

World Jet Fuel Survey Project 090

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Project manager: Ana Gabrielian, FAA

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Project 090

World Jet Fuel Survey (WJFS)

University of Dayton Research Institute

PI: Zachary West

PM: Ana Gabriëlian

Cost Share Partners: Global Bioenergies, ASG, Marathon, Boeing, Shell, IHI, Neste, GE Aviation, NRC Canada, LanzaTech, and University of Dayton



Objective:

- **Coordinate a worldwide survey of current aviation turbine fuels to support the development of a jet fuel technical property database**

Project Benefits:

- **Allow faster, data driven decisions regarding safety and operability of alternative fuels**
 - Provide a snapshot of physicochemical and performance properties of current jet fuels on the world market
 - Establish a baseline of fuel properties for comparison to candidate synthetic fuels
- Become a reference benchmark of property data for designers, operators, producers, researchers, and other fuel practitioners

Research Approach:

- Procure fuel samples from diverse, global production locations
- Coordinate and conduct fuel sample testing and evaluation
 - Specification and fit-for-purpose testing
- Manage data collection and distribution
- Anonymize samples
- Publish results regularly/annually through partnerships with the Coordinating Research Council (CRC) and the Volpe Center

Major Accomplishments (to date):

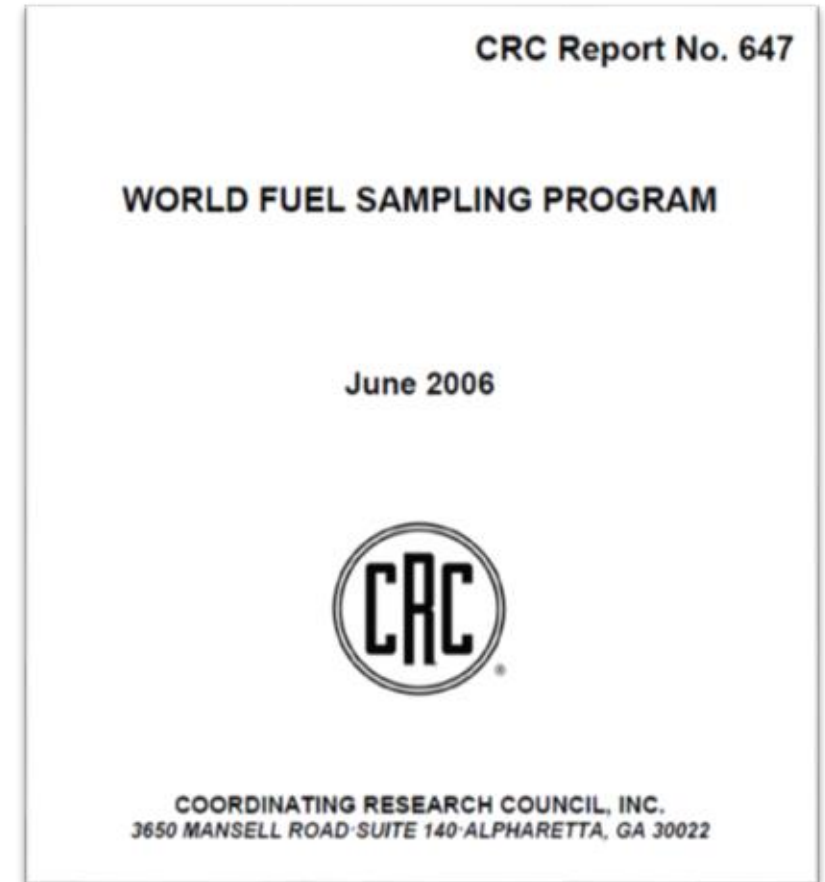
- Presented findings to industry:
 - FAA/ASTM Original Equipment Manufacturers (OEM) panel, UK Ministry of Defence (MOD) Aviation Fuels Committee (AFC) meeting, ASTM International, IASH 2024 conference, and the Energy Institute (EI)
- Secured partnership with CONCAWE to procure samples from European refineries
- Received 53 samples (representing >148,000,000 US Gallons of product)
- **Published Part 1: CRC Report No. AV-33-22, 2025**
<https://crcao.org/crc-project-no-av-33-22/>

Future Work / Schedule:

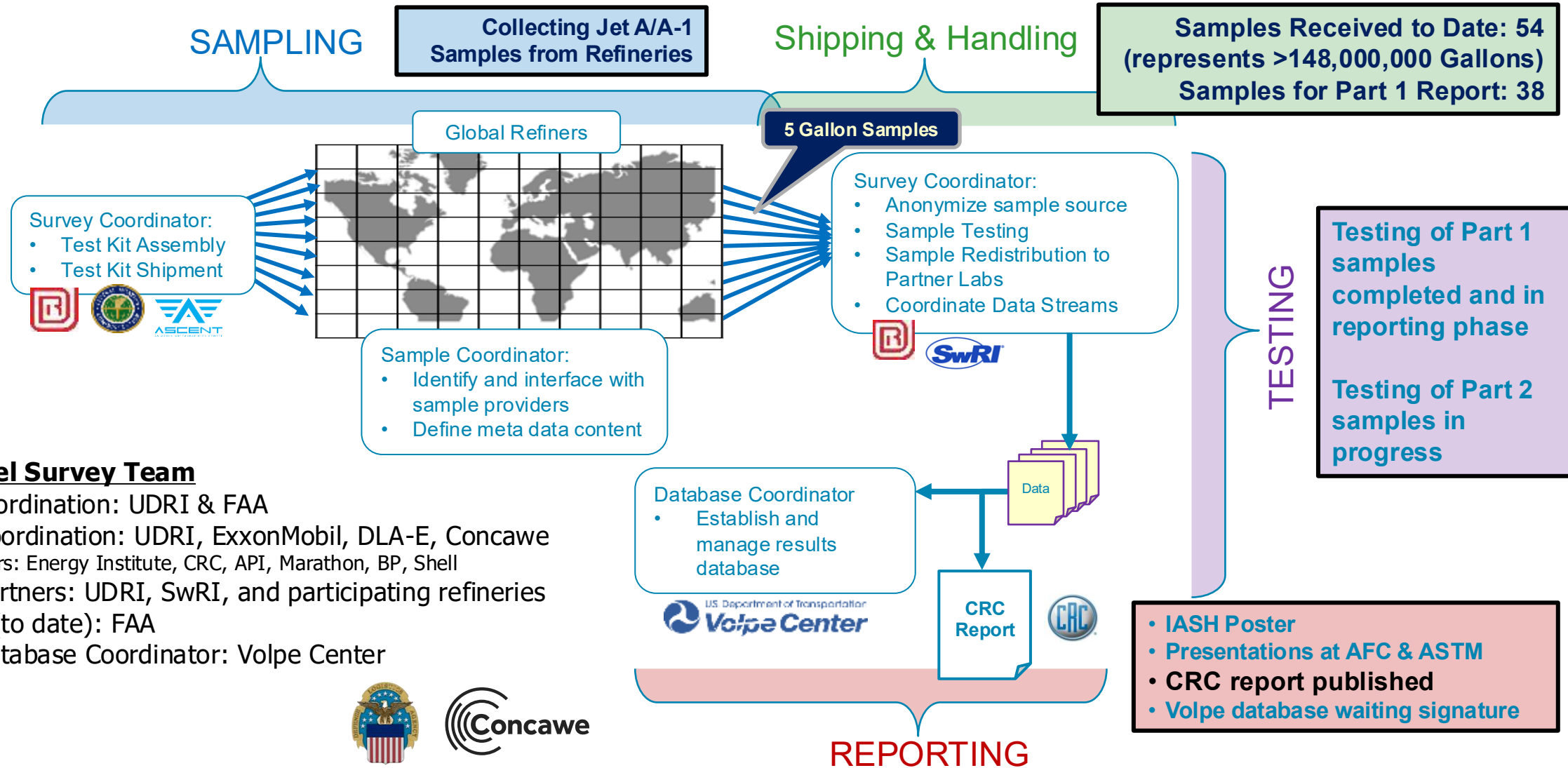
- Continue to collect samples & data for 2024-2025 (part 2)

Background

- While jet fuel is heavily specified, it is a fungible commodity that exhibits batch variations
- CRC World Fuel Sampling Program conducted in early 2000's
 - CRC Report No. 647, 2006
- Data relied on by industry for:
 - **ASTM D4054 Evaluation of Synthetic Aviation Turbine Fuel (SATF)—Real fuels data needed to make informed, technical decisions regarding safety and reliability**
 - Other Research or Investigations
 - Aircraft/Engine Design
- Industry needs updated survey to:
 - **Expand data to include Fit-for-Purpose properties**
 - Update data to reflect current trends in jet fuel properties and production methods



WJFS: Approach, Team, & Recent Status



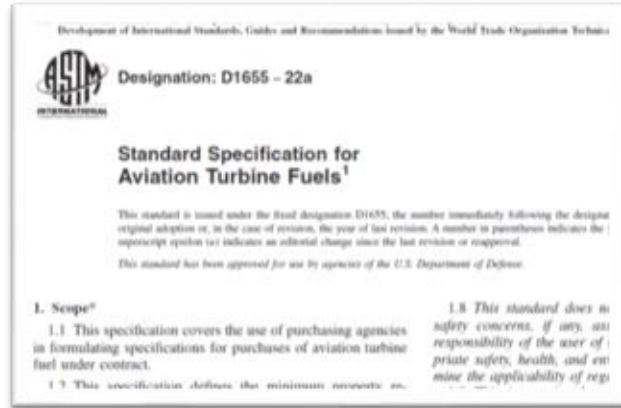
World Jet Fuel Survey Team

- Survey Coordination: UDRI & FAA
- Sample Coordination: UDRI, ExxonMobil, DLA-E, Concawe
 - Partners: Energy Institute, CRC, API, Marathon, BP, Shell
- Testing Partners: UDRI, SwRI, and participating refineries
- Sponsors (to date): FAA
- Results Database Coordinator: Volpe Center



Sample Data Collection

- Initial focus on Jet A/A-1 fuels (ASTM D1655 & DEF STAN 91-091)
- Use data from Refiner's Certificate of Quality (RCQ) document



- Over 300 Fit-for-purpose data points collected via 24 test methods per sample (in addition to RCQ data)

