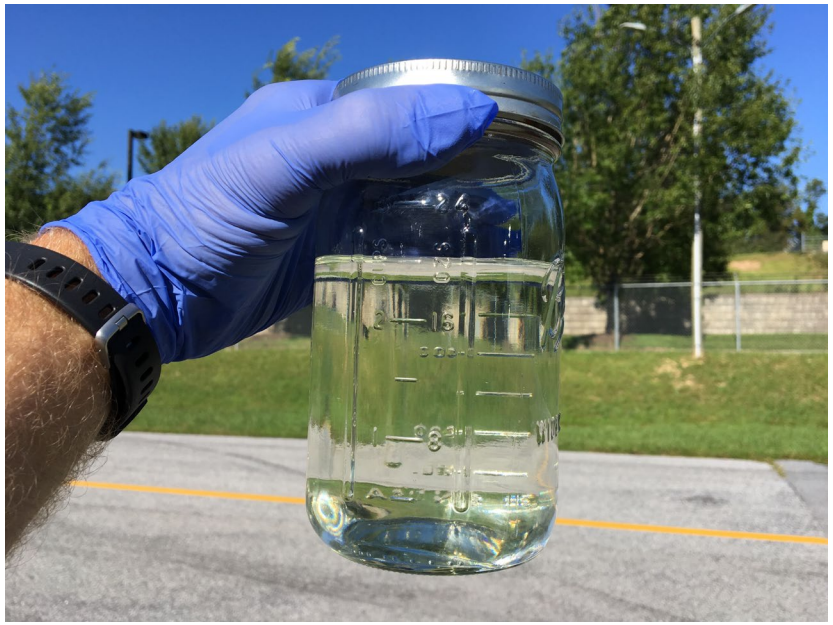
Fuel QC, Lab Tests and Remediation

What's Out There



The Good

The Bad

The Ugly

Contamination is Preventable

- **Effective QC Management**
- **Train Those Responsible**
- **Mitigate Human Factors**

Effective QC Management

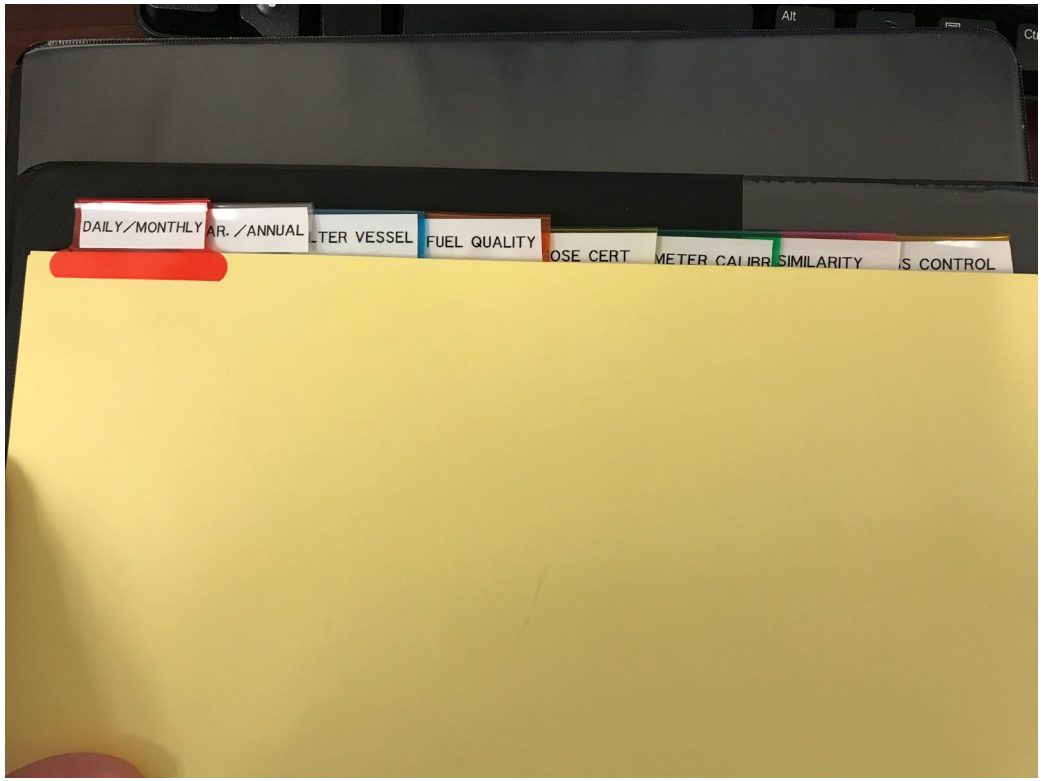
It doesn’t happen by accident

- **Document Inspections**
- **Catch concerns**
- **Know your normal**

Documentation

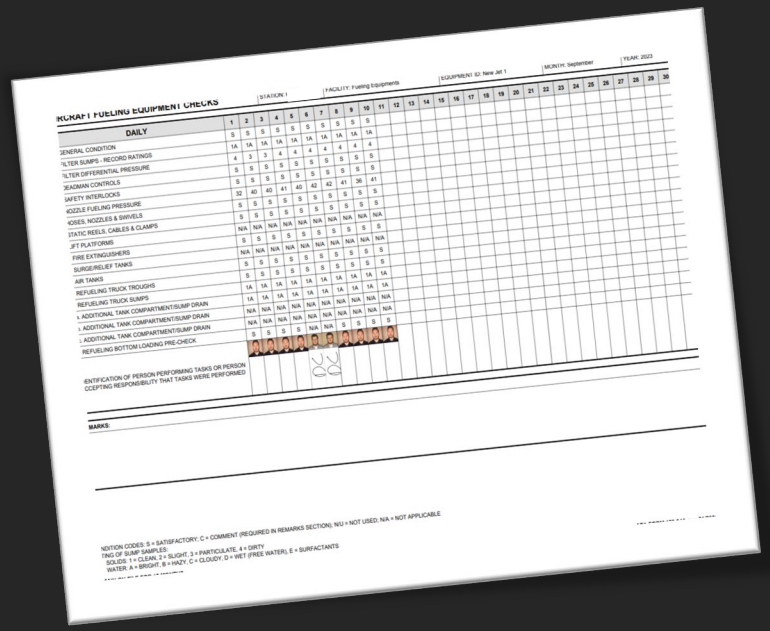
Find it Fast…

THIS:



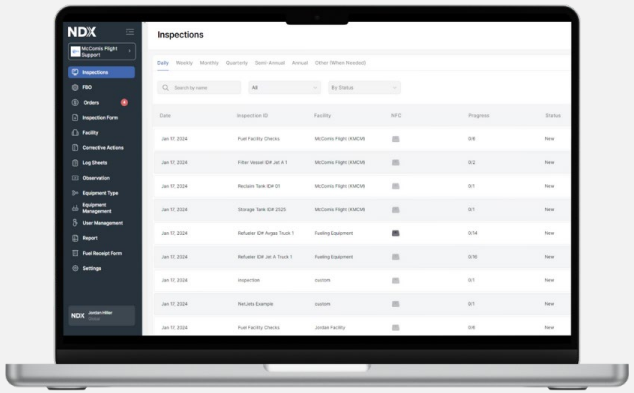
NOT THIS:

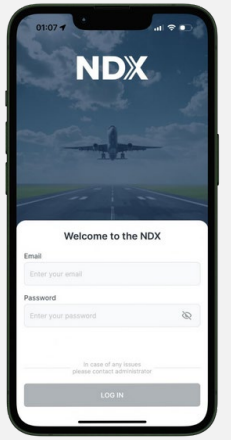
Seamless Integration With Existing Processes



