	Toluene	Note: Spectrograms 1, 3, & 5 are
2	Red	EF & Tol	0.25	0.147	repeats of samples of 0.25 mg of
8	Camo Green	EF	0.5	0.010	Eagle Ford oil with no added
4	Cyan Green	EF & Tol	0.25	0.05	Toluene
7	Magenta	EF & Tol	0.50	0	
9	Medium Green	Tol	0	0.0735	
6	Purple	EF & Tol	0.25	0.005	

Legend:
- EF - Green - 250 ppm - A - M1.ABS8 Serienumber: 1310052U1
- EF - Green - 250 ppm - .2 ml of Serienumber: 1310052U1
- EF - Green - 250 ppm - A - M1 - Serienumber: 1310052U1
- EF - Green - 250 ppm - .2 ml of Tol Serienumber: 1310052U1
- EF - Green - 250 ppm - A - M1 - Serienumber: 1310052U1
- EF - Green - 250 ppm - .2 ml of Tol Serienumber: 1310052U1
- EF - Green - 500 ppm - A - M1.ABS8 Serienumber: 1310052U1
- EF - Green - 500 ppm - .4 ml of Tol Serienumber: 1310052U1
- Tol - .1 ml of .0735 in 1 ml - A - Serienumber: 1310052U1

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Drilling Mud with Varying Condensate Levels
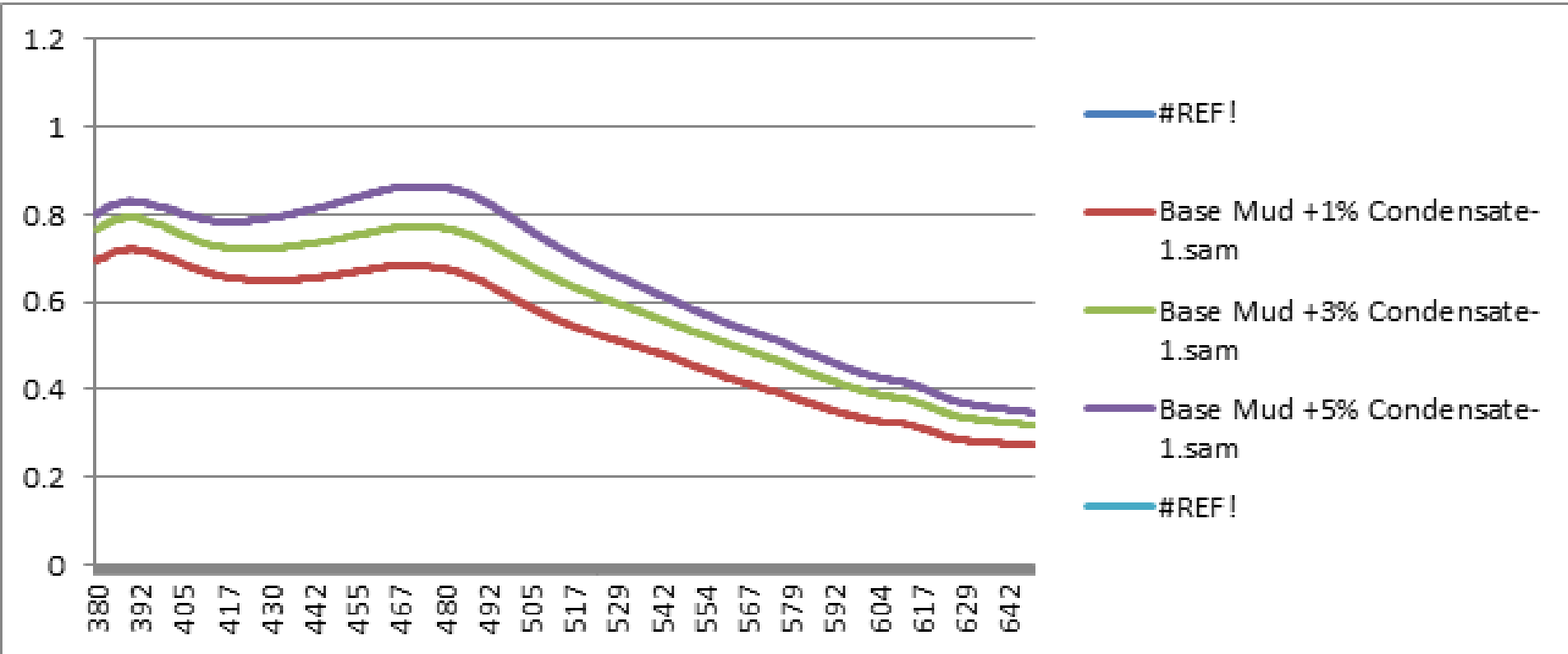
Sample Mud Log of Bakken and Three Forks