Fit-For-Purpose Testing

Property	Test Method
COMPOSITION	
Detailed Hydrocarbon Type (GCxGC)	UDRI FCM-101
Olefins	D1319
Hydrogen Content	D3701
Polar Organics (SPE-GCxGC)	UDRI FCM-102
Total Nitrogen	D4629
Trace Metals	UDRI FCM-107
BULK PHYSICAL AND PERFORMANCE PROPERTIES	
Distillation	D86
Simulated Distillation	D2887
Thermal Stability, Breakpoint	D3241
Lubricity	D5001
Viscosity (-40 to 100°C)	D7042
Density (-40 to 100°C)	D4052
Specific Heat (-40 to 140°C)	E2716
Surface Tension (-10, 25, 40°C)	D1331
Isentropic Bulk Modulus (35 to 75°C) v. Pressure	D6793
Thermal Conductivity (0 to 50°C)	D7896
Refractive Index	D1218
Water Solubility (0 to 50°C)	D6304
Air Solubility (oxygen/nitrogen)	UDRI FCM-103
True Vapor Pressure (0 to 120°C)	D6378
Dielectric Constant vs. Density	IP 638
Autoignition Temperature	E659
Hot Surface/Manifold Ignition Temperature	ISO 20823
Derived Cetane Number (DCN)	D6890



Status

CRC REPORT AV-33-22



FAA CENTER OF EXCELLENCE FOR ALTERNATIVE JET FUELS & ENVIRONMENT



CRC AV-33-22—WJFS (Part 1) Report: **Status**

- PUBLISHED:

World Jet Fuel Survey Part 1: 2023-2024, Report No. CRC AV-33-22, Coordinating Research Council, Dec 2025. <https://crcao.org/crc-project-no-av-33-22/>

- Report structure:

- Introduction
- Refiners Certificate of Quality Data
- Fit-for-purpose Data
- Composition-to-property Modeling
- References & Appendices

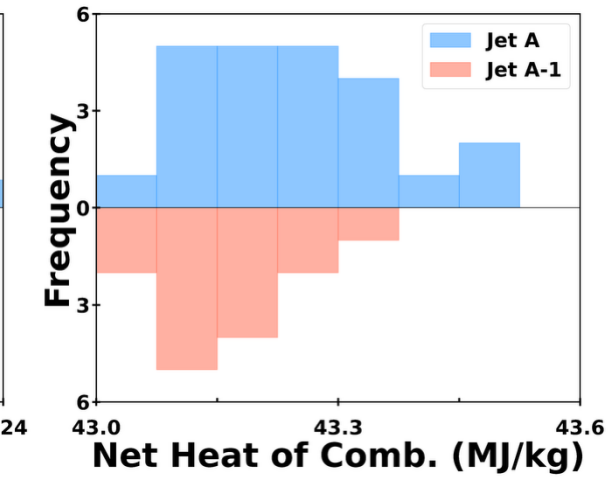
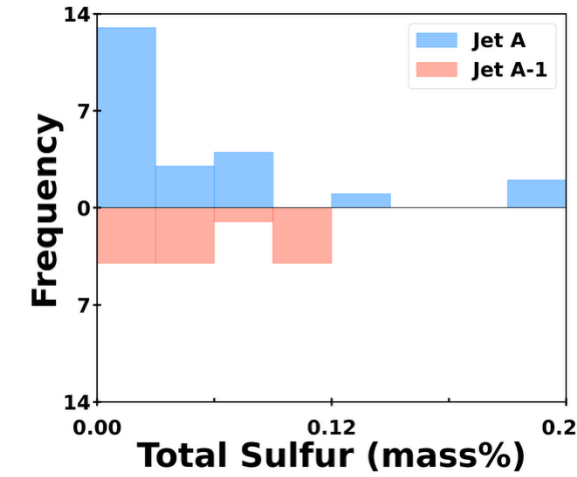
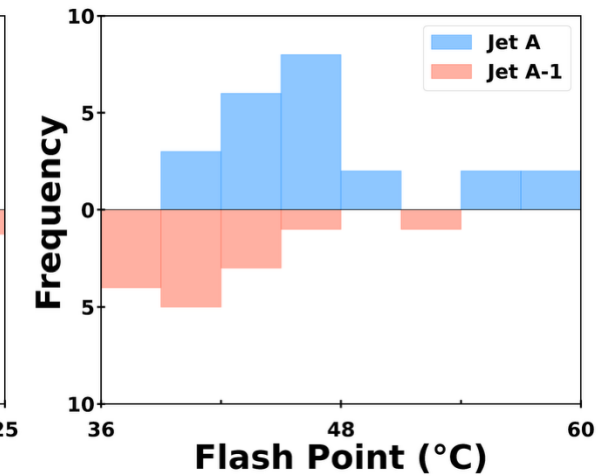
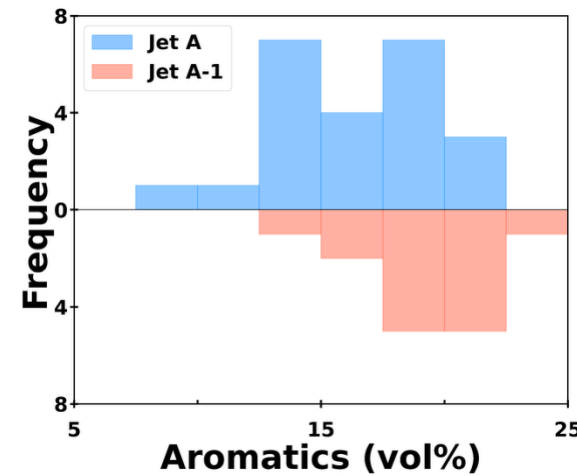


CRC AV-33-22—WJFS (Part 1) Report: Refiner's Certificate Data Summary

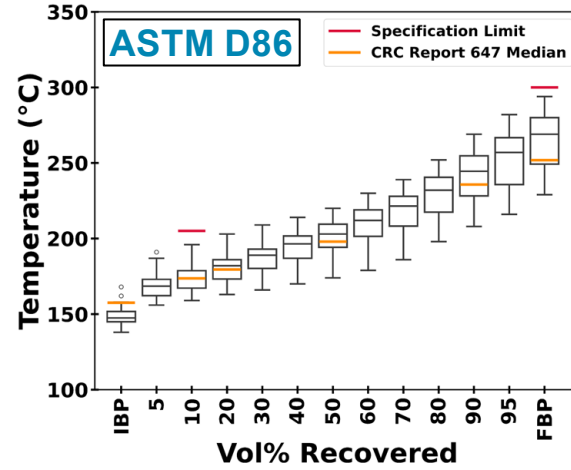
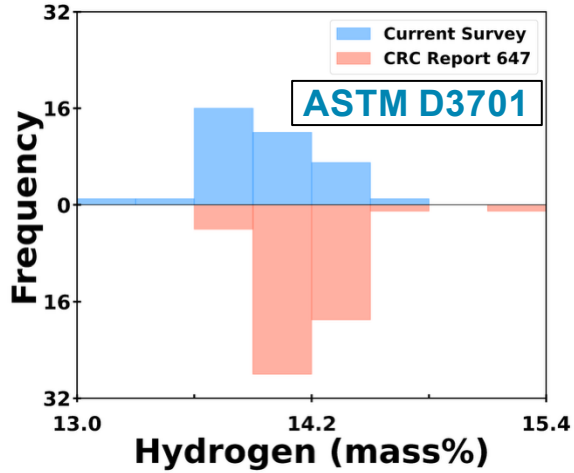
- Reported by **grade**, e.g., Jet A and Jet A-1; tabulated statistics and histograms for comparison

Table 2. Statistics for Jet A CoA data compared to specification limits from ASTM D1655.