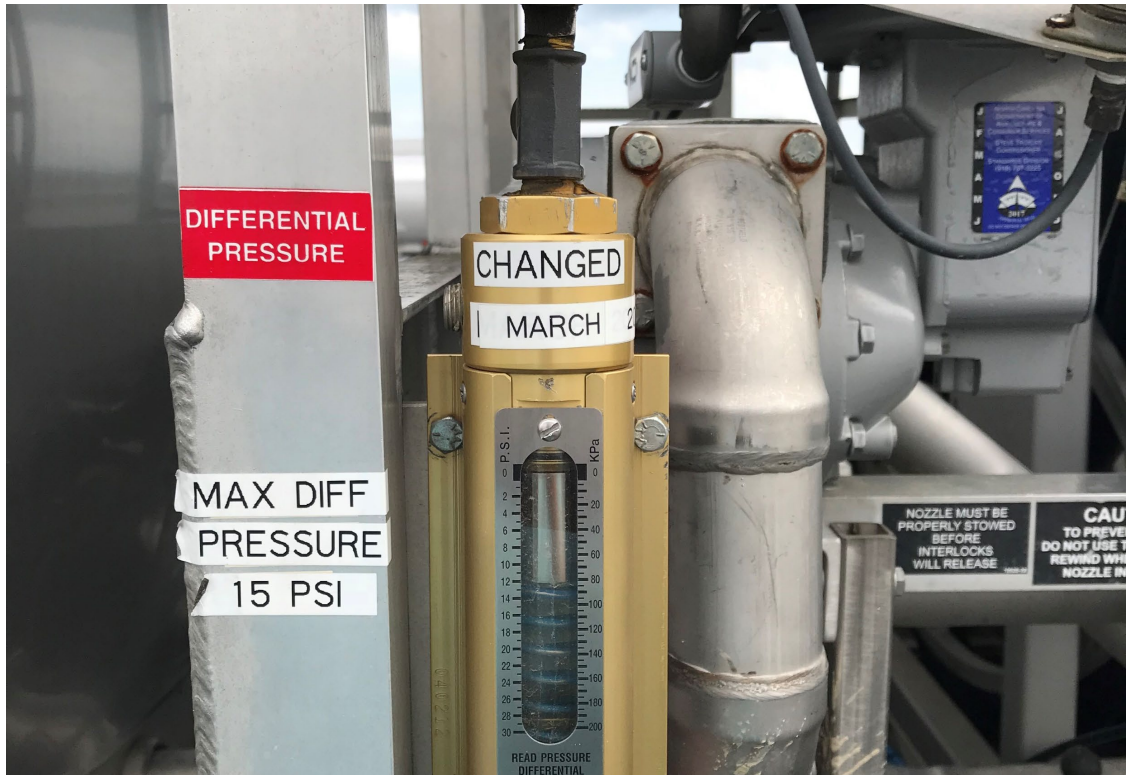
NDX

Bridging Traditional Recordkeeping with Modern Compliance Tools





Catching Concerns and Knowing “Your Normal”



- Max is 15psi
- Your normal DP is 5psi
- Now you’re at 10psi…

Training and Education

Invest in it!

A True Story...

Human Factors

The Ol' Pencil Whip…

- **Always 1A**
- **Always "Satisfactory"**
- **Always a Red Flag**

Laboratory Qualification Testing Overview

Facet
Filtration Group®

Object of Qualification Testing

Verify Filtration Performance Standard before an EI Witness – Specifically (EI-1581):

1) Total Solids less than 1 mg/gallon
2) Free Water Content of less than 15 PPMV
3) Media Migration of less than 10 fibers/liter

Initial Requirement for Qualification Testing

Manufacturing Facility

Specifically:

1) Inventory & Materials Control
2) Well Maintained up to date Equipment
3) Stable Workforce
4) 100% Repeatability
5) Quality Control (ISO 9001:2015)

Facet
Filtration Group®

Single biggest Requirement for Qualification Testing

Laboratory

Specifically:

1) Analytic Capabilities
2) Fuel
3) Pumps/Flow Control
4) Additive/Contaminant Control
5) Temperature Control (40f – 90f)
6) Ability to Clean Contaminated/Tested Fuel

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Filtration Group®

Requirements For EI-1581

(Aviation Filter/Water Separators)

Fuel Types:

1) Cat.C
2) Cat.M
3) Cat.M100

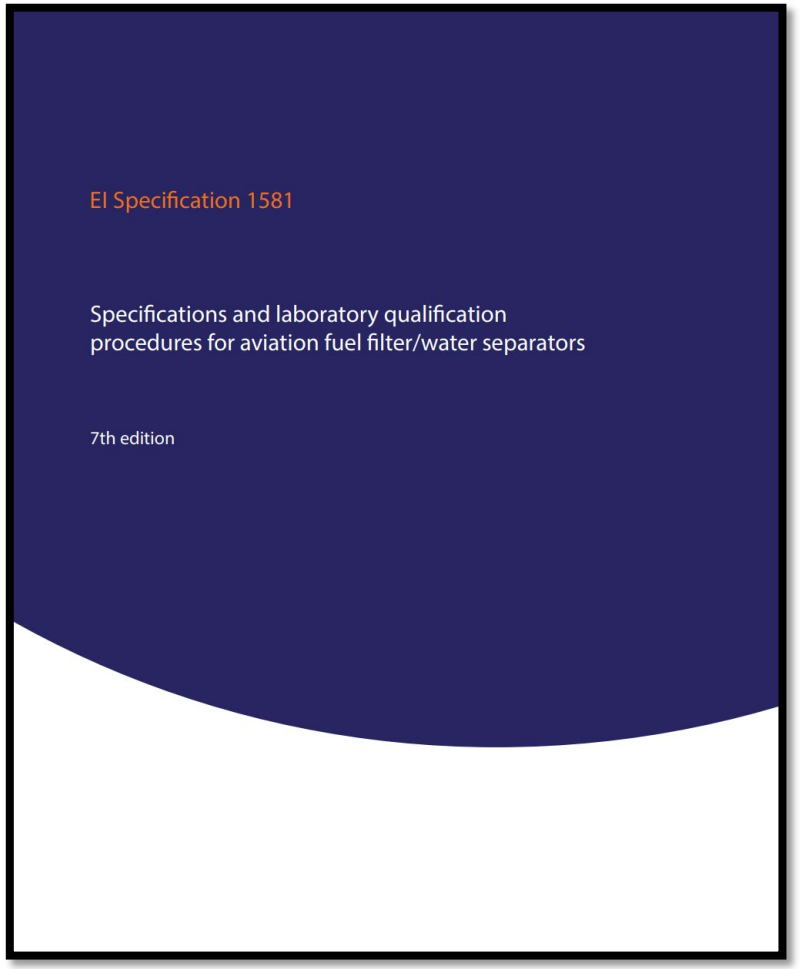
(Cat.M qualficiation also qualified to Cat.C/M100 is stand-alone)

Categories:

1) Single Scale
2) Full-Scale

Types:

1) S (3% water)
2) S-LW (.5% water)
3) S-M



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Requirements For EI-1581

(In Addition to Effluent Quality)

Solids Holding Capacity (19 mg/l x 75 minutes – S & S-LW)

Differential Pressure (10 psi Clean/Rated Flow)

Structural Strength of Elements (75 psi)

Structural Integrity (No Signs of Leaks or Tears)

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Filtration Group®

Single-Scale Procedure
(Basics)

1) Longest Element
2) Test Fuel/Additives/Contaminants (D1655/DefStan 91-091 - Stadis 450, DCI-4A, Di-EGME, +100, RIO, Arizona Test Dust, Water)
3) Element Conditioning (3 gpm/30 minutes)
4) Rated Flow (30 minutes/0.01% Water/S-S)
5) Stop/Drain/Solids Addition (75 minutes/DP tests plus S-S)
6) Water Injection – 150 minutes
7) Water Injection – 3% or 0.5% for 30 minutes
8) Final Inspection

Full-Scale Procedure

(Basics)

The Full-Scale test is a test of the complete design – Element Conditioning (media migration), water coalescence, solid holding and contaminated element coalescence. Vessel used must comply with EI-1596.

Facet
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Sampling

Media Migration – 3 gallons – Outlet – 1 -ASTM D2276

Solids – 1 to 3 gallons – Outlet – 10/6 - Intervals - ASTM D2276

Free-Water – TBD – Outlet – 4 – Intervals - ASTM D3240

Fuel Conductivity – TBD – ASTM D2724

MSEP – 0.125 gallons – ASTM D3948

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Filtration Group®

Final Inspection

1) Elements critically inspected for structural failure
2) Compatibility (EI-1589)
3) Electrostatic Charging
4) End-to-End Resistance

Finally – Reports Submitted

Thank You

Questions

Facet
Filtration Group®

Nobil Petroleum Testing, Inc.
Phone: (908) 994 - 1891 Fax: (908) 994 - 1896
840 Bond Street
Elizabeth, NJ 07201

AVIATION FUEL QUALITY CONTROL, LAB TESTS and REMEDIATION

Madi Mohtadi
Nobil Petroleum Testing, Inc.
President

GTP Aviation Fuel Handling Symposium

DALLAS, TX

WEDNESDAY FEBRUARY 19TH 2025

FUEL QUALITY DOCUMENTS- ASTM D1655 JET FUEL

COQ (RCQ) ASTM D1655

- Table 1
- Table 2
- Annex 1 for fuels containing synthesized comp.