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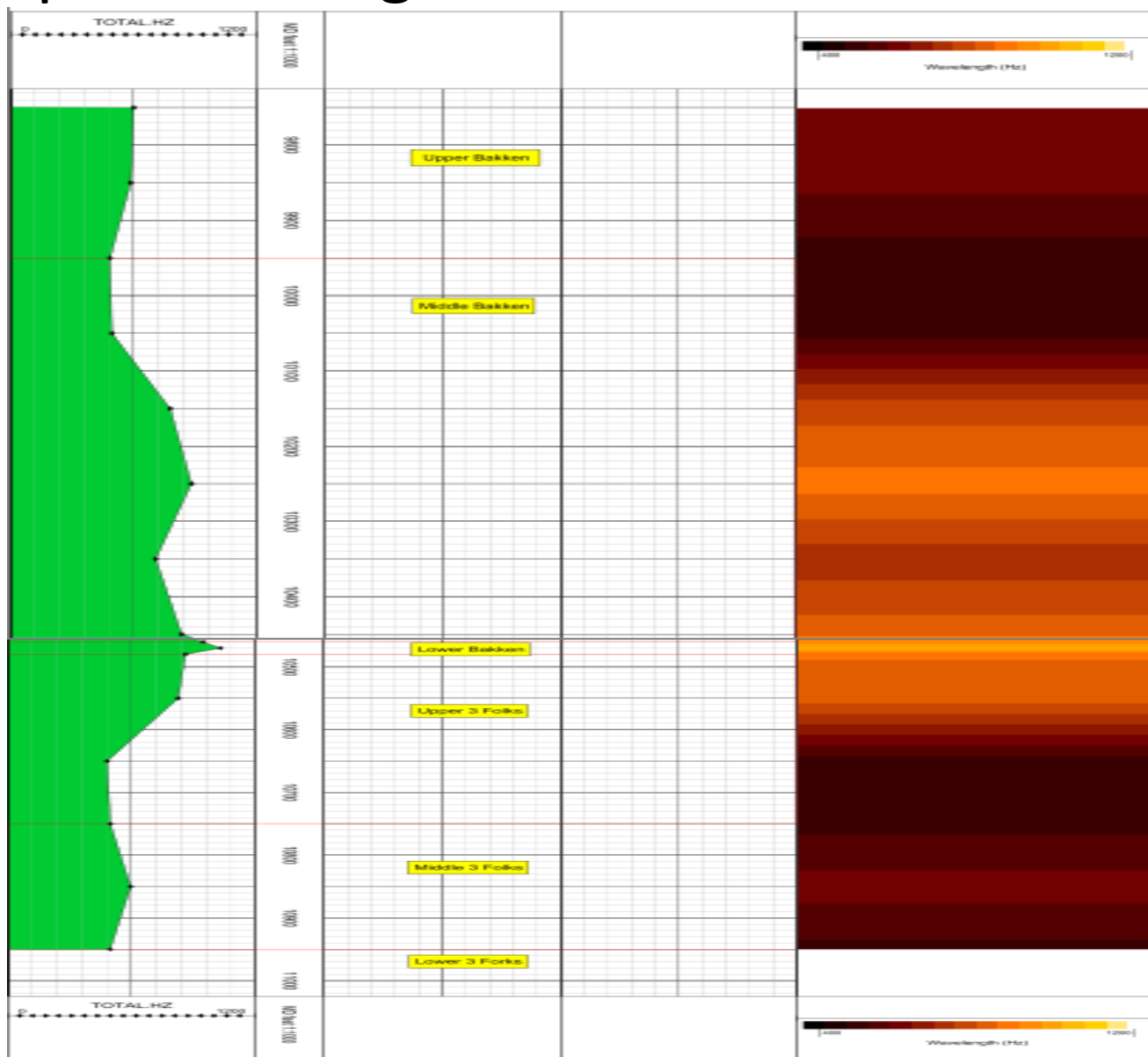
Some Identified Technology Applications

- **Laboratory Quality Data**
  - Real-time Analysis of Samples in Field
  - Knowing Progress without Delay

- **Fingerprinting – DNA Analysis**
  - Each Well of Same Crude Type Has Distinct Identification
  - Documentation of Contamination to Source

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Some Identified Technology Applications

- **Preventing Refinery Shutdowns** - **$10MM/day**
  - Level of Condensate in Crude on Way Into
  - Identifying Responsible Party
  - Document Refined Going Out

- **Preventing Blowouts at Well Sites**
  - Mud Weight – Condensate Level
  - Real-time Adjustments
  - Saves Time, Money $$$ and **Lives (invaluable)**

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Some Identified Technology Applications

- **Responsible Party - Liability**

  – Environmental Spills

  – Remediation Responsibility

  – Monitoring and Progress

- **Water Table / Production Water**

  – Baseline for Liability Protection

  – Real-time Analysis of Cleaning

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Still Easily Deployable in the field

- Significant savings of cost & time

- Many new applications beyond TPH/environmental –

  - In upstream oil & gas (drilling & production)

  - Rapid "fingerprinting"

  - Crude authenticity

  - Refinery operation

  - Responsible party (Liability) – environmental spills

  - Mud Pit Remediation

  - Production Water

  - Ongoing Monitoring

Preliminary Response has been Overwhelming –

"Lab in the field"

"Disruptive Technology"

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Water Testing Application

Evaluation Report of
InnerGeo — WaterReco's Hydrocarbon Extraction Vessel

Report Prepared for:

Analysis Performed by:

Hanby Environmental   Hanby PetroAnalysis

Report Prepared by:

6/6/2016
Hanby Environmental and Hanby PetroAnalysis
Charles D. Fator, President & CEO

Water Testing Application

Introduction

WaterReco's hydrocarbon extraction vessel was delivered to a well location in Frio County Texas producing from the Eagle Ford and adjacent formations on March 14, 2016. The vessel was connected to the discharge from the "heater-treater" and flow tested. Adjustments were made to the configuration over the first few days and on March 17, 2016 the samples of produced water were collected both entering and exiting the vessel. The vessel remained on location and was sampled again on March 28, 2016.

Hanby Environmental and Hanby PetroAnalysis were selected to provide testing services because we were able to measure total petroleum hydrocarbons (TPH) on-site using methods accepted by the EPA and several state agencies. The measurement of TPH concentration in water using this method captures all hydrocarbons that will partition to a solvent (carbon tetrachloride in this case) regardless to the hydrocarbons state of emulsification or availability as a free (non-aqueous phase) liquid. These are the set ups for both days of data collection.

Objectives

The primary objective of these tests is to collect sufficient TPH concentration values (data) in the produced water entering and exiting the vessel to evaluate the efficiency of the vessel to remove a significant portion of the hydrocarbons entrained in the produced water. Since inflow concentrations vary over time depending on well performance and the efficiency of other apparatus upstream of the test vessel (3-phase separator, heater-treater) there should be at least 30 samples collected (both in and out) to provide enough data to give statistically sound performance results.

Procedures

On-site testing was performed by Hanby Environmental and Hanby PetroAnalysis using our TPH in water field kit method and our Hanby Chemical Reaction Spectrophotometry ("CRS") method performed by our new Hydrocarbon ID device which is currently under development. A brief Hanby history is included at the conclusion of this report. These pictures are the two Hanby methods described.

Hanby Environmental and Hanby PetroAnalysis – InnerGeo and WaterReco Vessel Project   1 | P a g e

Water Testing Application

Calibration standards of 10,000 ppm, 5,000 ppm, 2,500 ppm, 1,000 ppm, 500 ppm, 250 ppm, and 125 ppm were prepared on site using the extract solvent and oil collected from the test well. These standards were then processed using both Hanby methods to provide color comparison for estimating TPH concentrations on-site and to convert the on-site spectrophotometer measurement to TPH concentrations later, after completion of the field campaign.

The pictures below are from the calibration standards prepared on site. Following these are the spectral curves of these calibrations created by the spectrophotometer. The first set is the entire calibration range from 125 ppm to 10,000 ppm. The second set is just the lower end calibration from 125 ppm to 1,000 ppm. In regards to the spectral curve pictures, the only difference in the left and right pictures, are the pictures to the right are zoomed in to be able to better see the legend sample descriptions.