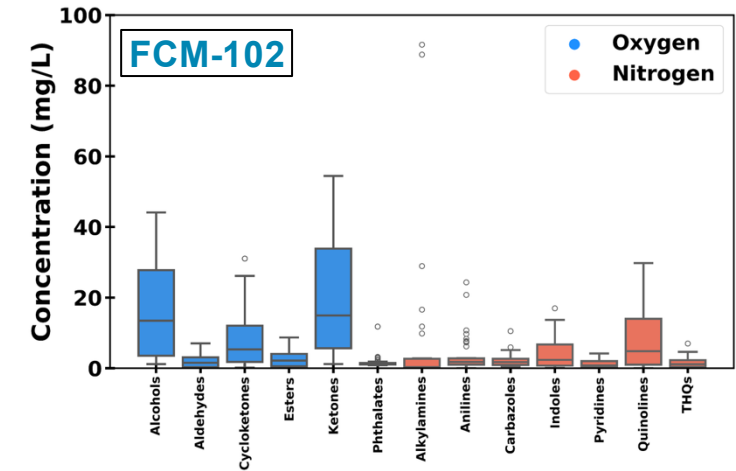
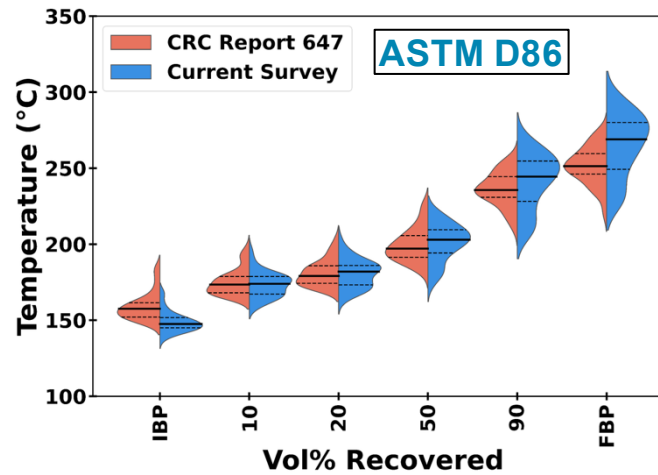
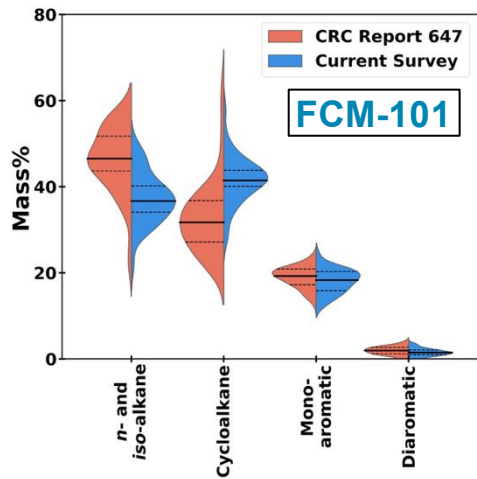
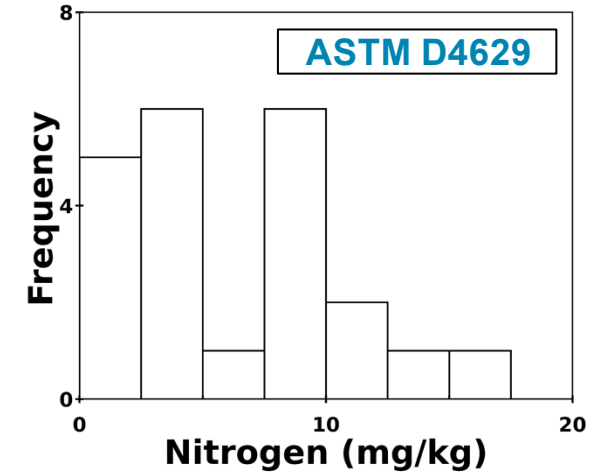
Property	Specification Limits		Jet A CoA Data				
	Min	Max	Min	Max	Mean	Weighted Mean	Count
Acidity (mg KOH/g)	N/A	0.10	0.00	0.02	0.00	0.00	23
Aromatics (vol%)	N/A	25	10	22	16	17	23
Mercaptan Sulfur (mass%)	N/A	0.003	0.000	0.003	0.001	0.001	17
Total Sulfur (mass%)	N/A	0.30	0.00	0.21	0.05	0.06	23
10 vol% Recovered (°C)	N/A	205	158	196	176	175	23
50 vol% Recovered (°C)	Report		192	220	207	208	22
90 vol% Recovered (°C)	Report		221	286	250	250	23
Final Boiling Point (°C)	N/A	300	249	330	276	276	23
Residue (%)	N/A	1.5	0.8	1.3	1.1	1.2	14
Loss (%)	N/A	1.5	0.0	1.3	0.5	0.5	14
Flash Point (°C)	38	N/A	41	58	47	45	23
Density at 15°C (kg/m ³)	775	840	793	816	805	806	15
Freezing Point (°C)	N/A	-40	-62	-40	-50	-49	23
Viscosity at -20°C (mm ² /s)	N/A	8.0	3.6	6.2	4.8	4.8	22
Net Heat of Combustion (MJ/kg)	42.8	N/A	43.0	43.5	43.2	43.2	23
Smoke Point (mm)	18.0 or 25.0	N/A	18.9	28.1	23.1	23.0	23
Naphthalenes (vol%)	N/A	3.0	0.2	2.0	1.0	1.1	23
Thermal Stability Filter Pressure Drop (mmHg) ¹	N/A	25	0	3	0	0	23
Existent Gum (mg/100 mL)	N/A	7	1	4	2	1	23
Microseparator Rating Without Electrical Conductivity Additive	85	N/A	99	99	99	99	1
Microseparator Rating With Electrical Conductivity Additive	70	N/A	94	100	98	98	21
Electrical Conductivity (pS/m) ²	50	600	0	292	87	24	10



CRC AV-33-22—WJFS (Part 1) Report: **Fit-for-Purpose Data Summary**

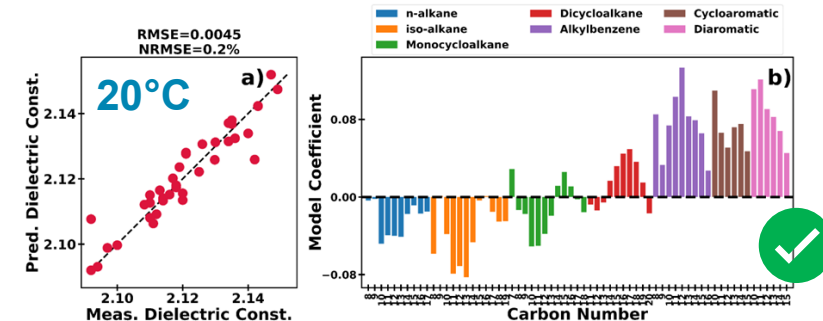
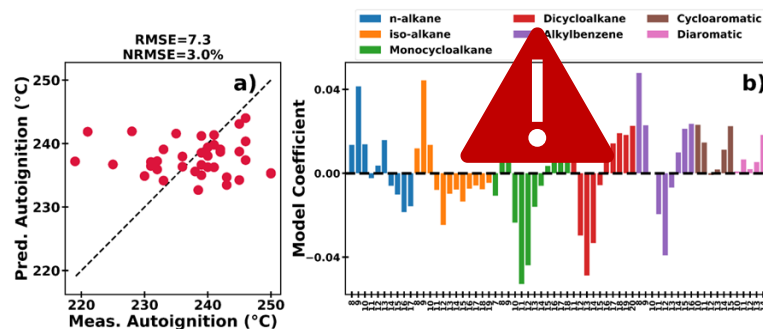
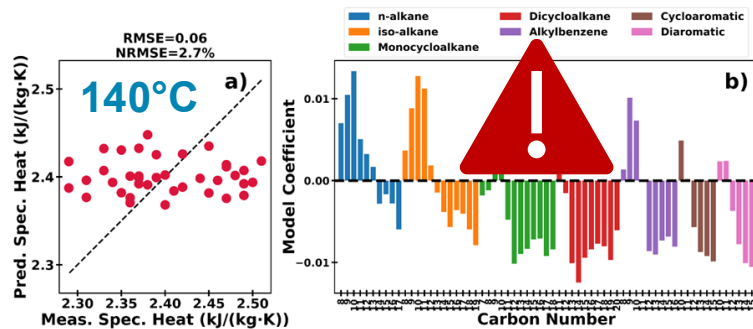
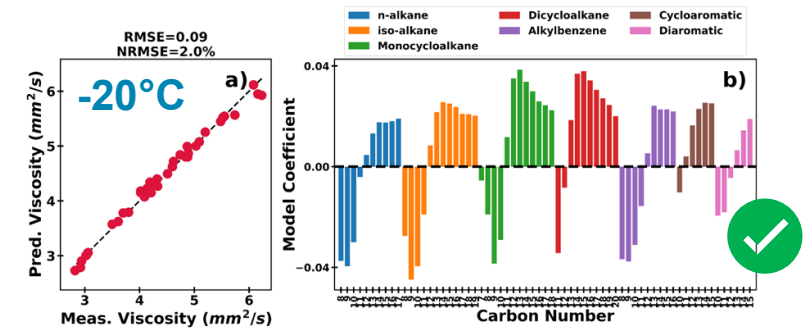
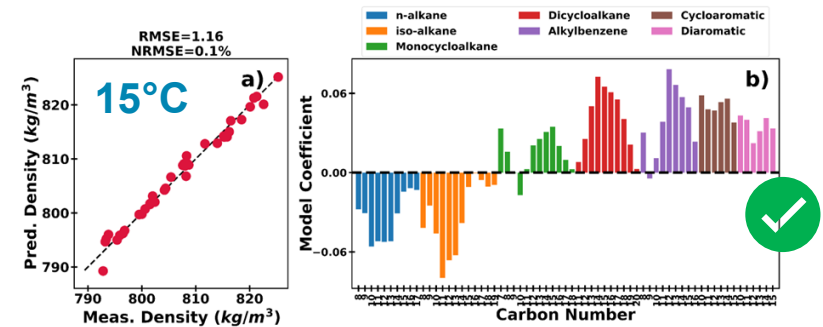


- Comparisons by survey (when available); tabulated, split violin, histogram, & box plots
- 10 new/updated FFP property data collected



CRC AV-33-22—WJFS (Part 1) Report: Composition-to-Property Summary

- Models trained using partial least squares (PLS) regression
 - Demonstrate a quantitative composition-property relationship (QCPR)
- Identify correlations between properties and composition
 - Good model performance → model coefficients provide insight into fuel chemistry
 - Poor model performance → experimental method development and/or more advanced modeling techniques are required
- Planned: detailed briefing at IASH Sept 2026



ASTM Task Force AC935: Update D4054 “Basis of Experience”

CONTRIBUTION TO INDUSTRY



Contribution to Industry

- Major driver for this work was to update ASTM D4054 “Basis of Experience”
 - Planning to update existing 11 figures + add 1 new plot (distillation)
- ASTM Task Force AC935
 - Est. December 2025 (Anaheim, CA)
 - Met on 2-April-26
 - Plan to brief at June 2026 (Chicago, IL)
 - Ballot change ~next semester

Figure	Property
A1.1	Viscosity
A1.2	Lubricity vs Additive
A1.3	Specific Heat
A1.4	Density
A1.5	Surface Tension
A1.6	Bulk Modulus
A1.7	Thermal Conductivity
A1.8	Density vs Dielectric Constant
A1.9	Conductivity vs Additive
A1.10	Air Solubility
A1.11	Vapor Pressure



Figure A1.1: Viscosity

Updates: Figure (data + visualization) and Table 2 (comments)

Supporting Information

Box plot data is from CRC Report 647 (ASTM D455, measured at -40, -20, and 20°C) and CRC AV-33-22 (ASTM D7042, measured at all depicted temperatures). The horizontal lines represent the 1st and 99th percentile from the API Jet Fuel Survey 2022 (ASTM D445, D7042, D7945, and IP 71, measured at -20°C). The dashed and dash-dot lines were calculated using the equations for Figure 2-8 in the CRC Handbook (CRC Report 663).