Certificate of Quality (Refinery Certificate of Quality)

- The definitive original document describing the quality of aviation fuel batch at the Point of Manufacture.
- Confirms batch conformance to the specification.
- Usually issued by the product originator's

COA ASTM D1655

- Table 1

Certificate of Analysis

- Usually by independent inspectors and/or laboratories
- Typically produced downstream of refineries
- COA not equivalent to COQ

Incidental Materials ASTM D1655 Table 3 (FAME, DRA)

Testing for Incidental Materials

- FAME max 50mg/Kg
- DRA max 72 µg/L

"8 PT TEST"

- Appearance /Saybolt Color
- Gravity
- Distillation
- Flash Point
- Freezing Point
- Copper Corrosion
- Existent Gum
- Water Sep. Char.

Recertification of Test Certification

- Properties particularly sensitive to contamination.
- when possibility of cross contamination (eg multi-product pipeline, barge transport)

Testing and Field Checks

- Supply chain testing and checks
- Fuel is maintained clean and dry, and free of contaminants
- ICAO 9977,ATA 103 EI/JIG Standards API standards

D1655 NON-MANDATORY APPENDIX

X3. Forms for reporting inspection data on aviation turbine fuels- EXAMPLE of COQ/COA

EXAMPLE OF CERTIFICATE OF ANALYSIS / CERTIFICATE OF QUALITY

For fuel supplied to ASTM D1655 _____ (Record Revision Level)

Date Sampled: _____ Product: _____ Tank: _____

Batch No.: _____ Sample No. _____ Quantity: _____

Location: _____ Vessel: _____ Pipeline: _____

Property		Jet A or Jet A-1	Test Method	Test Result	Pass/Fail
COMPOSITION					
Acidity, total mg KOH/g	max	0.10			
1. Aromatics, percent by volume	max	25			
2. Aromatics, percent by volume	max	26.5			
Sulfur, mercaptan, percent by mass	max	0.003			
Sulfur, total percent by mass	max	0.30			
VOLATILITY					
Distillation temperature, °C:					
10% recovered, temperature	max	205			
50% recovered, temperature		report			
90% recovered, temperature		report			
Final boiling point, temperature	max	300			
Distillation residue, %	max	1.5			
Distillation loss, %	max	1.5			
Flash point, °C	min	38			
Density at 15 °C, kg/m³		775 to 840			
FLUIDITY					
Freezing point, °C	max	-40 Jet A -47 Jet A-1			
Viscosity -20 °C, mm²/s	max	8.0			
COMBUSTION					
Net heat of combustion, MJ/kg	min	42.8			
One of the following requirements shall be met:					
(1) Smoke point, mm, or	min	25.0			
(2) Smoke point, mm, and	min	18.0			
Naph-thalenes, vol.%	max	3.0			
CORROSION					
Copper strip, 2 hrs at 100 °C	max	No. 1			
THERMAL STABILITY					
(2.5 h at control temperature of 260 °C min)					
Filter pressure drop, mm Hg	max	25			
Tube rating: One of the following requirements shall be met:					
(1) Annex A1 VTR, VTR Color Code	Less than	3 (no peacock or abnormal color deposits)			
(2) Annex A1 ETR or Annex A1 ESTR	max	85			
CONTAMINANTS					
Existent gum, mg/100 mL	max	7			
Water Reaction Characteristics					
Without electrical conductivity additive	min	85			
With electrical conductivity additive	min	70			
ADDITIVES					
Electrical conductivity additive					

Choose the applicable Certification, with the statement of conformance/nonconformance:

☐ CERTIFICATE OF ANALYSIS: Certified that this sample ☐ meets ☐ does not meet the indicated tests requirements of latest revision of D1655 Specification noted above

☐ CERTIFICATE OF QUALITY: Certified that this sample ☐ conforms ☐ does not conform to the latest revision of ASTM D1655 Specification noted above

Signed: _____ Title: _____

Date : _____ Lab Quality System: _____

Notes: _____

Fig. X.3.1 Example form for Certificate of Analysis/ Certificate of Quality for aviation turbine fuel- Table 1

Choose the applicable Certification, with the statement of conformance/nonconformance:

☐ CERTIFICATE OF ANALYSIS: Certified that this sample ☐ meets ☐ does not meet the indicated tests requirements of latest revision of D1655 Specification noted above

☐ CERTIFICATE OF QUALITY: Certified that this sample ☐ conforms ☐ does not conform to the latest revision of ASTM D1655 Specification noted above

Signed: _____ Title: _____

Date : _____ Lab Quality System: _____

Notes: _____

COA EXAMPLE CONT

EXAMPLE OF CERTIFICATE OF ANALYSIS / CERTIFICATE OF QUALITY

For fuel supplied to ASTM D1655-XXX (Record Revision Level)

Date Sampled: _____ Product: _____ Tank: _____

Batch No.: _____ Sample No. _____ Quantity: _____

Location: _____ Vessel: _____ Pipeline: _____

Property		Jet A or	Test Method	Test Result	Pass/Fail
COMPOSITION					
Acidity, total mg KOH/g	max	0.10			
1. Aromatics, percent by volume	max	25			
2. Aromatics, percent by volume	max	26.5			
Sulfur, mercaptan, percent by mass	max	0.003			
Sulfur, total percent by mass	max	0.30			
VOLATILITY					

ATA103-FUEL RECEIPTS INTO AIRPORT STORAGE- 8 POINT TEST-AND SPECIFICATION LIMITS

PROPERTY	SPEC LIMIT	MAX DIFFERENCE FROM PRIOR SHIPPING CERTIFICATE
Visual Appearance t	Clear & Bright	
API Gravity, Corrected to 60 °F (15 °C)	37 to 51 °API (775-840 kg/m³)	1 °API
Distillation		
10% Recovered	400 °F (205 °C) max	14 °F (8 °C)
50% Recovered	Report	14 °F (8 °C)
90% Recovered	Report	14 °F (8 °C)
Final Boiling Point	572 °F (300 °C) max	14 °F (8 °C)
Residue	1.5% max	Spec Limit
Loss	1.5% max	Spec Limit
Flash Point	100 °F (38 °C) min	5 °F (3 °C)
Freezing Point		
Jet A	-40 °F (-40 °C) max	5 °F (3 °C)
Jet A-1	-53 °F (-47 °C) max	5 °F (3 °C)
Water Separation (MSEP or WSI)		
Using [ASTM D7224]	85 min	Spec Limit at Point of Receipt
or		
Using [ASTM D8073]	88 min	Spec Limit at Point of Receipt
or		
Using [ASTM D3948]	85 min	Spec Limit at Point of Receipt
Copper Corrosion Strip	No. 1 max	Spec Limit
Existent Gum	7 mg/100 mL max	Spec Limit

ATA103 recommends thermal oxidation stability as well – ASTM D3241

SAMPLING

- RELIABILITY OF THE DATA
  - TYPE OF SAMPLING: REPRESENTATIVE OR DIAGNOSTIC SAMPLES-
  - SAMPLING LOCATION
  - TESTS NEEDED- CONSIDER QUANTITY
  - SAMPLE CONTAINER- ASTM D4306
  - SAMPLING EQUIPMENT- JET FUEL- NO Cu or Cu alloys- Thermal Oxidation Stability
  - FLUSH SAMPLING LINE TO ENSURE DISPLACEMENT OF FUEL
  - FOR DIAGNOSTIC SAMPLE- FIRST FLOW MIGHT BE NEEDED
  - CORRECT SAMPLING PRACTICES
    - WEAR GLOVES
    - DON'T TOUCH INSIDE OF THE LID OR CAP
    - RINSE THE CONTAINER
    - RINSE FUNNEL (IF USED)
    - CLEAN THE AREA AROUND THE SAMPLING PORT- FOR MICROBILA SAMPLING- WIPE W ALCOHOL AND LET IT DRY FULLY
    - LEAVE HEAD SPACE IN THE SAMPLE CONTAINER
  - FILLING SAMPLE TAGS WITH CORRECT INFORMATION, CORRECT IDENTIFICATION
  - CORRECT HANDLING OF THE SAMPLE FROM TIME IT WAS TAKEN TO THE LAB – MICROBIAL CONTAMINATION SAMPLES WITHIN 4H, KEEP COOL, INITIATION OF THE TEST WITHIN 24H FROM SAMPLING

SAMPLING STANDARDS AND GUIDELINES

- INDUSTRY STANDARDS: IATA, ATA103, EI, JIG
- API MPMS- Manual of Petroleum Measurements Standards
- EI/ IP Standard Methods and Practices
  - EI/IP475- Petroleum Liquids- Manual Sampling
  - EI/IP 216- Particulate Contamination in Aviation Fuel by Line Sampling
- ASTM
  - D4057/MPMS 8.1- Standard Practice for Petroleum and Petroleum Products Sampling
  - D4767- Standard Practice for Manual Sampling for Liquid Fuels, Associated Materials and Fuel Systems Components for Microbiological Testing
  - D4306- Standard Practice for Sample Containers for Tests affected by Trace Contamination
  - D2276- Standard Test Methods for Particulate Contaminants in Aviation Fuels by Line Sampling

Independent Testing Lab, Inc.