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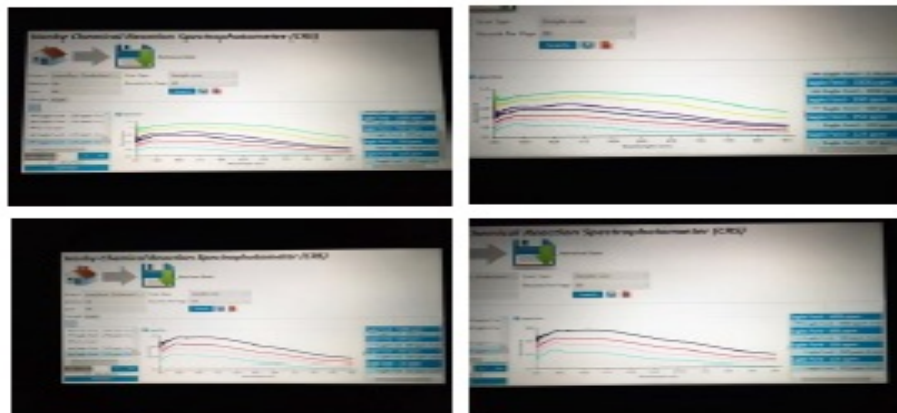
Water Testing Application

Inflow samples were acquired at Port 1 after purging an approximate one-liter volume and outflow samples were acquired at Port 6 using the same procedure (Figure 1 below). There were 33 samples collected and tested on March 17, 2016 over a period of 4.5 hours with 15 samples for Port 1 (Inflow) and 18 samples from Port 6 (Outflow). An additional 30 samples were collected and tested on March 28, 2016 over a three-hour period with 15 samples from Port 1 and 15 samples from Port 6.

Figure 1. WaterReco Vessel with arrows indicating the sampling ports 1 and 6.

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The pictures below reflect both extraction methods.

The picture on the left reflects the Hanby Chemical Reaction Spectrophotometric method and the picture on the right is the Hanby TPH Water Field Test Kit method.

The following pictures are just examples of the types of results that are developed utilizing these methods. By obvious visual observation of these, you can see the high oil content or ppm oil in water concentration depicted by the dark results which are the inflow water to the vessel, followed by the significantly reduced ppm or oil in water concentration depicted by the much lighter results which are outflow water from the vessel. In the pictures below on the right, the first dark color has the script 1-10 and the next has the script 6-10. In these scripts, the first number indicates the port the sample was taken from and the second number is the test sequence number. So shown below in the example is test sequence number 10 and the dark result is from port 1 (inflow) and the light result is from port 6 (outflow). The same is the case for the following pictured results from sequence test number 13. This is followed by a group picture of multiple test sequences from sequence number 7 through 13.
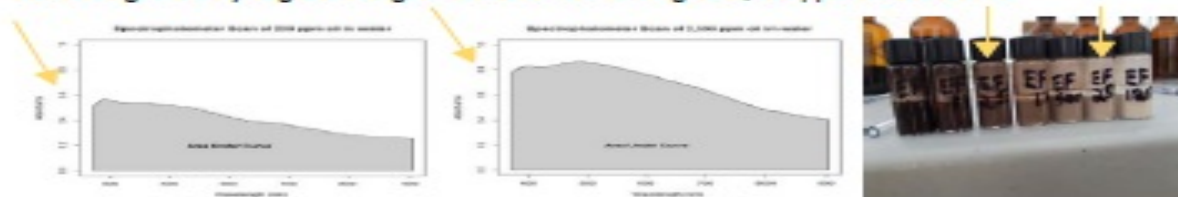
Hanby Environmental and Hanby PetroAnalysis – InnerGeo and WaterReco Vessel Project   4 | P a g e

Water Testing Application

These pictures are just examples of the analytical work in process.

Discussion

Spectrophotometer data were processed after field testing was complete using R-Project open-source statistical software. Spectrophotometer data consisted of absorbance values for wavelengths ranging from 347 nm to 902 nm in 0.27 nm increments or 2048 measurements per scan. Absorbance values in wavelengths below 370 nm were excluded to reduce noise present in the lower wavelengths. Each spectrophotometer scan was reduced to area under the curve (AUC) to best consolidate the results into a single measure of TPH concentration present in the water (Figures 2 below). These illustrate the difference in the results comparing the "area under the curve" of the calibrations of 250 ppm to 2,500 ppm. As depicted, as the concentration level of ppm increases, the resulting spectral curve shifts higher above the x-axis of wavelength, creating a larger area under the curve, providing the means to calculate the exact concentration level correlated back by the created calibrations that were created and analyzed of 125, 250, 500, 1,000, 2,500, 5,000 and 10,000 ppm. Additionally, note that the y-axis which represents light absorbance by the sample also increases as concentration level goes up. This can visually be seen in the results by high concentration ppm being dark in color and low concentration ppm being light in color. The dark results absorb more light when illuminated providing the higher absorption reading on the y-axis. So depicted below, in the low concentration of 250 ppm, the absorption reading across the entire spectral curve is below 0.6 and in the high concentration of 2,500 ppm, the absorption reading is closer to 0.8. Very easily you can see that the shaded area under the curve is significantly larger and higher in the case of the higher 2,500 ppm concentration.

Hanby Environmental and Hanby PetroAnalysis — InnerGeo and WaterReco Vessel Project   5 | P a g e

Water Testing Application

AUC was then plotted against the known concentrations of each of the calibration standards and a best fit curve was found [Figure 3 below]. A third degree polynomial curve with an R^2 value of 0.9945 (perfect fit is 1.0) was selected as the best fit. The formula for this curve was used to calculate TPH concentrations in the collected samples.