CURRENT

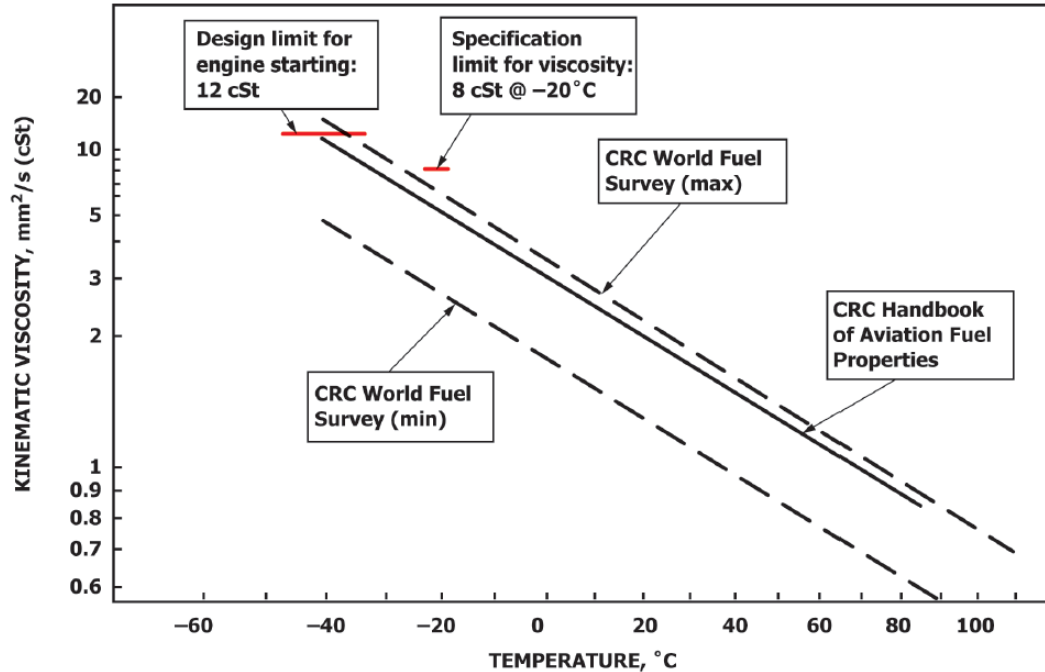
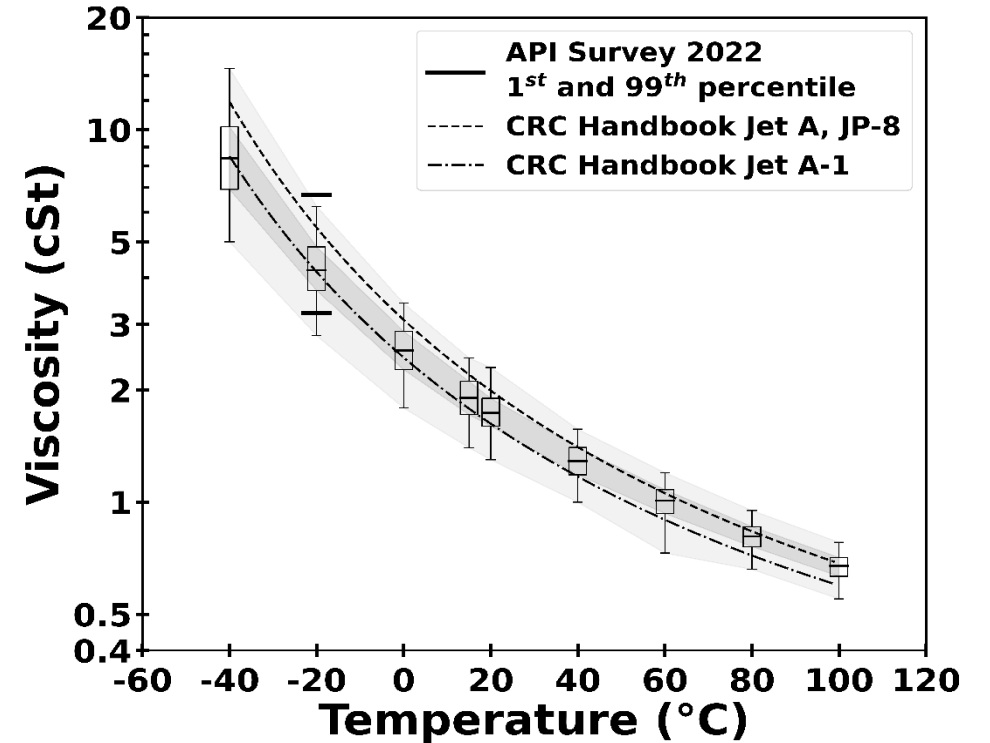


FIG. A1.1 Typical Viscosity Characteristics of Jet Fuel

– Table 2, comment:

Plot viscosity at -40 °C (or freezing point plus 5 °C, whichever is higher), -20 °C, 25 °C, and 40 °C. See Fig. A1.1 for typical values.

PROPOSED



– Table 2, comment:

– Plot viscosity from at least -40°C to 40°C at multiple temperatures. See Fig. A1.1 for typical values.

Figure A1.2: Response to CI/LI Additive

Updates: Figure (data + visualization)

Supporting Information

The scatter plot data on the left was taken from CRC Report AV-2-04a "Comparative Evaluation of Semi-Synthetic Jet Fuels." The histogram on the right represents combined data from CRC Report 647 and CRC AV-33-22 on fuels as received (additive concentration is not known). Measurements from both CRC Report 647 and CRC AV-33-22 were taken via ASTM D5001.

CURRENT

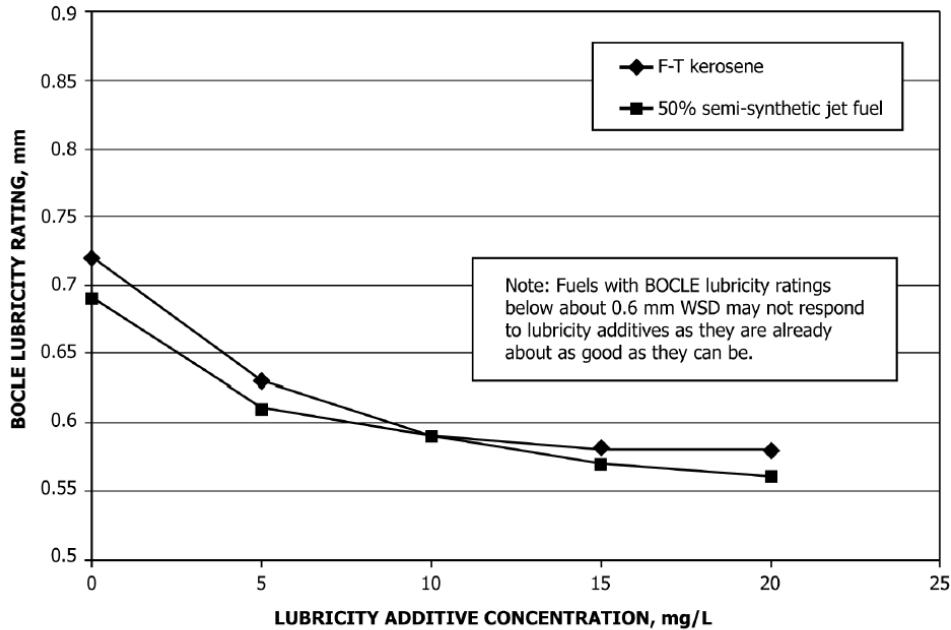


FIG. A1.2 Typical Response to Corrosion Inhibitor/Lubricity Improver (CI/LI) Additive

PROPOSED

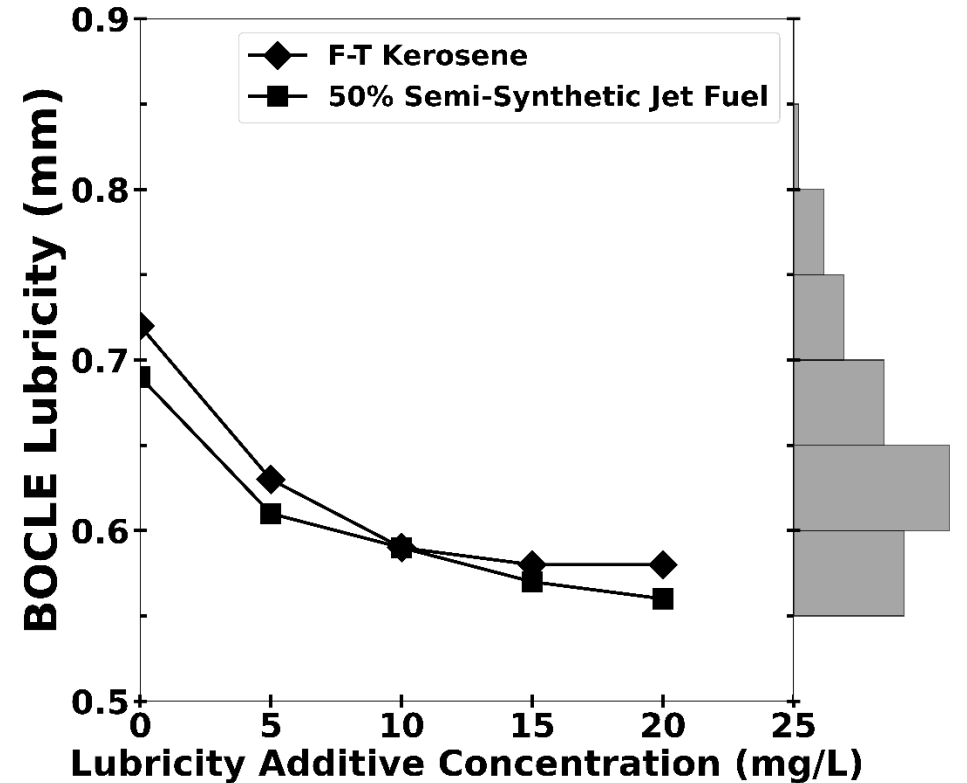


Figure A1.3: Specific Heat Capacity

Updates: Figure (data + visualization) and Table 2 (method)

Supporting Information

Box plot data is from CRC AV-33-22, which used ASTM E2716. The dashed lines was calculated using the equation for Figure 2-14 in the CRC Handbook (CRC Report 663).