Address
Phone Number:.....

Order NO: 1234

8 PT TEST REPORT

For fuel supplied to ASTM D-1655-XX

Customer:	Fuel Management Company	**Date In Lab:**	10/31/2024
Location:	Location	**Date Sampled:**	10/31/2024
Terminal:	xyz	**Lab Nbr:**	xxxx-xx
Product:	Jet A	**Tank/Vessel No:**	TK# 87
Marked:	ABC-XXXXX-XXXXXX	**Submitted By:**	Customer

Property	Test Method	Specs (min/max)	Result	Pass/Fail
GRAVITY AT 60 DEG °F / API	D4052	37/51	44.8	Pass
DENSITY AT 15 DEG °C, kg/m³	D4052	775/840	801.9	Pass
FLASH POINT, DEG F	D56 AUTOMATIC	min 100	112	Pass
COPPER STRIP, 2 h at 100°C	D130	1a/1b	1a	Pass
FREEZING POINT, °C	D7153	max -40.0	-50.9	Pass
DISTILLATION, IBP, DEG F	D86 MANUAL		309.0	Report Only
10 % RECOVERED, DEG F	D86 MANUAL	max 400	337.0	Pass
50 % RECOVERED, DEG F	D86 MANUAL		385.0	Report Only
90 % RECOVERED, DEG F	D86 MANUAL		465.0	Report Only
END POINT, DEG F	D86 MANUAL	max 572	525.0	Pass
RECOVERY, PERCENT BY VOLUME	D86 MANUAL	min 97	98.5	Pass
RESIDUE, PERCENT BY VOLUME	D86 MANUAL	max 1.5	1.0	Pass
SAYBOLT COLOR	D156		+21	Report Only
MICROSEPAROMETER, RATING	D3948	min 85	96	Pass
EXISTENT GUM, mg/100 mL	D381	max 7	<1	Pass

Samples shall be retained by Independent Testing Lab for a period of 7 days unless otherwise requested in writing.

Analysis Report

This sample meets the indicated tests requirements of the latest revision of D1655 Specification as noted above

Signed: _____ Title Lab Manager

Date: October 31, 2024 Lab Quality System: ISO 9001:2015

CONTAMINATION with OTHER PRODUCTS
CROSS CONTAMINATION

Lighter Product Contamination

API Gravity	High
Distillation IBP	10% is Low
Flash Point	Low
Viscosity	Low
Color Due to Possible AVGAS Comingling	Red, Blue, Green Tint

Heavier Product Contamination

JFTOT fails	Diesel Comingling
Microseparometer Fails	Possible Oil or Diesel Contamination
Freeze Point	Fails Low
Viscosity	High
Existent Gum	High and Oily
Distillation FBP	90% Residue is High
API Gravity	Low
Color Due to Possible Red Diesel Comingling	Red Tint

FUEL DETERIORATION

Deterioration

API Gravity	Low,	
Distillation IBP	10% High,	Weathering loss of light ends
Existent Gums	High and Dry	
Visual Color Change		Oxidation

PRESENCE OF SURFACTANTS- WATER SEPARATION CHARACTERISTICS

MANUFACTURE POINT (TABLE 1 D1655)

CONTAMINANTS			
Microseparometer,R Rating			D3948
Without electrical conductivity additive	min	85	
With electrical conductivity additive	min	70	

- PREVENTS TRACE SURFACTANTS FROM REFINERY PROCESSES
- D3948 USED FOR CLAY TREATERS PERFORMANCE ASSESSEMENT

SUPPLY CHAIN (D1655 Non mandatory App X1.13.2, ATA103)

Property	Jet A or Jet A-1	Test Method
Water Separation Characteristic, rating		
Without electrical conductivity additive	Min 85	D3948
With electrical conductivity additive	Min 70	D3948
With or without electrical conductivity additive	Min 85	D7224
With or without electrical conductivity additive	Min 88	D8073

- CONTAMINATION WITH STRONG SURFACTANTS FROM MISADITISATION OR CROSS CONTAMINATION
- PREDICTION OF COALESCENCE PERFORMANCE OF F/S

Thermal Oxidation Stability

Fuel Instability

- Formation of peroxides and hydroperoxides
- Formation Insoluble material that may coat surfaces or form particles
- Formation of higher molecular weight compound with limited fuel solubility

Possible Cause:

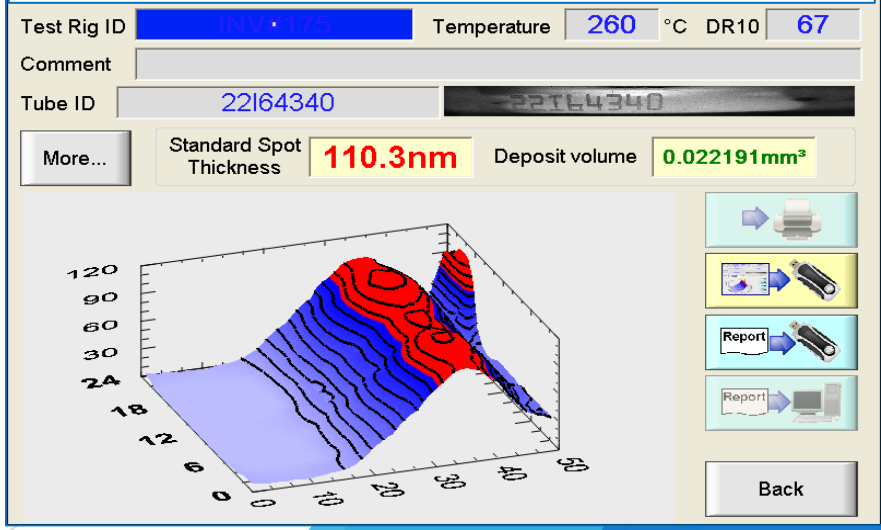
- ppm levels certain nitrogen and/or sulfur compounds, organic acids, reactive olefins
- Certain dissolved metals act as catalyst for the oxidation reactions. COPPER!! (SAMPLE EQUIPMENT!! ONLY JET FUEL APPROVED SAMPLE EQUIPMENT AND SAMPLE CONTAINERS !!- ASTM D4306)

REMMEDY:

- MDA TREATMENT
- SOMETIMES CLAY TREATING THE FUEL
- PROPER SAMPLING AND SAMPLING EQUIPMENT

VTR- Annex 1 D3241
D1655 Spec limit deposit thickness: <3

ITR Annex 2 D3241
Spec limit deposit thickness: max 85 nm



ASTM D1655- CLEANLINESS AND ABSENCE OF CONTAMINATION IS A REQUIREMENT

8. Workmanship, Finish, and Appearance

The aviation turbine fuel specified in this specification shall be ***visually free of undissolved water, sediment, and suspended matter. The odor of the fuel shall not be nauseating or irritating…***

- APPEARANCE CHECK- CLEAR & BRIGHT, WHITE BUCKET- First visual indication of contamination
- MICROBIOLOGICAL TEST- Microbial growth causes fuel degradation and system failures
- FILTER MEMBRANE TESTING FOR PARTICUALTES- Particulates can clog filters and damage engines
- TESTING FOR FREE WATER- Water causes corrosion and microbial growth

Nobil Petroleum Testing, Inc.
Phone: (908) 994 - 1891 Fax: (908) 994 - 1896

840 Bond Street
Elizabeth, NJ 07201

THANK YOU!

QUESTIONS?

MADI MOHTADI

EMAIL: madi.mohtadi@nobilpetroleumtesting.com

PHILLIPS 66

PROVIDING ENERGY. IMPROVING LIVES.