Figure 3. Spectrophotometer Calibration. Best fit curve is Fit 3 (3rd degree polynomial).
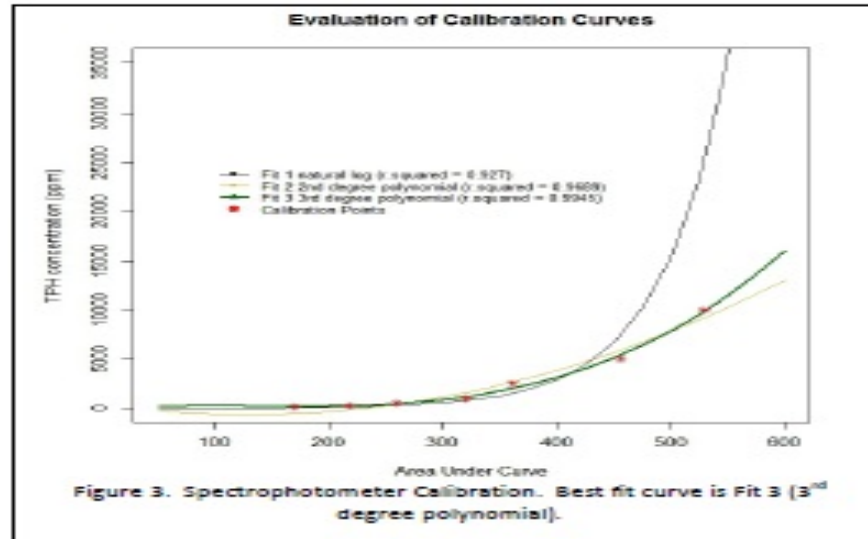
Results

Individual results for each sample tested can be found in Table 1 at the back of this report. Inflow concentrations of TPH ranged from 2,152 to 15,045 ppm oil in water with a median TPH concentration of 9,341 ppm (n=30). Outflow TPH concentrations ranged from 200 to 7,100 ppm oil in water with a median concentration of 1,556 ppm. Using median TPH values for Inflow and Outflow the reduction in TPH concentrations passing through the WaterReco vessel is approximately 83%.

In order to provide a visual representation of these results, based on the median figures, a review of the results reflected below in Table 1 and highlighted by bold and red scripts, it was determined that the sample results that most closely related to those of the median calculated figures, that sequence test number 20 from the first test series (3/17/16) and test sequence number 8 from the second series (3/28/16) most closely match these median figures. So reflected in the pictures below in test sequence number 20 from the first test series, the inflow from port 1 reflected a concentration of 9,995 ppm and the outflow from port 6 reflected a reduced concentration of 1,366 ppm.

Hanby Environmental and Hanby PetroAnalysis – InnerGeo and WaterReco Vessel Project   6 | P a g e

Water Testing Application

Likewise, in test sequence 8 from the second test series, reflected inflow of 10,878 ppm and outflow of 2,381. In this second test series, to provide an addition reference point, also reflected in the pictures is a third result that was captured by the Hanby CRS method, whereby a 1 to 5 dilution was performed on the inflow sample extraction in order to show that even after being diluted by the solvent by a factor of 5, the resulting color developed was still darker than that of the outflow. These dilution results were omitted from the results table to keep from confusing the most prominently relevant direct results comparisons of the inflows vs. outflows.

Important to note regarding the design of our technology is that the solubility of oil in water is around 10,000 ppm, which is why that is the highest calibration that we prepared. When oil concentration in water is over 10,000 ppm, it floats in water, which is what you see in an oil spill. So our technology is designed to be focused on the lower end, whereby we can detect traces of oil in water down to single digit parts per billion. As can be observed throughout the results in this report, when the concentration of oil is around the 10,000 ppm concentration, the result is very dark to black in color. We designed our technology to have this as the upper concentration threshold, mainly because this is what is the most relevant to the past approaches that our technology has been utilized for; having been on every major oil spill response. Thus, higher concentration results readings do not make sense to perform. However, when higher concentration reads are desired, it is simple math to back into the higher concentrations through performance of dilutions. As previously referenced, as a matter of interest, during our field testing and outside the scope of this project, we did perform dilutions on the second day series tests, to obtain an accurate estimate for "real" inflow concentration which is above the detection range of our conventional Hanby CRS Method of 10,000 ppm. We could easily adjust our method to performing the dilutions prior to taking readings and performing the simple math calculations into our conventional

Water Testing Application

method to increase the detection range, but for now we have not identified a larger enough market place to warrant these needs, so we elect to do required dilutions on an as needed basis.

In this case, utilizing the highest calibration we prepared of 10,000 ppm, which results in a very high absorbance reading of between 1 and 1.2 and by performing 1 to 5 dilutions on the sample extractions, we can calculate backing into the inflow concentration levels and get an accurate estimated idea for what the "actual" inflow concentrations were, but that is outside the scope of this project.

As an example point of reference, below is compared the second series sequence number 8 to the calibrations. Note the far right vial in the right picture being the 1 to 5 dilution performed. Visually, the color resulting from this 1 to 5 dilution falls in between the calibrations in the left picture of 1,000 ppm and 2,500 ppm, being only slightly lighter than the 2,500 ppm calibration color. Thus, it can be concluded that it is approximately 2,000 ppm after being diluted by factor of 5, thus multiply the estimated result of 2,000 ppm by this factor provides for the result prior to dilution of being 10,000 ppm (1%). This is also supported by the result in the first vial in the right picture being prior to dilution and it resulting visually in the same color as the first vial in the left calibration picture which is the 10,000 ppm (1%) calibration. This example supports the math that estimates the "actual" inflow concentrations above the conventional upper detection limit of 10,000 ppm (1%) which could be the scope of future project such it be warranted.

The following pictures are simply group combinations of all tests performed in the second series up to that particular analysis. So the first picture is through test sequence number 8 and the second picture is all tests performed that day through test sequence number 15. These are just additional visual points of reference of how the concentration levels reduced from inflow to outflow, but also reflect the variations based on the well flow control. However, as is reflected by the results table, it is easy to see the performance of the vessel which is the primary objective of this project.

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Using Figure 4 below, being a statistical plot (box and whisker) comparing the TPH concentrations of the inflow to the vessel to that of the outflow, the effect of the vessel process can be seen graphically. The interquartile range (IQR), represented by the grey area in the boxes, can be viewed as a representation of the variability of the TPH concentrations. Note that the inflow has a much greater variability than the outflow. This may be related to the lack of control over flow rates through the vessel, since the well did not flow continuously but discharge oil, water, and gas intermittently over the test periods.

Figure 4. Box plot summarizing the performance of WaterReco's oil recovery vessel. The small circles represent outliers and the greyed area is the interquartile range.