CURRENT

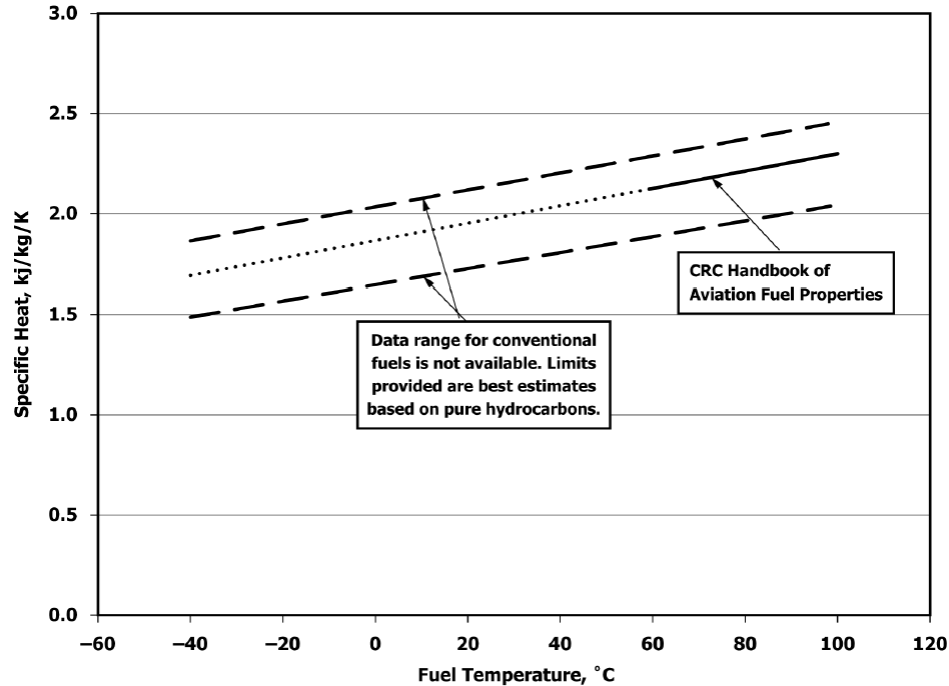
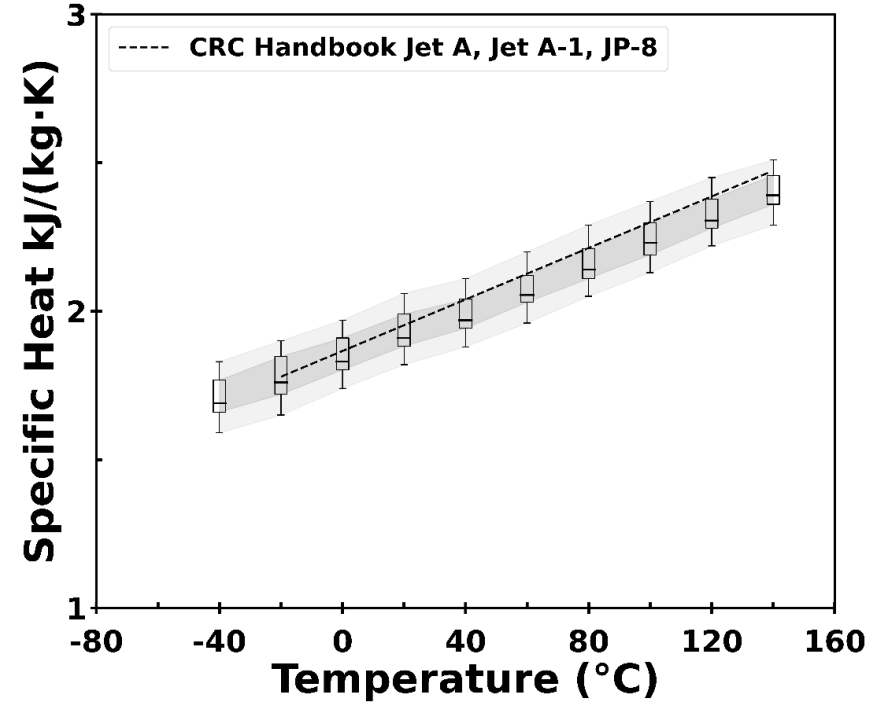


FIG. A1.3 Typical Specific Heat Characteristics of Jet Fuel

- Table 2, method:
- ASTM E1269

PROPOSED



- Table 2, method:
- ASTM E1269 or E2716

Figure A1.3: Density

Updates: Figure (data + visualization)

CURRENT

PROPOSED

Supporting Information

Box plot data is from CRC Report 647 (Solartron densitometer) and CRC AV-33-22 (ASTM D4052). The horizontal lines represent the 1st and 99th percentile from the API Jet Fuel Survey 2022 (ASTM D4052). The dashed and dash-dot lines were calculated using the equations for Figure 2-1 in the CRC Handbook (CRC Report 663). CRC Report 647 had variable density measurement temperatures spanning from -39 to 71°C. The density values from CRC Report 647 were linearly interpolated or extrapolated to -40, -20, 0, 15, 20, 40, and 60°C for each fuel. The R2 values for the density versus temperature linear fit were ≥ 0.996 for all the fuels. CRC AV-33-22 had density reported at all the temperatures depicted above and therefore did not require interpolation or extrapolation. CRC AV-33-22 had R2 values ≥ 0.999 . API Jet Fuel Survey 2022 had density reported at 15°C.

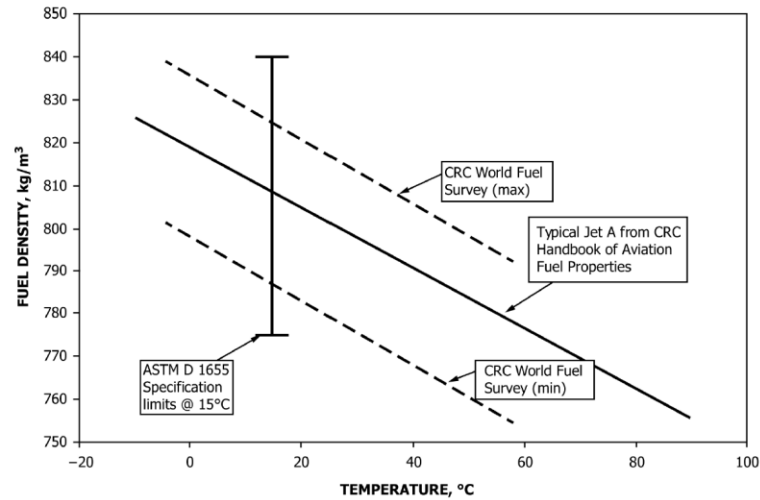


FIG. A1.4 Typical Density Characteristics of Jet Fuel

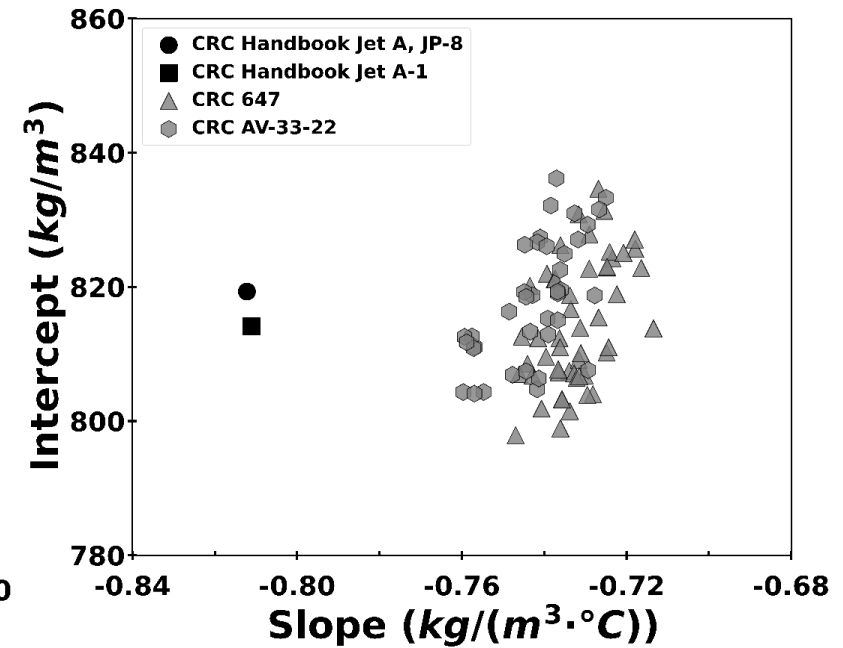
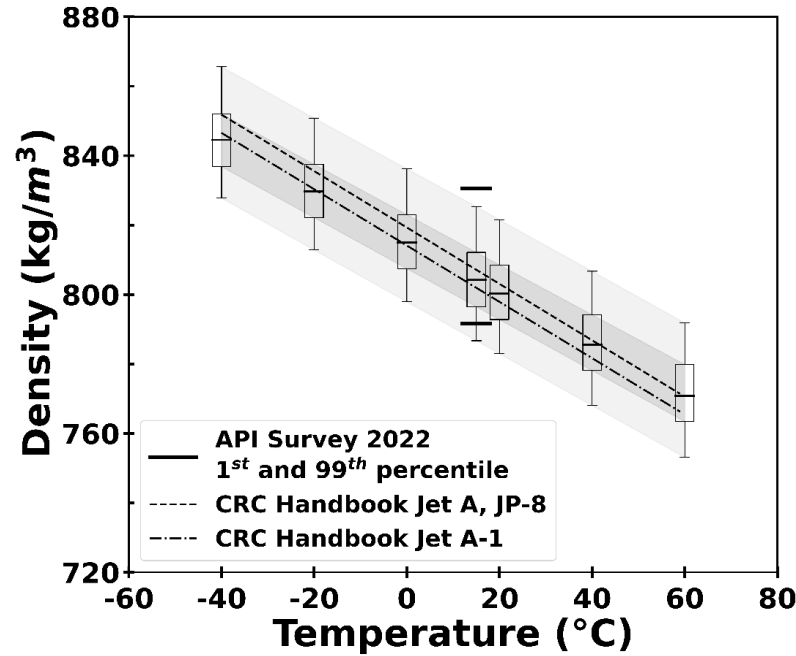


Figure A1.5: Surface Tension

Updates: Figure (data + visualization)

CURRENT

PROPOSED

Supporting Information

Box plot data is from CRC Report 647 (ASTM D971) and CRC AV-33-22 (ASTM D1331). The dashed and dash-dot lines were calculated using the equations for Figure 2-9 in the CRC Handbook (CRC Report 663). CRC Report 647 had surface tension measured at -10°C, 22.2°C (72°F), and 40°C. The surface tension values from CRC Report 647 were linearly interpolated from 22.2°C to 22.0°C. The R2 values for the surface tension versus temperature linear fit were ≥ 0.92 , excluding four fuels with R2 values below 0.90 that were dropped before plotting. CRC AV-33-22 had surface tension reported at -10°C, 25°C, and 40°C. Surface tension values from CRC AV-33-22 were linearly interpolated from 25°C to 22°C. The R2 values for the surface tension versus temperature linear fit were ≥ 0.96 for all the fuels.