Contaminants Adsorbed by Clay Treatment

Analytical Investigation

Enrico Lodrigueza

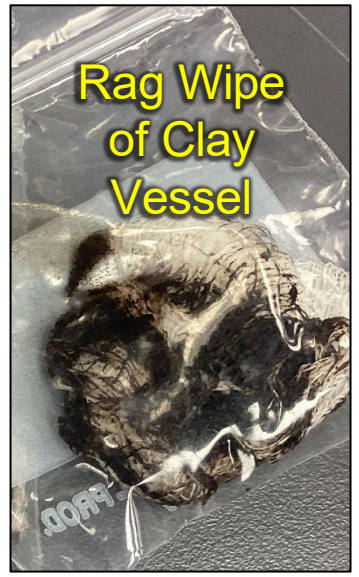
Jesse Contreras, Heather Day, and Leonard Nyadong

Gammon Symposium
February 19, 2025

Chevron Phillips Chemical Company (CPChem) Sweeny Complex SWEENY, TX

Background

- Terminal supplied with jet fuel from a major multi-product pipeline
- Filtration system: pre-filter ➡ clay (2 in parallel) ➡ filter/coalescer
- Tanks recertified by inspection lab
  - Tank A: Thermal stability @ 275 °C: Pressure drop = 3.0 mm Hg and Tube Rating = <1, MSEP = 92
  - Tank B: Thermal stability @ 275 °C: Pressure drop = 5.0 mm Hg and Tube Rating = 1, MSEP = 87
- After filtration
  - Thermal stability @ 260 °C: Pressure drop = 0 mm Hg and Tube Rating = >4, ITR = 330 nm, MSEP = 98



Clay Treatment Efficiency

EI 1530 Annex H

Monitor effectiveness by comparison of upstream and downstream values

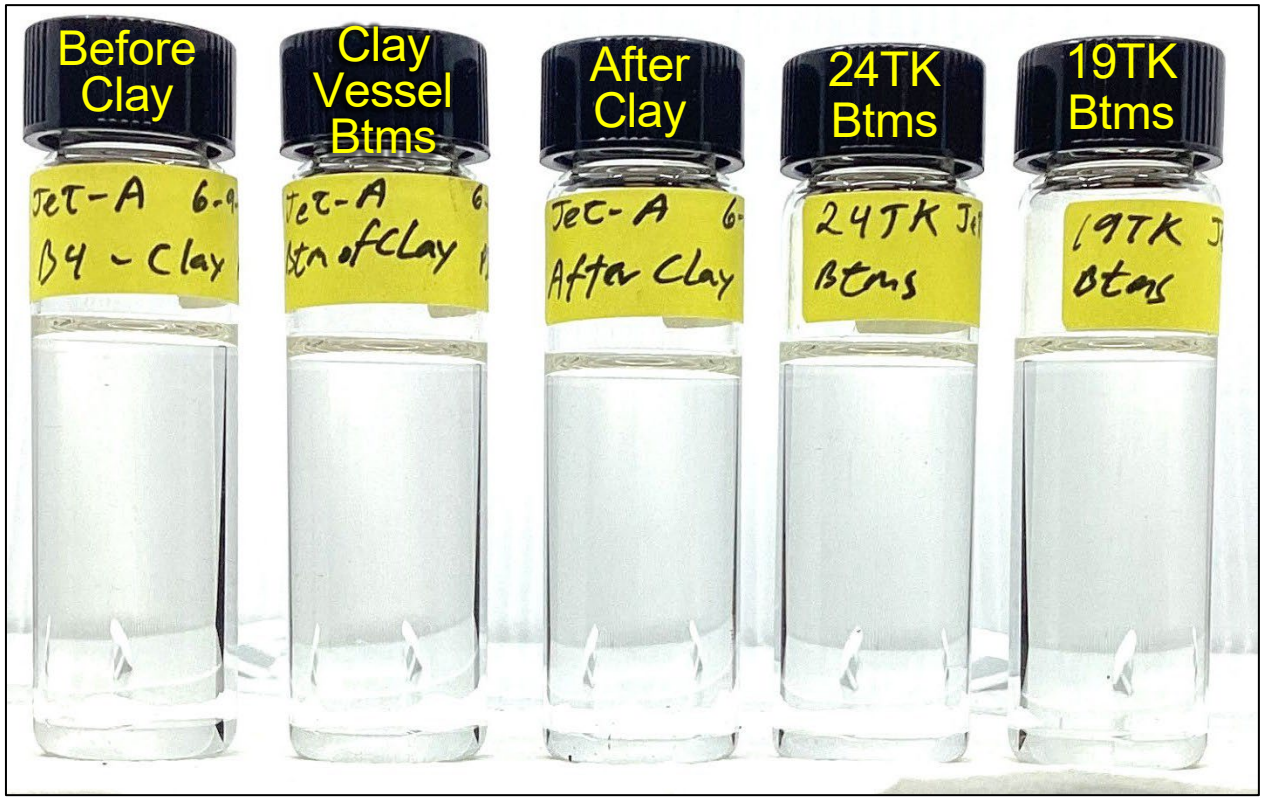
- Conductivity **No additive**
- Water separability **MSEP = 98 after clay**
- dP Reading (< 15 psi at rated flow) **dP readings well below 15 psi**

Other observations

- Disarmed filter/coalescer – surfactants not removed
- Brown water drains - surfactants not removed
- High volume of water drains – wet system