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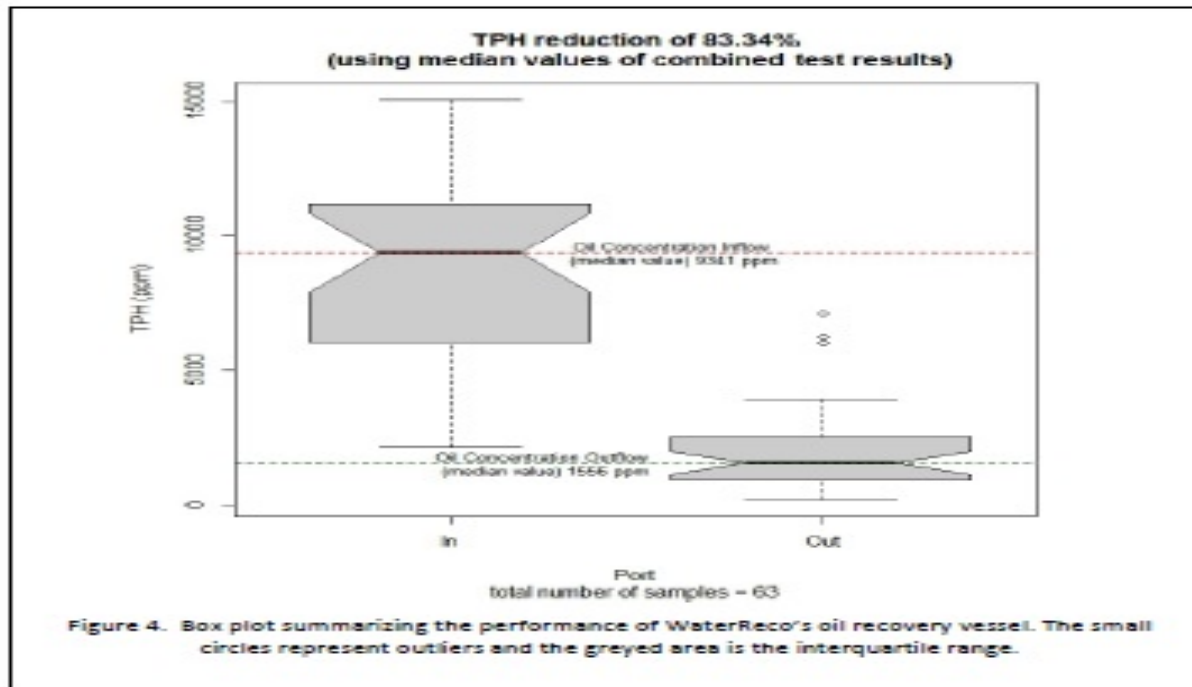
Water Testing Application

Conclusion

Over two test periods the vessel was able to reduce the TPH concentration of the produced water by 83%. The recovered oil was discharged to a separate vessel. This process provided additional oil production for the well and (although slightly) reduced the volume of fluids for disposal.

Hanby Environmental and Hanby PetroAnalysis were pleased to be a part of this validation process. In our opinion, this real time analysis was the only accurate and effective way to validate the performance of the vessel. In comparing to the alternative method of taking samples and sending them to a fixed laboratory, on top of being a sampling logistics headache, by the time the samples were received and analyzed by a fixed laboratory, the samples could be changing providing inaccurate analysis results. It is our professional opinion that real time analysis of samples provides the most accurate and reliable feedback. It was also this real time feedback that on the day prior to the first series of testing allowed for configuration changes to be made, adjusting the vessel to provide more reliable and more accurate performance results which mainly consisted of well control. This would not have been possible by sending samples to a fixed laboratory. It was this real time feedback that lead to the inclusion of a check value to help control flow and then to inspire the future modification of the further flow control measure of flow moving through a tank prior to moving toward the vessel to further reduced resulting variations. This was just a thought inspired by these real time feedback analysis results and is outside the scope of these results. It is the thought that by doing this on the next round of testing that variation should be further reduced.

Water Testing Application

Table 1. TPH concentrations in the water samples collected

Test Name	Area Under Curve	Concentration from Curve Fit #3 (ppm)	Port ID (1=In, 6=Out)	Test ID Number	Timecode
1-10-1.sam	511.35	8618	1	10	3/17/2016 16:29
1-11-1.sam	521.79	9337	1	11	3/17/2016 16:43
1-12-1.sam	517.88	9063	1	12	3/17/2016 17:01
1-16-1.sam	560.59	12364	1	16	3/17/2016 18:12
1-17-1.sam	548.83	11386	1	17	3/17/2016 18:26
1-18-1.sam	545.86	11147	1	18	3/17/2016 18:39
1-19-1.sam	546.76	11219	1	19	3/17/2016 18:54
1-20-1.sam	530.88	9995	1	20	3/17/2016 19:10
1-21-1.sam	430.33	4265	1	21	3/17/2016 19:23
1-22-1.sam	552.98	11724	1	22	3/17/2016 19:36
1-23-1.sam	589.91	15045	1	23	3/17/2016 19:52
1-24-1.sam	578.68	13976	1	24	3/17/2016 20:01
1-7-2.sam	543.72	10977	1	7	3/17/2016 15:26
1-8-1.sam	518.07	9076	1	8	3/17/2016 15:51
1-9-1.sam	571.40	13311	1	9	3/17/2016 16:12
6-10-1.sam	199.76	225	6	10	3/17/2016 16:33
6-11-1.sam	279.68	654	6	11	3/17/2016 16:47
6-12-1.sam	246.58	395	6	12	3/17/2016 17:03
6-13-1.sam	237.18	345	6	13	3/17/2016 17:17
6-14-1.sam	355.29	1874	6	14	3/17/2016 17:30
6-15-1.sam	418.79	3805	6	15	3/17/2016 17:45
6-16-1.sam	334.96	1445	6	16	3/17/2016 18:15
6-17-1.sam	380.64	2530	6	17	3/17/2016 18:28
6-18-1.sam	380.00	2512	6	18	3/17/2016 18:42
6-19-1.sam	401.08	3168	6	19	3/17/2016 18:56
6-20-1.sam	330.73	1366	6	20	3/17/2016 19:12
6-21-1.sam	303.38	932	6	21	3/17/2016 19:25
6-22-1.sam	299.78	884	6	22	3/17/2016 19:39
6-23-1.sam	350.36	1762	6	23	3/17/2016 19:54
6-24-1.sam	352.44	1808	6	24	3/17/2016 20:05
6-7-1.sam	361.30	2016	6	7	3/17/2016 15:30
6-8-1.sam	153.26	200	6	8	3/17/2016 15:54
6-9-1.sam	324.77	1260	6	9	3/17/2016 16:15
1-1-1.sam	529.60	9901	1	1	3/28/2016 12:40
6-1-1.sam	398.19	3071	6	1	3/28/2016 12:40
1-2-1.sam	416.98	3736	1	2	3/28/2016 13:10
6-2-1.sam	314.00	1085	6	2	3/28/2016 13:10