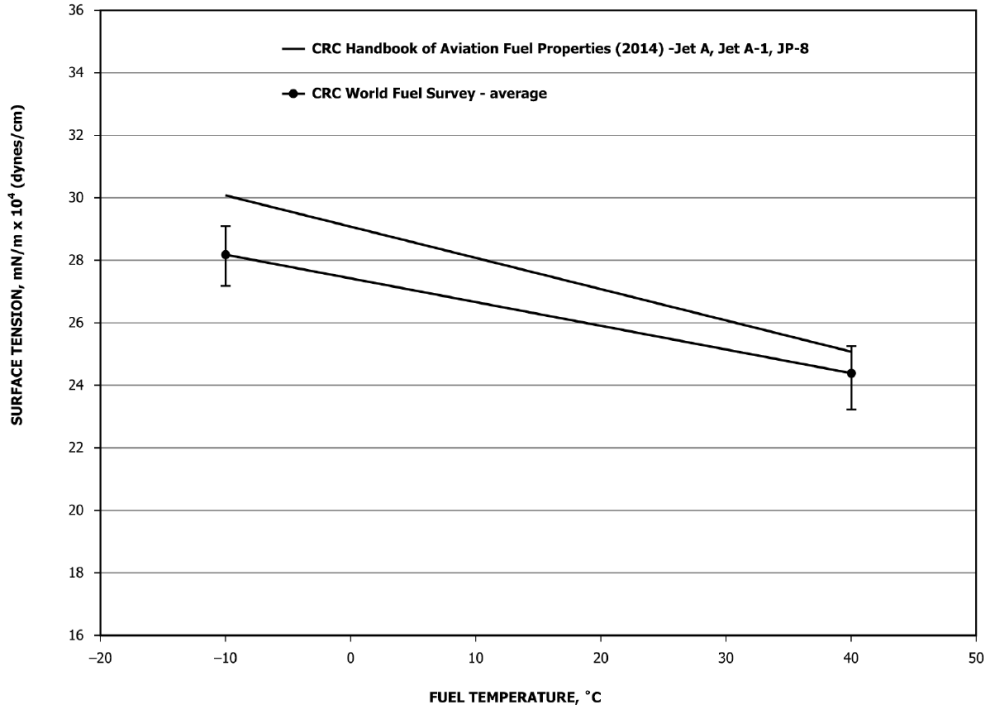


FIG. A1.5 Typical Surface Tension Characteristics of Jet Fuel

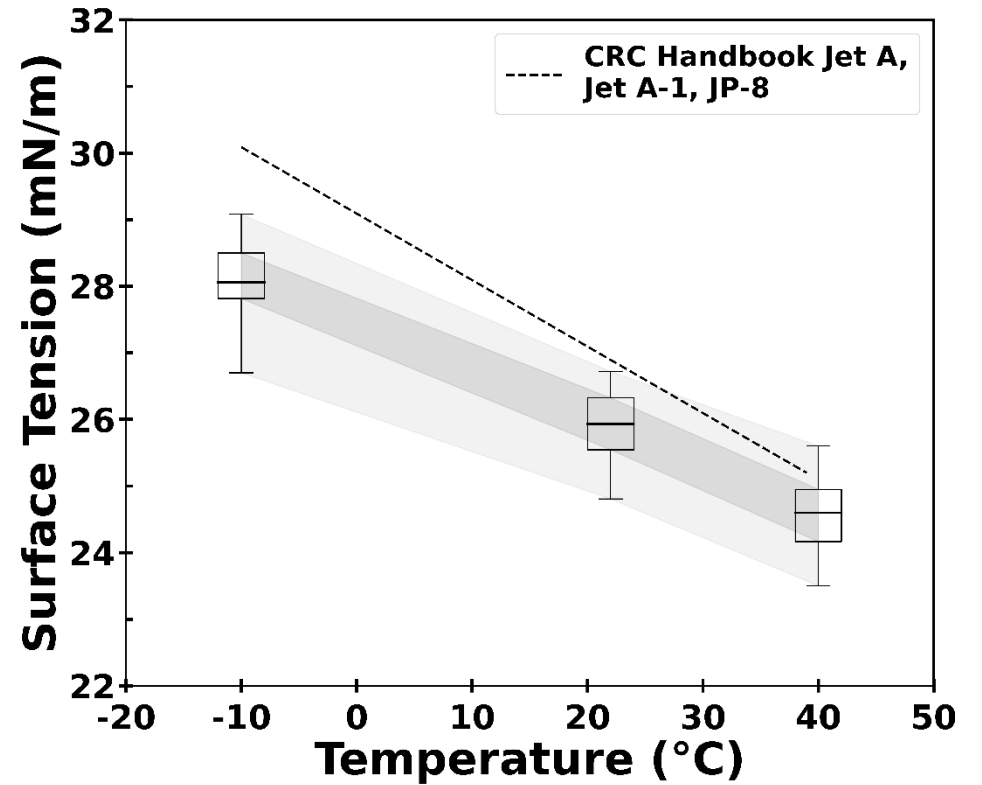


Figure A1.6: Bulk Modulus

Updates: Figure (data + visualization) and Table 2 (method)

Supporting Information

Box plot data is from CRC AV-33-22 which used FED-STD-791 Method 7507. The bold horizontal lines represent the minimum and maximum values calculated using the equations for Figure 2-27 in the CRC Handbook (CRC Report 663) at pressures of 7, 14, 21, and 28 MPa and temperatures of 75°C and 35°C.

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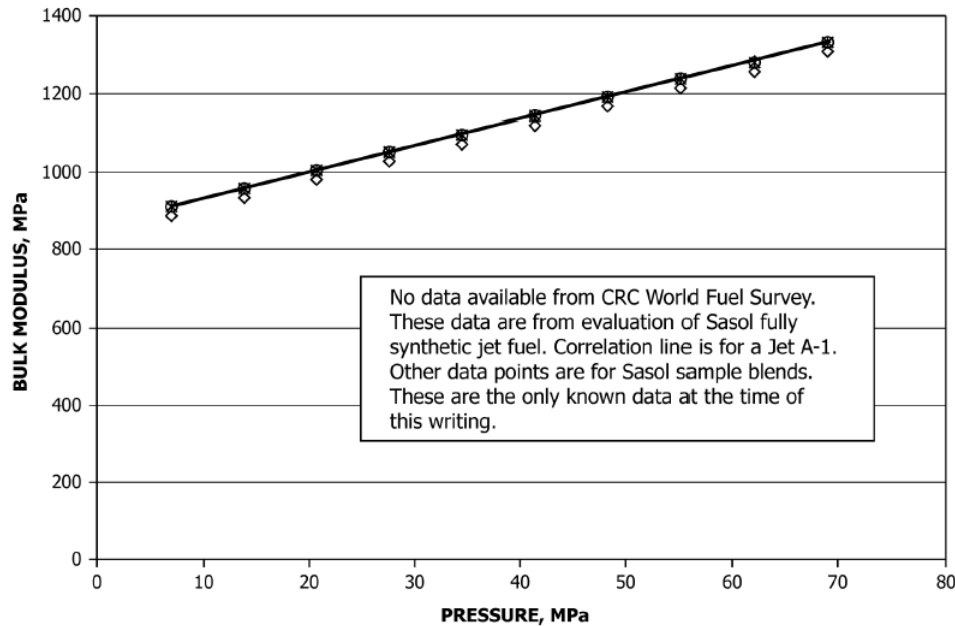
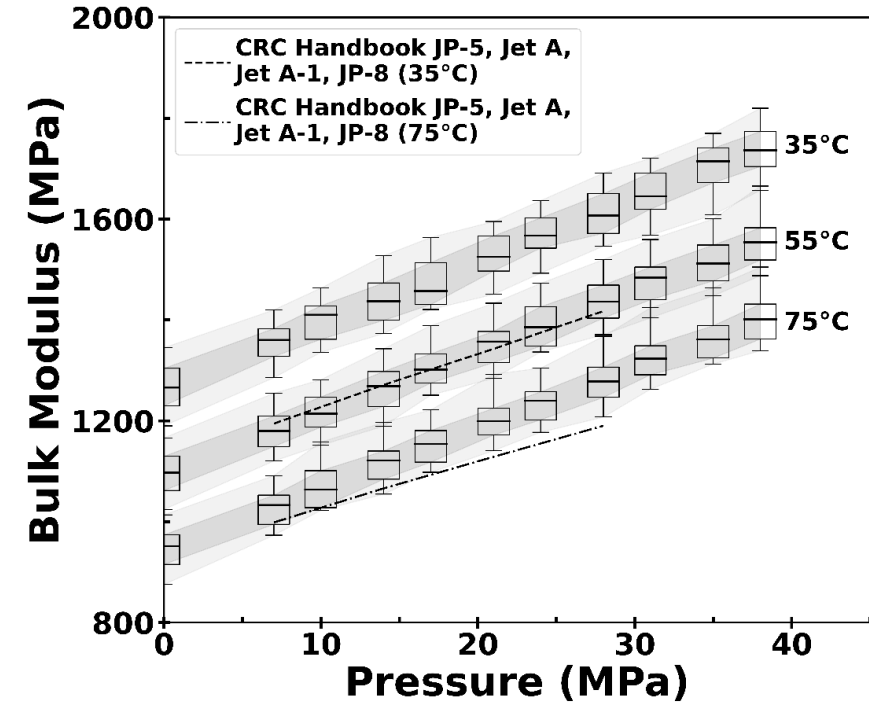


FIG. A1.6 Bulk Modulus Characteristics

- Table 2, method:
 - ASTM D6793 (withdrawn)

PROPOSED



- Table 2, method:
 - Federal Standard 791, Method 7507

Figure A1.7: Thermal Conductivity

Updates: Figure (data + visualization) and Table 2 (method)

Supporting Information
 Box plot data is from CRC AV-33-22 which used ASTM D7896. The dashed line was calculated using the equation for Figure 2-16 in the CRC Handbook (CRC Report 663).