} **No issues**

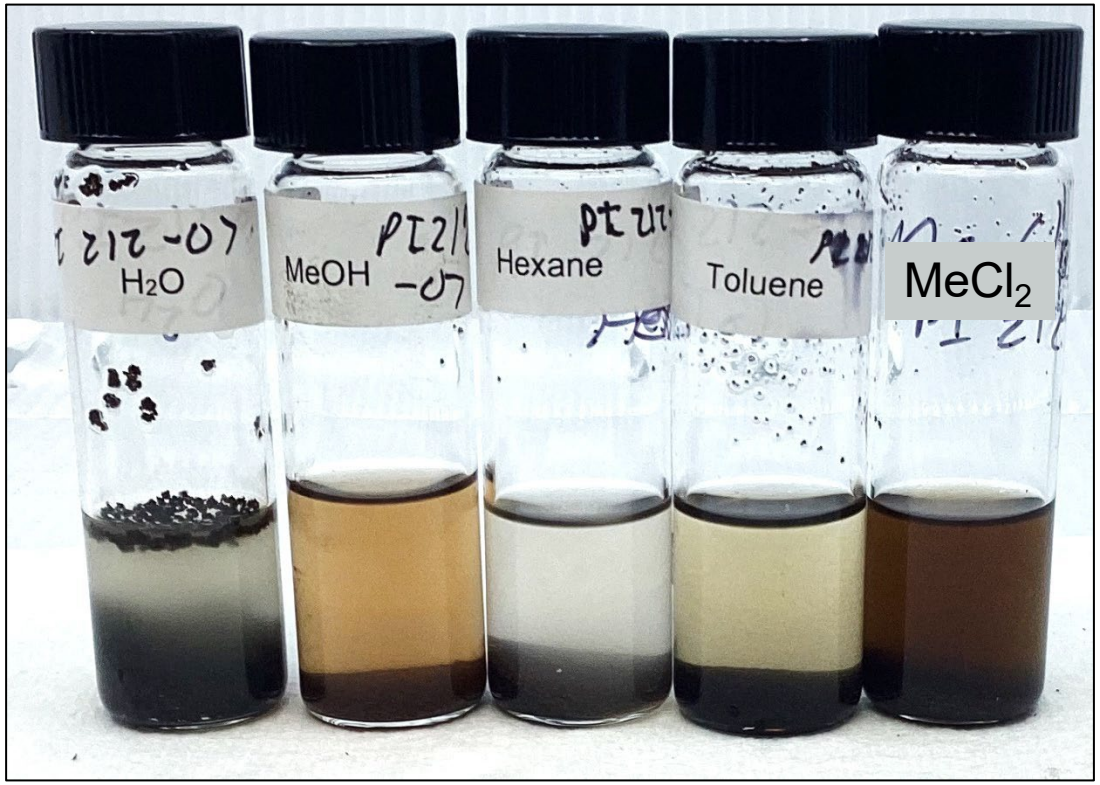
Picture of Samples



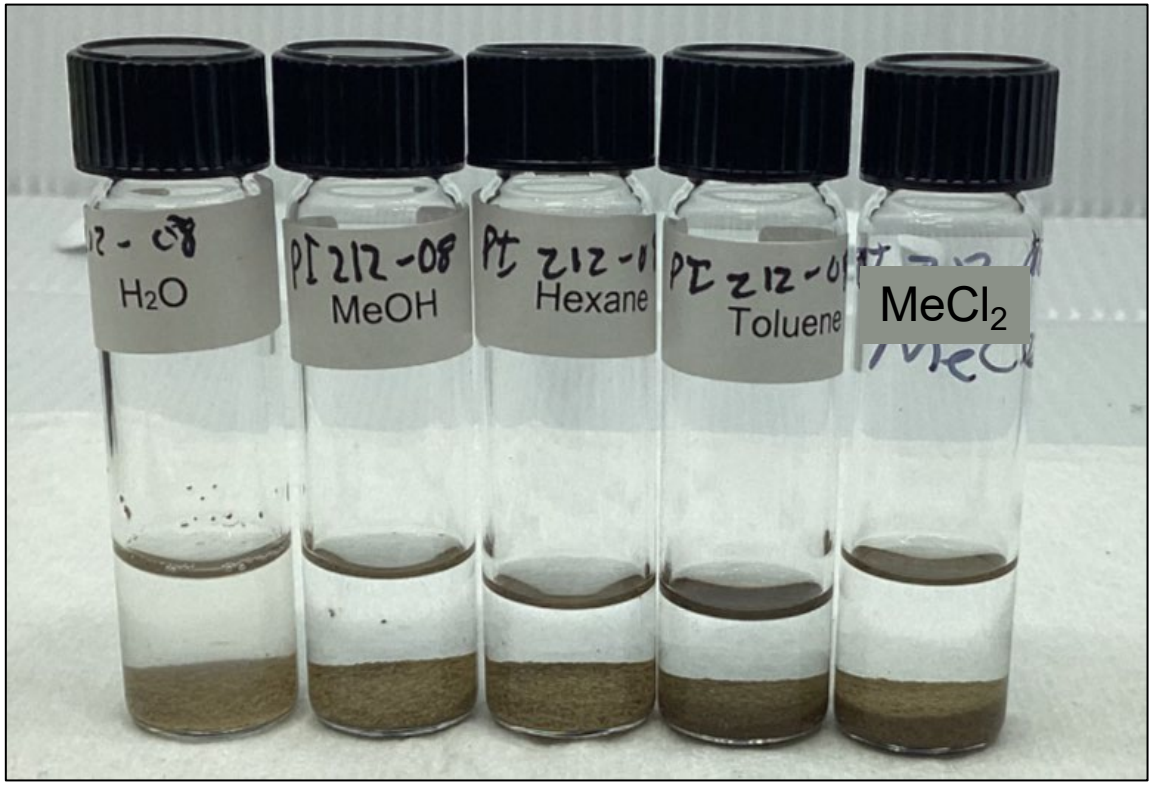
All the Jet Fuel samples were clear and bright, there were no solids or water present.
The spent clay was dark in color compared to new clay.

Solvent Extraction of Clay

Spent Clay



New Clay



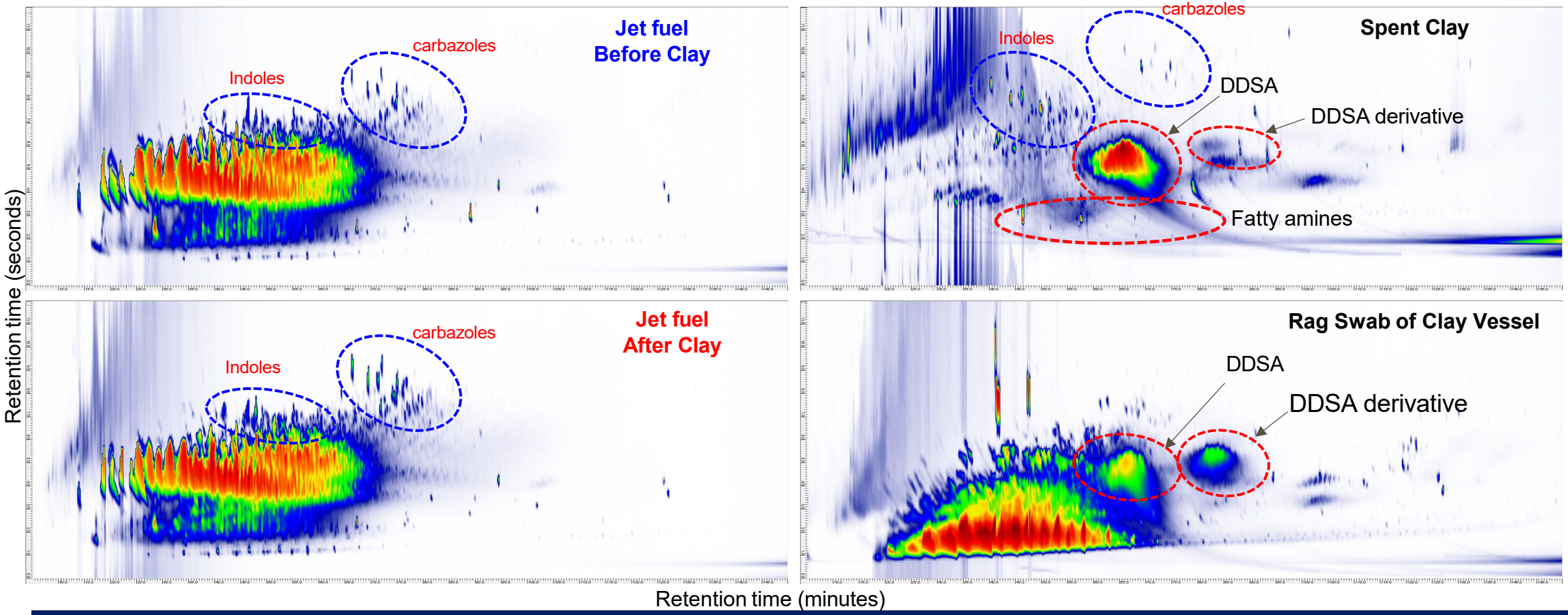
- The different colors indicates that the spent clay accumulated material that was extracted by the solvents.
- Darker color from the MeOH and $MeCl_2$, suggests that the darker material is composed of polar compounds.

Metal Analysis by ICP-MS

Elements (ppb)	Jet B4 Clay	Jet After Clay	New Clay	Spent Clay
Fe	6.07	4.75	2972	3320
Ba	4.17	0.42	1042	545
Pb	0.56	0.39	15 1.7	311. 6
Cd	0.19	0.00	30.4	10.2
Cr	0.19	0.07	7.81	4.13
Sn	0.14	0.35	1.60	0.55
Ni	0.10	0.11	1.22	3.73
Co	0.00	0.00	0.93	0.82
Cu	0.57	1.21	0.93	3.13
As	0.12	0.12	0.74	1.35
Ag	0.09	0.00	0.69	0.10

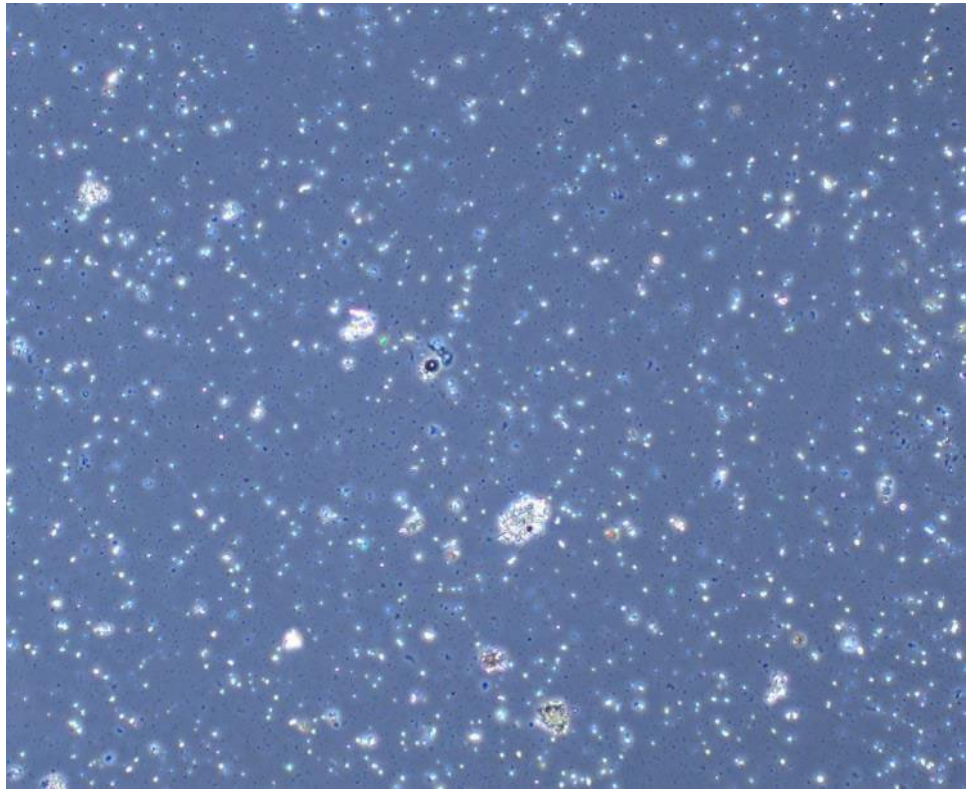
- The level of metals is slightly higher in the Jet After-Clay and Spent Clay samples.
- Some of the metals in the Jet After-Clay sample may have leached out from the clay.