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1-3-1.sam	521.91	9346	1	3	3/28/2016 13:25
6-3-1.sam	467.72	6017	6	3	3/28/2016 13:25
1-4-1.sam	394.72	2959	1	4	3/28/2016 13:35
6-4-1.sam	327.98	1316	6	4	3/28/2016 13:35
1-5-1.sam	366.74	2152	1	5	3/28/2016 13:45
6-5-1.sam	421.79	3921	6	5	3/28/2016 13:45
1-6-1.sam	392.00	2872	1	6	3/28/2016 14:00
6-6-1.sam	363.64	2074	6	6	3/28/2016 14:00
1-7-1.sam	525.10	9573	1	7	3/28/2016 14:15
6-7-1.sam	384.83	2653	6	7	3/28/2016 14:15
1-8-1.sam	542.46	10878	1	8	3/28/2016 14:30
6-8-1.sam	375.35	2381	6	8	3/28/2016 14:30
1-9-1.sam	500.53	7913	1	9	3/28/2016 14:40
6-9-1.sam	471.71	6229	6	9	3/28/2016 14:40
1-10-1.sam	500.80	7930	1	10	3/28/2016 14:55
6-10-1.sam	331.50	1380	6	10	3/28/2016 14:55
1-11-1.sam	445.23	4914	1	11	3/28/2016 15:05
6-11-1.sam	312.95	1069	6	11	3/28/2016 15:05
1-12-1.sam	482.74	6842	1	12	3/28/2016 15:15
6-12-1.sam	340.62	1556	6	12	3/28/2016 15:15
1-13-1.sam	382.92	2596	1	13	3/28/2016 15:30
6-13-1.sam	193.76	216	6	13	3/28/2016 15:30
1-14-1.sam	536.17	10392	1	14	3/28/2016 15:40
6-14-1.sam	223.95	289	6	14	3/28/2016 15:40
1-15-1.sam	468.13	6039	1	15	3/28/2016 15:55
6-15-1.sam	487.20	7100	6	15	3/28/2016 15:55

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Water Testing Application

The Hanby Story

Our company has been around for the last 30 years as an environmental company. As Hanby Environmental we manufacture TPH Field Test Kits for the immediate analysis of water and soil samples. In a matter of 4 minutes for soil and 6 minutes for water, you will know the concentration level for the hydrocarbon or contaminate. This very economical quantification and qualification has proven to be an extremely valuable tool the world over on every major oil spill response and on remediation projects. By independent studies performed by the US EPA and US Army Corps of Engineers both found that the results per the Hanby method correlated to laboratory results within a variance of 10%, which is 2.5x better than the acceptable variance for field analysis of 25%.

The Hanby method is a visual colorimetric method utilizing the human eye to compare the sample results to the color calibration photos included in the kits with the color indicating the hydrocarbon or contaminant and the hue or lightness or darkness providing the concentration level thereof. More recently, rebranded under Hanby PetroAnalysis, we have developed a new portable and field ready instrument called the Hydrocarbon ID that standardizes the result reading effectively replacing the subjectivity of human eyes, with that of a computer eye by the use of a uv/vis spectrometer. Through this process, we put a lab in the field immediately obtaining results as accurate or more than that of a laboratory. The uv-vis spectrometer provides a unique identifying spectral curve and then an area under the curve calculation is made to get an exact concentration level. The unique spectral curve identifier is in line with DNA analysis and fingerprinting of hydrocarbons including crude oils.

Our chemical reaction produces robust colors by the excitement of aromatics that make up between 3-30% of a crude oils make up. Reading these results from samples of water, soil, cuttings, drilling mud/fluids or core samples, we are able to use the aromatics as the marker compounds to fingerprint the hydrocarbons including crude oils. This is a revolutionary new technology utilizing molecular spectroscopy in the field or at the wellhead. The numerous applications for this new technology are still being uncovered all the time.

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What's Been Said of HANBY'S

Chemical **R**eaction **S**pectrophotometry

- **"Disruptive Technology"**

- **"Lab in the Field"**

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What's Been Said of HANBY'S
Chemical **R**eaction **S**pectrophotometry

- **"Game Changing"**

- **"A Paradigm Shift for Environmental Protection"**

Fire Extinguisher and Flashpoint Killer

- ELMN8 Fire has been found to be a very useful tool in the Fire Fighting Industry.

- This Non-Toxic and Non-Hazardous Solution is More Effective than the More Commonly Relied Upon and Toxic Foam.

- ELMN8 Fire Can Be Applied in A Foam To Create More of a Blanket Coverage, While Also Lowering The Amount of Product to Provide the Needed Coverage.

- When Applying, The Product Requirement is Much less Than Foam and Water.

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Fire Extinguisher and Flashpoint Killer