CURRENT

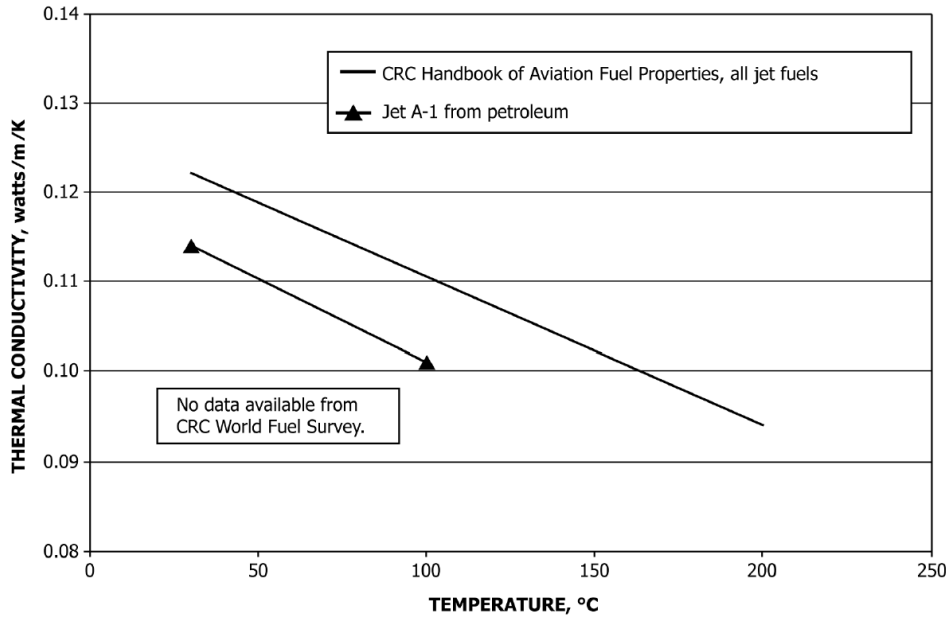
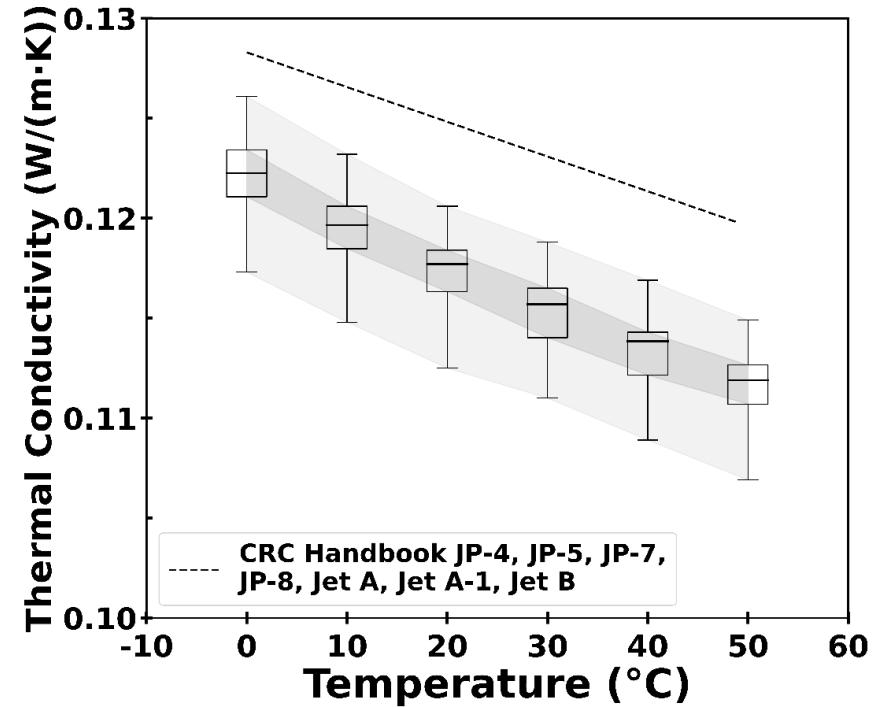


FIG. A1.7 Typical Thermal Conductivity Characteristics of Jet Fuel

- Table 2, method:
- ASTM D2717

PROPOSED



- Table 2, method:
- ASTM D2717 or D7896

Figure A1.8: Density vs Dielectric Constant

Updates: Figure (data + visualization)

Supporting Information

Scatter plot data is from ARINC 611 (K-cell, measured from -46 to 26°C), CRC Report 647 (K-cell, measured from -39 to 71°C), and CRC AV-33-22 (IP 638, measured from 10 to 30°C). The dashed and dash-dot lines represent the density and dielectric constant values calculated from -40°C to 71°C using the equations for Figures 2-1 and 2-20 in the CRC Handbook (CRC Report 663).

CURRENT

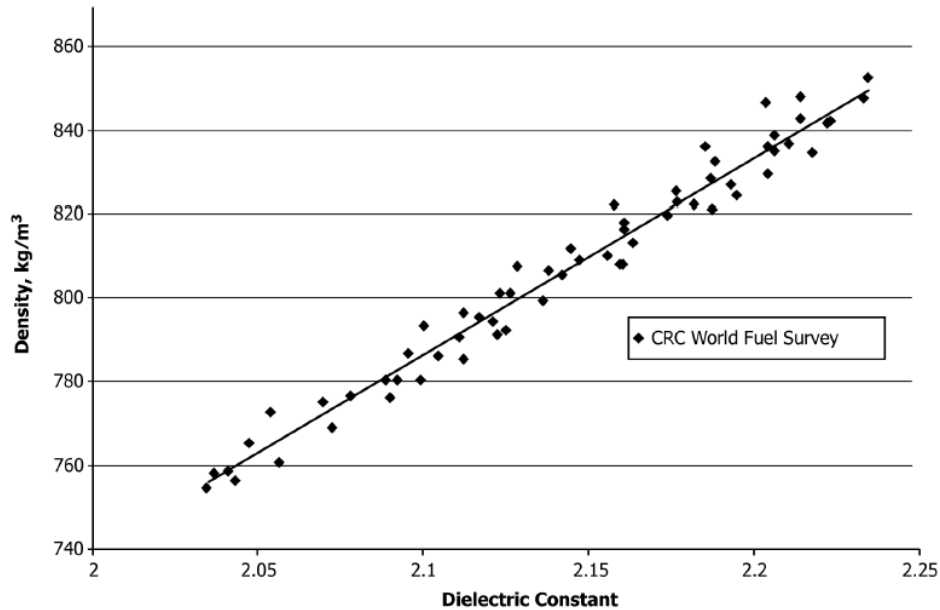


FIG. A1.8 Typical Dielectric-Density Characteristics for Jet Fuel

PROPOSED

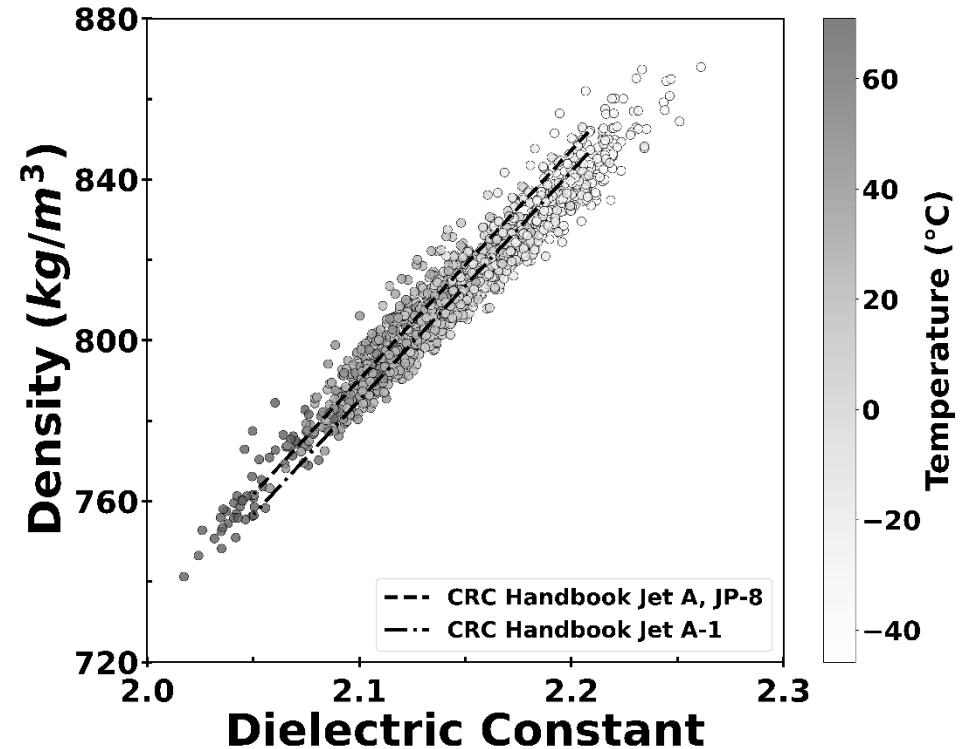


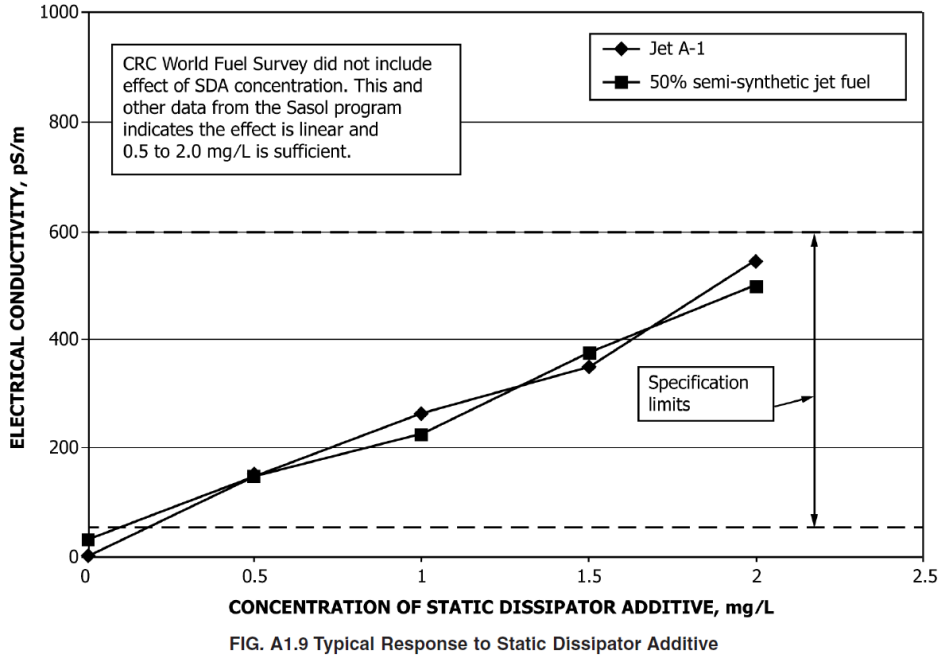
Figure A1.9: Response to SDA

Updates: Figure (data + visualization)

Supporting Information

The scatter plot data on the left was taken from CRC Report AV-2-04a "Comparative Evaluation of Semi-Synthetic Jet Fuels." The histogram on the right represents combined data from CRC Report 647 (ASTM D2624, measured at 22°C), CRC AV-33-22 (ASTM D2624, measured at 22 ± 5°C), and API Jet Fuel Survey 2022 (ASTM D2624 and IP 274, temperature not specified) where the concentration of static dissipator additive is not reported for most fuels.