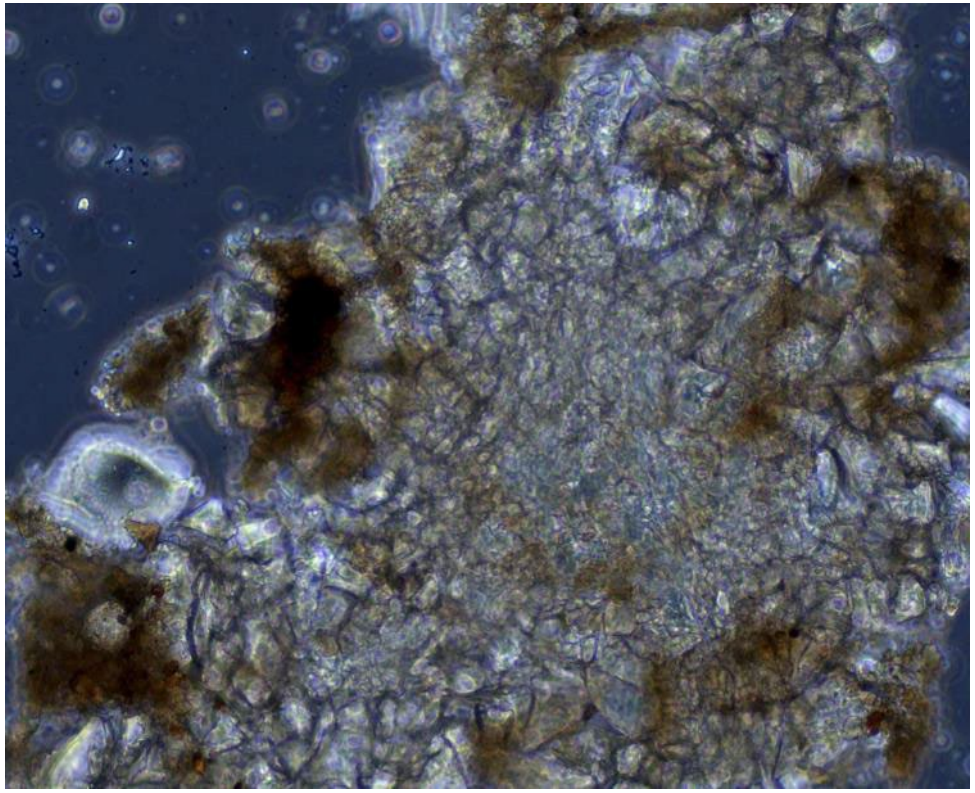
GCxGC MS Analysis of Jet Fuel, Spent Clay, and Rag Swab



- The spent clay and rag are dominated by DDSA and also show presence of indoles, carbazoles, fatty amines compounds which contributed to disarming the clay.
- The jet before and after clay filtration show presence of indoles, carbazole, which were also observed in the spent clay.
- The jet samples after clay appears to show a greater proportion of indoles and carbazole.

Light Microscopy for Bacteria Analysis



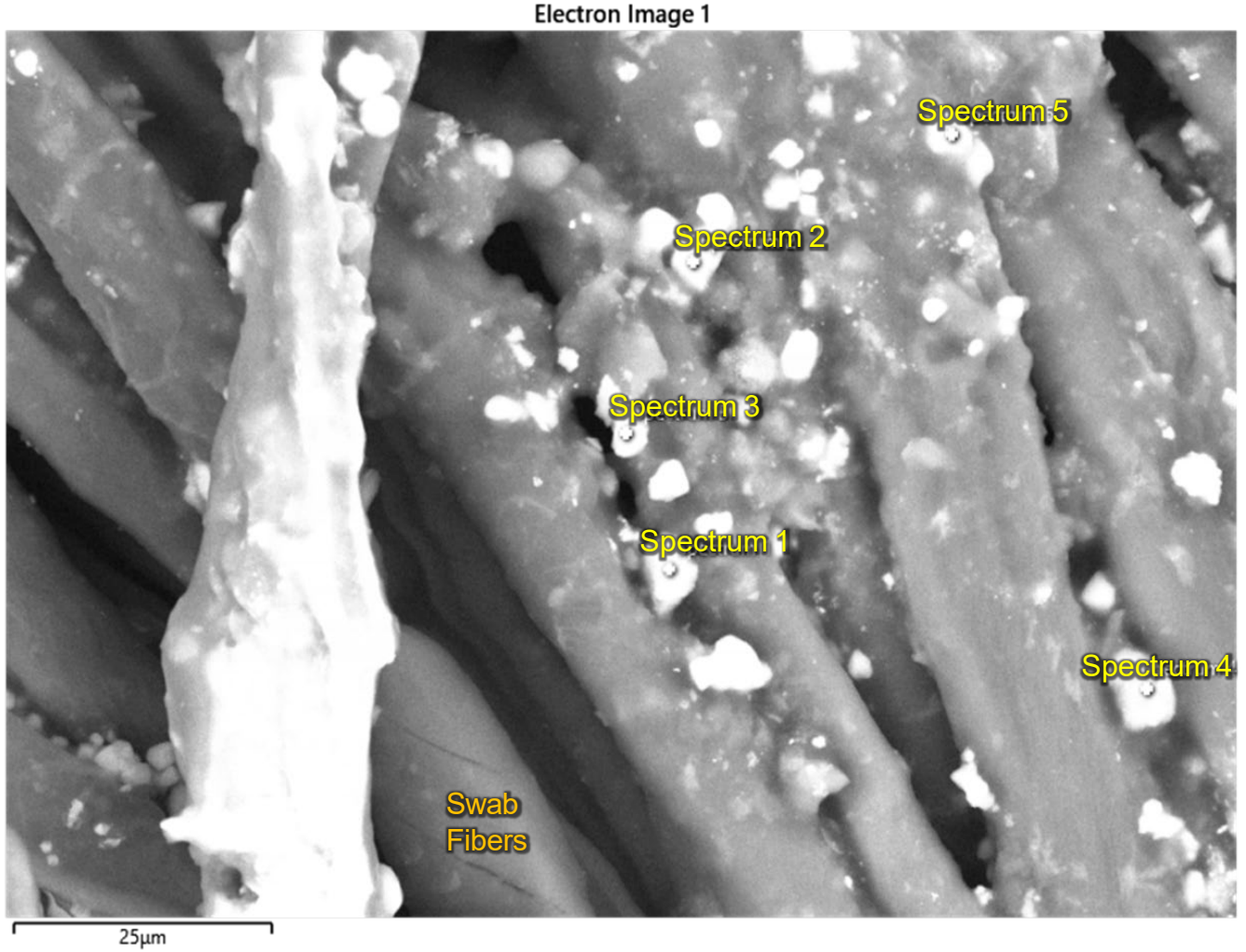


- Some of the material in the rag was found to be soluble in water indicating potential salts.
- Material did not show evidence of bacteria by light microscopy.

Scanning Electron Microscopy (SEM) Analysis of Rag

Rag Swab from Clay Vessel

Element wt%	Spectrum 1	Spectrum 2	Spectrum 3	Spectrum 4	Spectrum 5
C	23.47		50.97	40.87	56.08
O	49.81	11.60	7.31	41.24	6.51
Na	0.44	31.63	19.83	0.63	18.38
Mg				0.43	
Al				1.28	
Si				15.16	
S		0.56	0.23	0.14	0.16
Cl	0.33	56.22	21.66	0.25	18.87
Ca	25.94				
Total	100.00	100.00	100.00	100.00	100.00



- The Na to Cl mole ratio was greater than 1 indicating potential presence of caustic, which could have stripped out DDSA from pipelines and form a DDSA salt.
- Material did not show evidence of bacteria by neither light microscopy or SEM analysis.

Summary

- Clay was disarmed
  - Traditional metrics to monitor efficiency were insufficient
  - Corrosion inhibitor – main contaminant. Likely stripped out from pipeline by caustic carryover.
  - Wet - 2.9 wt% Water
  - Water soluble salts in the rag – no indication of microbial growth

- Operational changes
  - Thermal stability monitored downstream of clay – tested at 275 ℃ and tube rating by ITR or ETR
  - Minimum quarterly testing of MSEP and thermal stability

- Proposed revision in EI 1530 to test MSEP and thermal stability to monitor clay efficiency