Controlled Diesel Fire for Demo Extinguished in 6 Seconds

Car Engine Fire for Demo Extinguished in 7 Seconds

Non-Toxic and Non-Hazardous ELMN8 Fire vs Traditionally Used Toxic Foam

6 Seconds

7 Seconds

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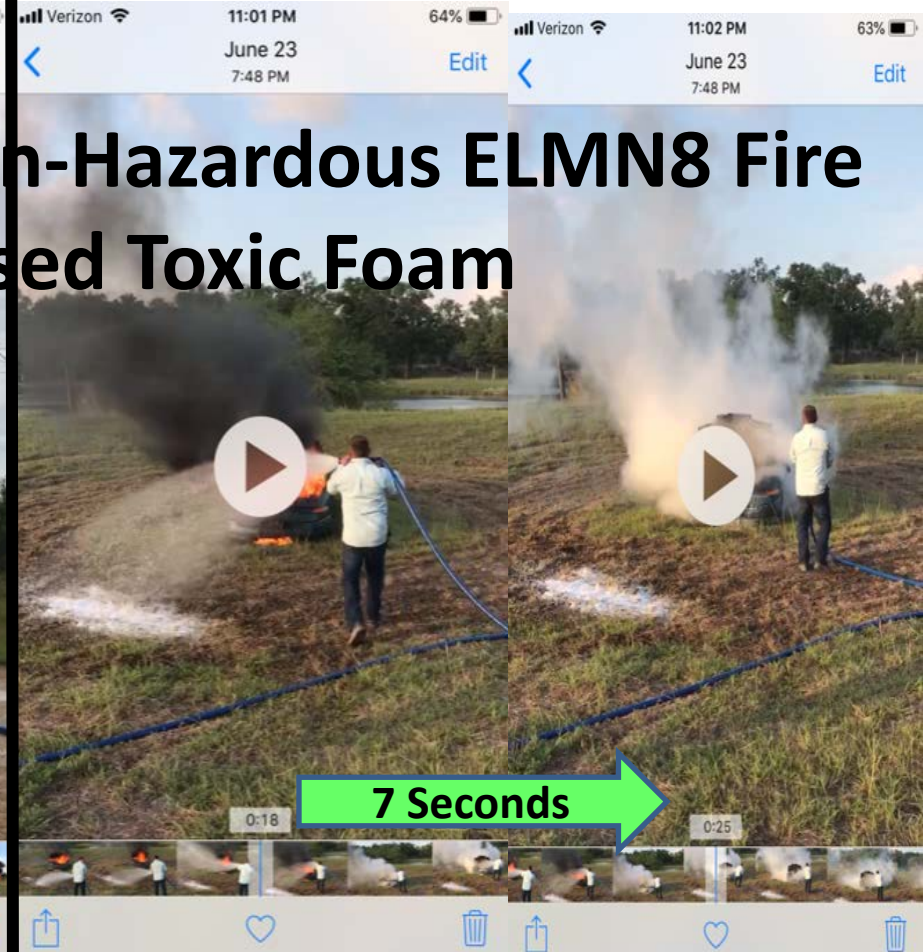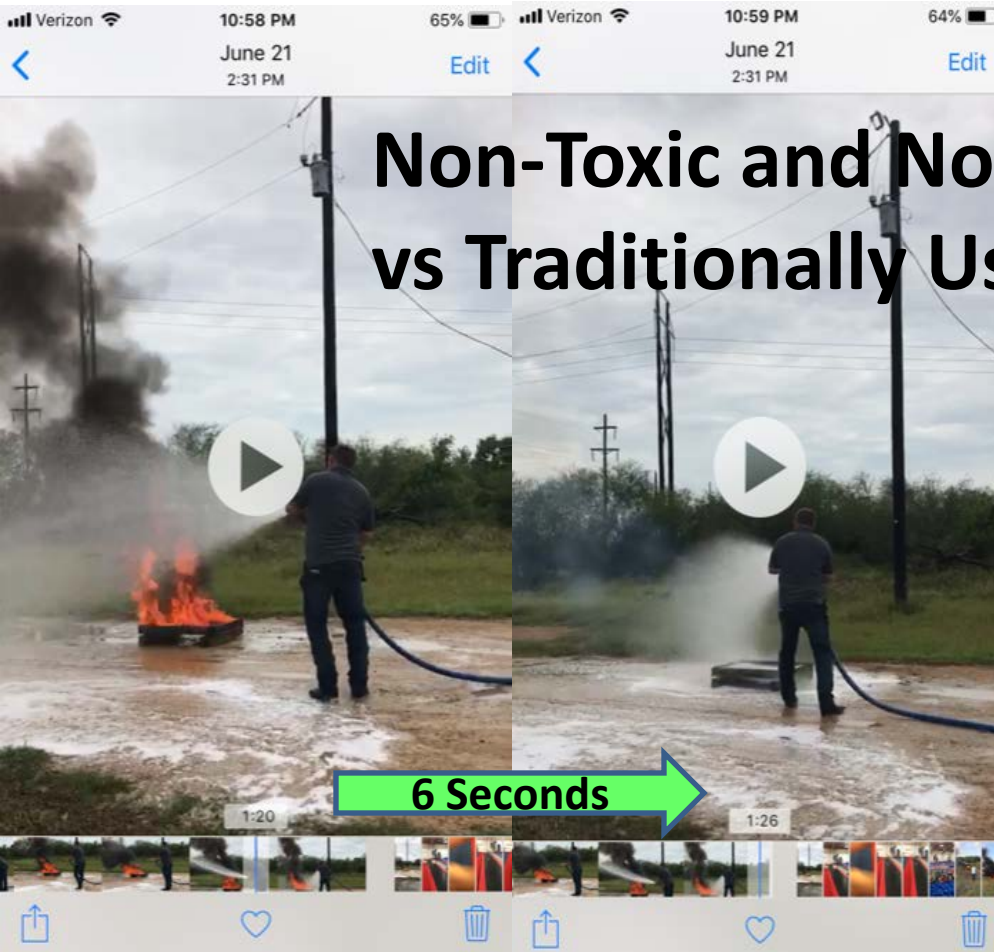
Fire Extinguisher and Flashpoint Killer

Car Fire – Fully Engulfed for Demo – Extinguished in 1.5 Mins
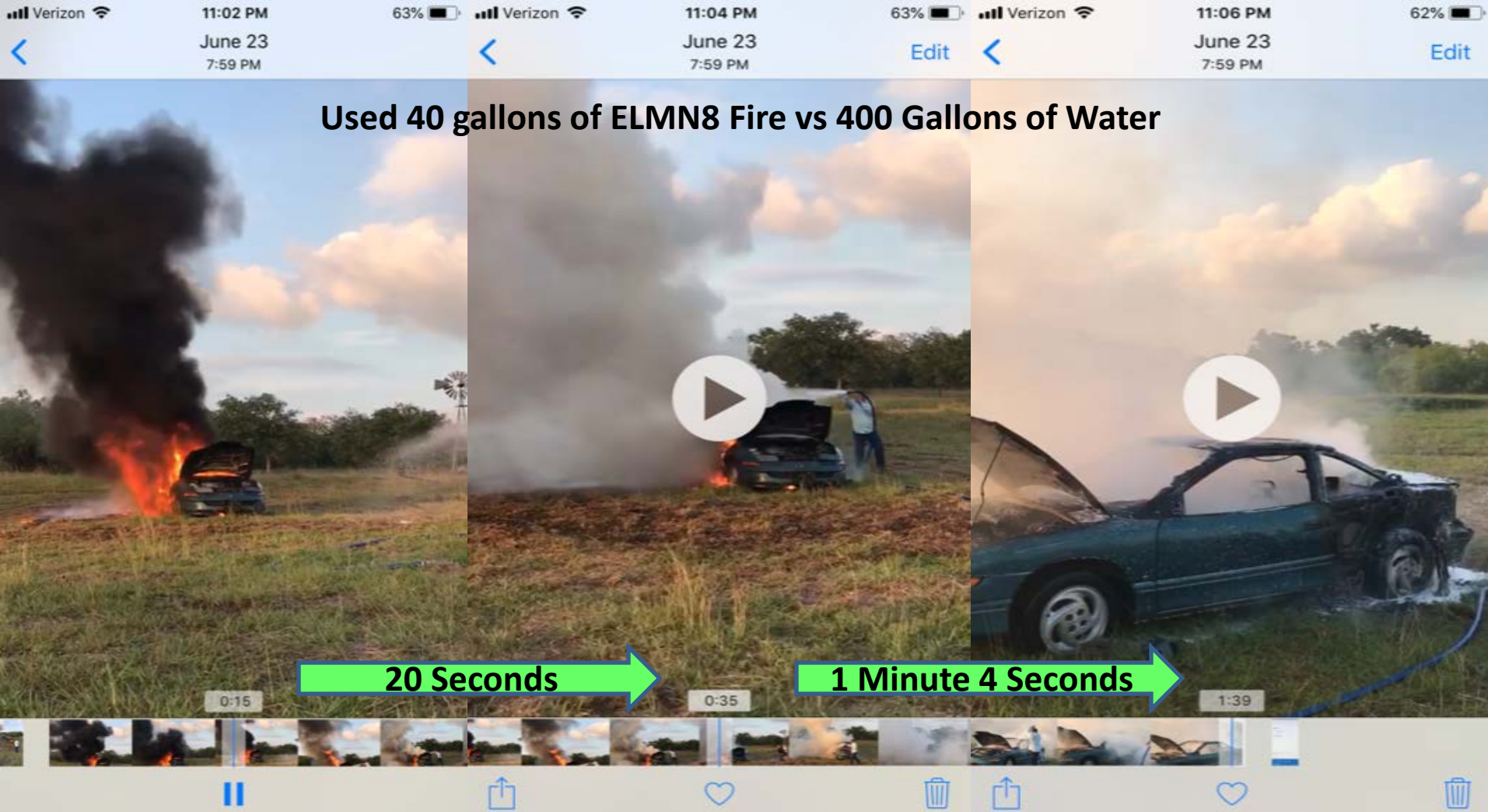
Used 40 gallons of ELMN8 Fire vs 400 Gallons of Water