- 15 dP for clay may be incorrect

Second Event – The Sequel

Chevron Phillips Chemical Company (CPChem) Sweeny Complex SWEENY, TX

Background

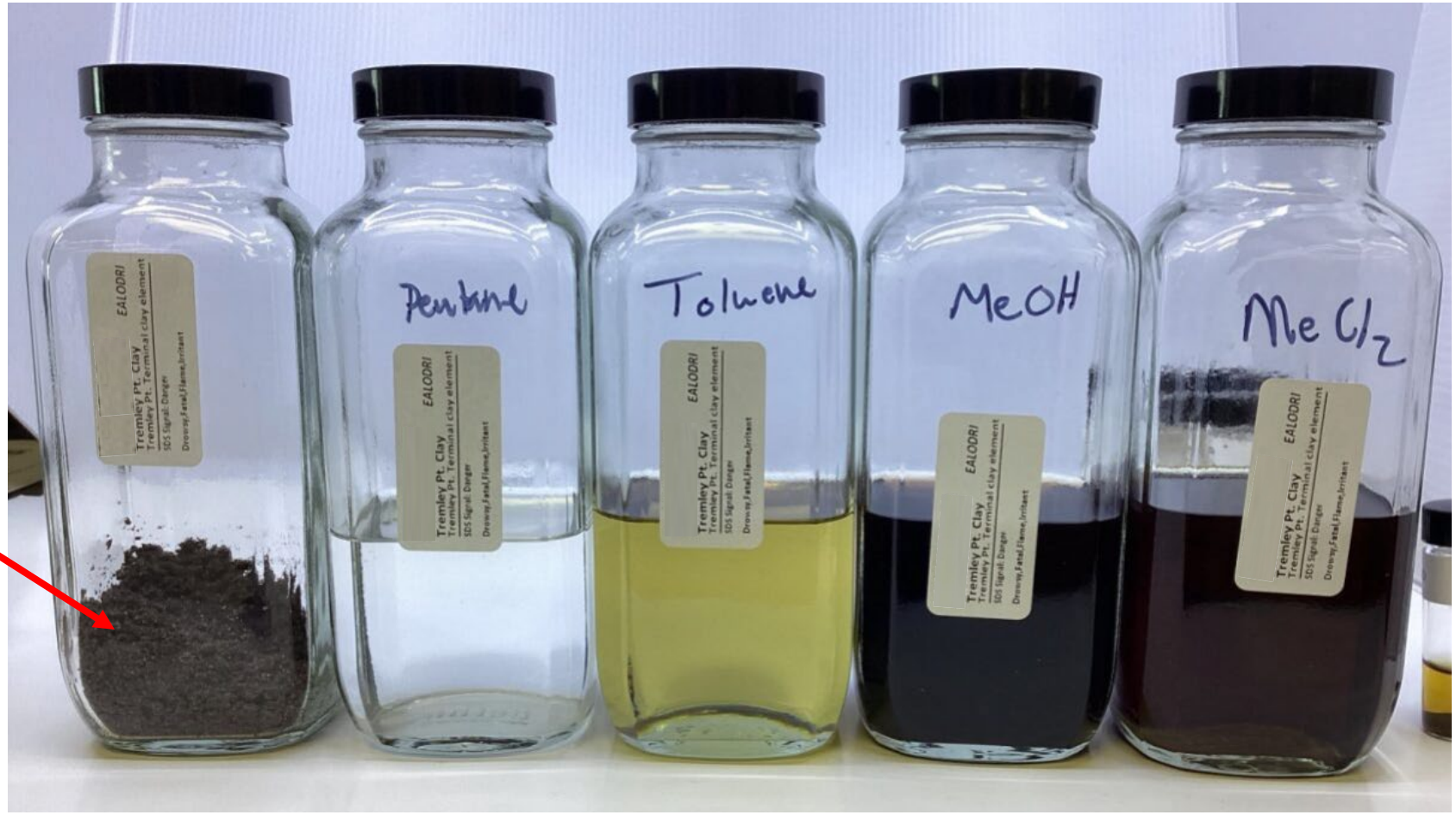
- The terminal experienced a reoccurrence after ~220,000 barrels throughput.
- TK C: Thermal stability @ 275 ℃ - Pressure drop = 0 mm Hg and Tube Rating (ETR) = 15 nm

- After clay
  - Thermal stability @ 275 ℃: Pressure drop = 0 mm Hg and Tube Rating (ETR) = **111 nm**
  - Thermal stability @ 260 ℃: Pressure drop = 0 mm Hg and Tube Rating (ETR) = 20 nm

- A sample of spent clay was analyzed to determine what contaminants were adsorbed

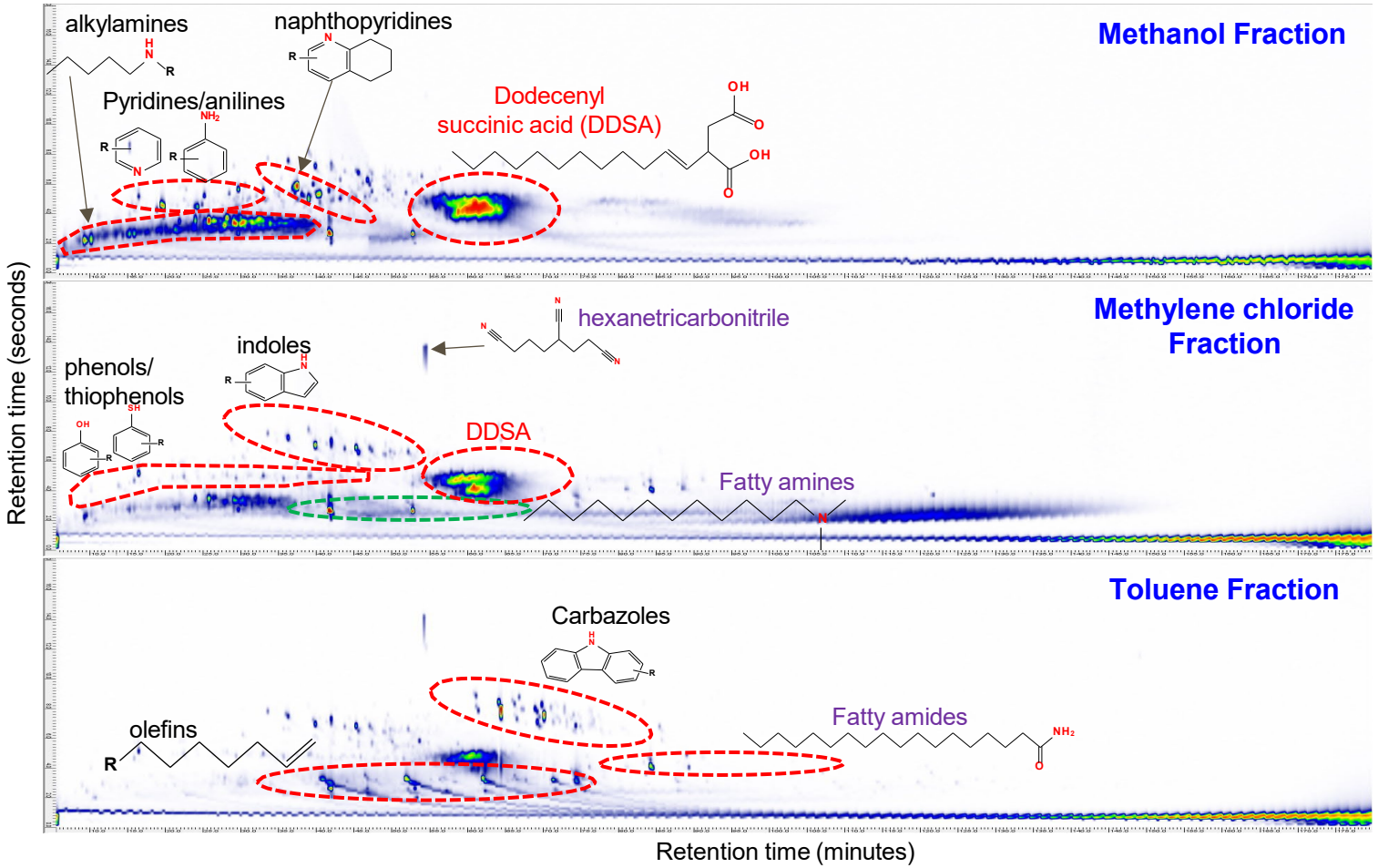
Spent Clay Filter Cartridge

Solvent Extraction of Spent Clay



- The spent clay was washed with different solvents to extract the compounds that saturated the clay.
- Both $MeCl_2$ and MeOH polar solvents show dark color, indicating that the clay was likely saturated with polar organic compounds and potential organic salts.

GCxGC MS Analysis of Spent Clay



- Dodecenyl succinic acids is the dominant components and is likely responsible for overwhelming the clay bed resulting in breakthrough.
- Presence of phenols, thiophenols, indoles, carbazoles, pyridines, anilines, naphthopyridines, olefins, fatty amines, alkylamines, fatty amides and carbonitrile also removed.
- Phenols, thiophenols, indoles, carbazoles, pyridines, anilines, naphthopyridines, olefins are native to jet fuel and typically originate from cracked stock.

Summary

- DDSA corrosion inhibitor is the dominant component responsible for overwhelming the clay bed resulting in breakthrough.
- DDSA could be present as an organic salt, which could be leaching out from the saturated clay potentially due to presence of water in the jet fuel.
- Continue weekly testing of thermal stability.
- Reconfigured clay vessels in series
  - Thermal stability tested between clay vessels