20 Seconds ➔ 1 Minute 4 Seconds ➔

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Fire Extinguisher and Flashpoint Killer

ELMN8

- **ELMN8 Used As a Fire Extinguisher and Killer of Flashpoint to Remover Ignition Danger:**
- **OMG Solutions Product ELMN8 As A Fire Extinguisher:**
  - https://youtu.be/KGQH0kNTtOQ
- **OMG Solutions Product ELMN8 Used To Kill The Flash Point of Gasoline:**
  - https://youtu.be/6w8x8dVdIhA
- **OMG Solutions ELMN8 Extinguishes A Cardboard Box on Fire and Then It Doesn't Reignite:**
  - https://youtu.be/ySukoeBRLYE

Fire Extinguisher and Flashpoint Killer

- **ELMN8 Used As a Fire Extinguisher and Killer of Flashpoint to Remover Ignition Danger:**

- **OMG Solutions ELMN8 Used As A Fire Extinguisher On A Gas Flowing Fireplace:**

  https://youtu.be/qGz0cB31RDU

- **OMG Solutions Product ELMN Extinguishes Fire and Kills Flash Point:**

  https://youtu.be/_mPHpNPu8kM

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Fire Extinguisher and Flashpoint Killer

ELMN8

- **ELMN8 Used As a Fire Extinguisher and Killer of Flashpoint to Remove Ignition Danger:**

- **ELMN8 Fire Extinguishes Dry Burning Christmas Trees In 15 seconds:**

  https://youtu.be/HPDz7ZG3Z74

- **ELMN8 Fire Extinguishes Gas Fire on Water in Half Drum in 7 Seconds:**

  https://youtu.be/VCT03Feuq5k

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- **ELMN8 Used As a Fire Extinguisher and Killer of Flashpoint to Remove Ignition Danger:**

- **ELMN Fire With Foam Applicator Tip Extinguishes Gas Drum Fire in 26 Seconds:**

  https://youtu.be/VweakP_VBOg

- **ELMN8 Fire Used to Extinguish Tires Fire in 20 Seconds:**

  https://youtu.be/283TlaoWzLg

Fire Extinguisher and Flashpoint Killer

- **ELMN8 Used As a Fire Extinguisher at The Houston Fire Academy by HFD 22:**

Fire Extinguisher and Flashpoint Killer

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Fire Extinguisher and Flashpoint Killer

- ## **ELMN8 Used As a Fire Extinguisher at The Houston Fire Academy by HFD:**

- ## ELMN8 Fire Puts Out A Diesel Pan Fire in 20 Seconds With A Hand Pump Up Sprayer:

https://youtu.be/iceqpj2gj64

- ## ELMN8 Fire Again Puts Out A Diesel Pan Fire in 20 Seconds Using A Pump Up Hanby Sprayer:

https://youtu.be/gMviM-FmwyA

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Fire Extinguisher and Flashpoint Killer

- **ELMN8 Used As a Fire Extinguisher at The Houston Fire Academy by HFD:**

- **ELMN8 Fire Puts Out A Diesel Pan Fire in 5 Seconds:**
  https://youtu.be/qihkLYX-Brw

- **ELMN8 Fire Puts Out A 10x10 Diesel Pan Fire in 40 Seconds:**
  https://youtu.be/sy4cpNVFL5A

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Fire Extinguisher and Flashpoint Killer

- **ELMN8 Used As a Fire Extinguisher at The Houston Fire Academy by HFD:**

- **ELMN8 Fire Puts Out 10x10 Diesel Pan Fire in 45 Seconds Again:**

  https://youtu.be/lWeYkIK8LKE

- **ELMN8 Fire Puts Out The 10x10 Diesel Pan Fire in 15 Seconds:**

  https://youtu.be/FfDnMJvvn1E

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Fire Extinguisher and Flashpoint Killer

- ## ELMN8 Used As a Fire Extinguisher at The Houston Fire Academy by HFD:

- ## ELMN8 Fire With A Foam Tip Creates A Good Foam Blanket:

    https://youtu.be/mLL2KadSJLk

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Fire Extinguisher and Flashpoint Killer

ELMN8

- We'd like to Acknowledge and Thank The Houston Fire Department and Fire House 22 for Their Work in This Testing:

- A Very Special "Thank You" to Pat Nagler, His Captain Buck McClain and Fire Fighter Lionel Matthews All of HFD 22 Who Performed All The Testing!

This Concludes The Presentation

- **We appreciate everyone's attention and interest in our Products**
- **For More Product Information, please visit our websites and contact us for more details**

  - **www.HanbyEnvironmental.com**

  - **www.HanbyPetroAnalysis.com**

  - **www.OMGSol.com**

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