CURRENT



PROPOSED

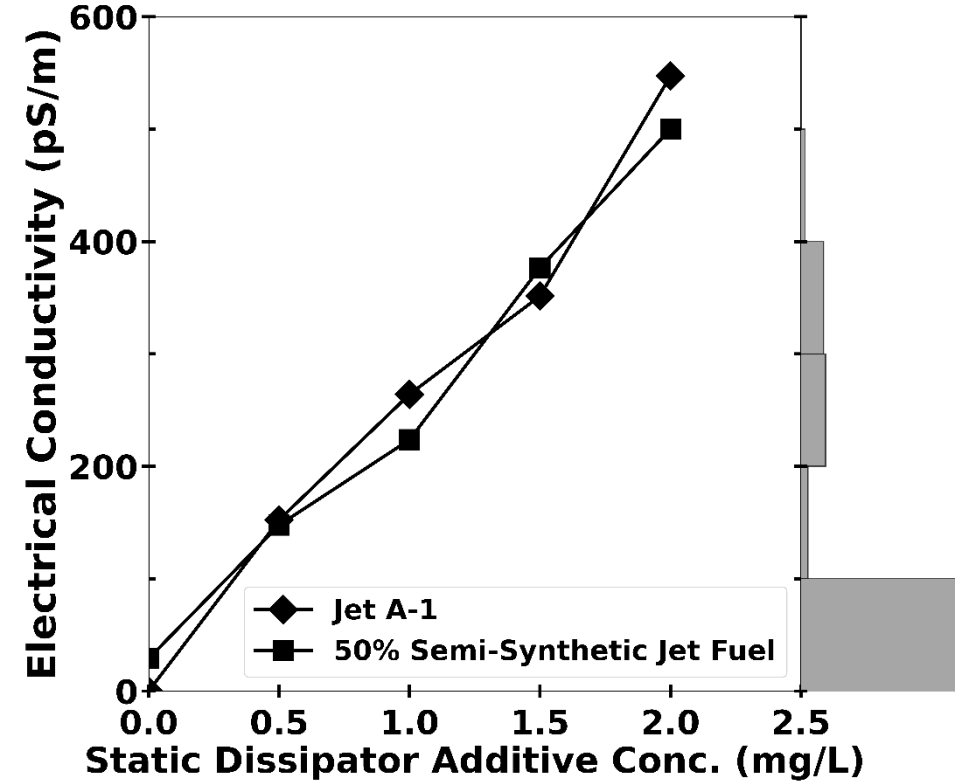


Figure A1.10: Air Solubility

Updates: Figure (data + visualization) and Table 2 (method)

Supporting Information

Data was taken from AFRL-RQ-WP-TR-2020-0017 and CRC AV-33-22. Both sources measured air solubility using UDRI FC-M-103.

CURRENT

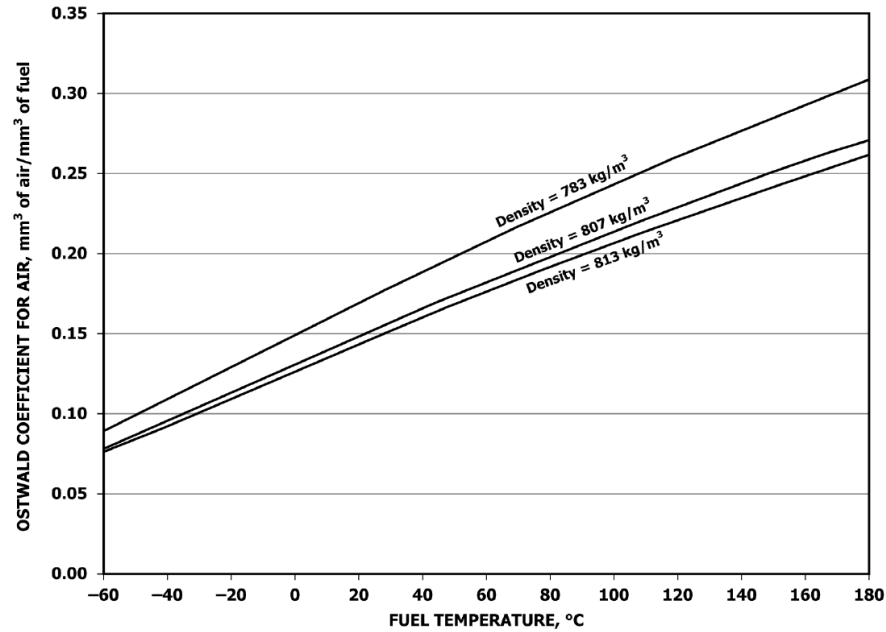


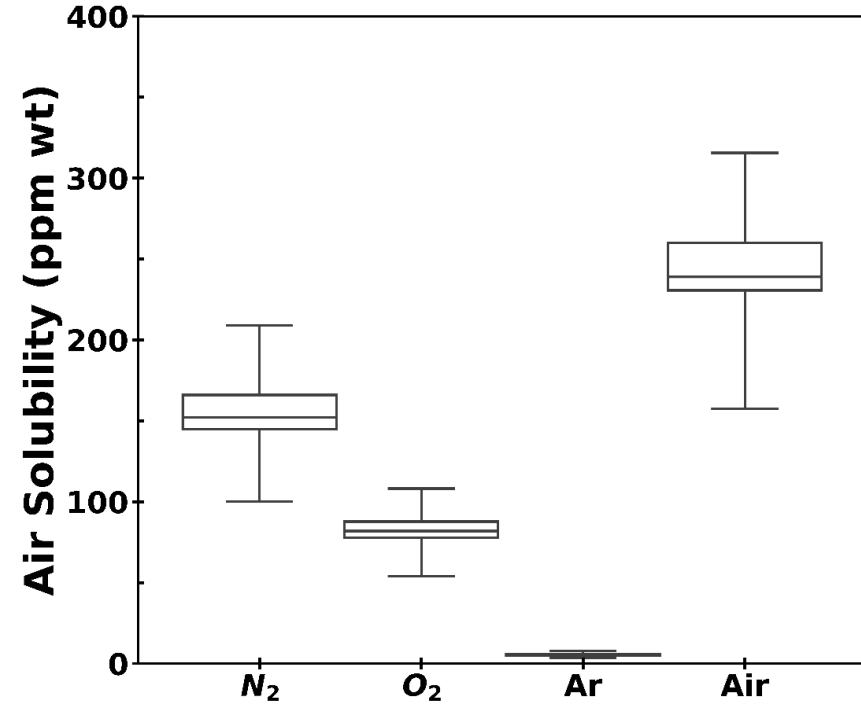
FIG. A1.10 Typical Air Solubilities Based on Least and Most Dense Fuels for which Engines are Designed

– Table 2, method:

– None given...

Ostwald & Bunsen
Coefficient (mm³ of gas/
mm³ of fuel)

PROPOSED



– Table 2, method:

– UDRI FCM-103

Figure A1.11: Vapor Pressure

Updates: Figure (data + visualization)

Supporting Information

Box plot data is from CRC AV-33-22, which had vapor pressure measured via ASTM D6378. Fuels with 0 kPa vapor pressure (20 of 38 fuels at 0°C) were dropped before plotting. The dashed line was calculated using the equation for Figure 2-12 in the CRC Handbook (CRC Report 663).

CURRENT

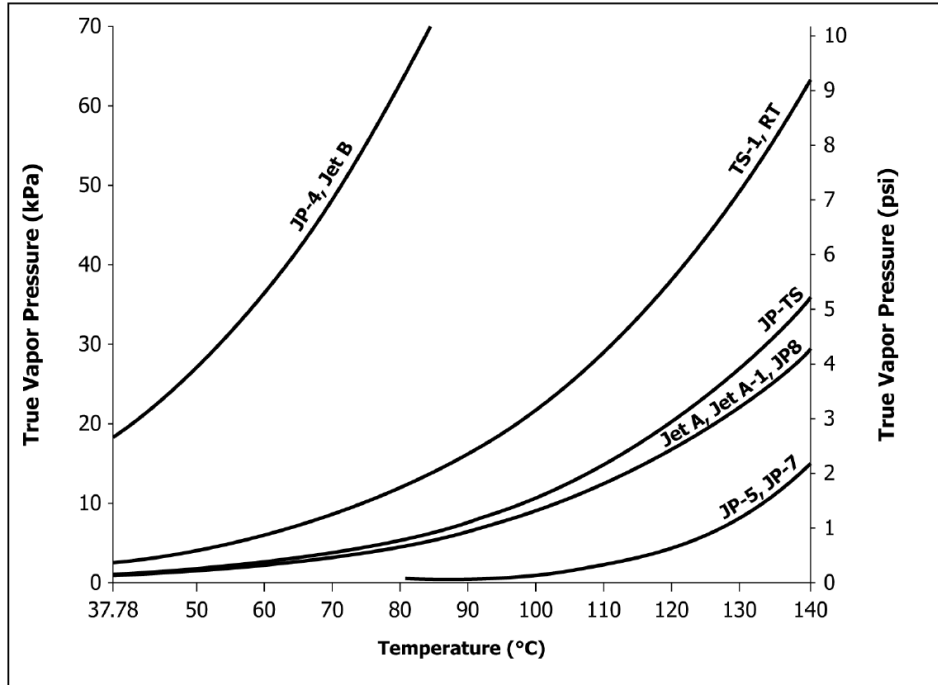
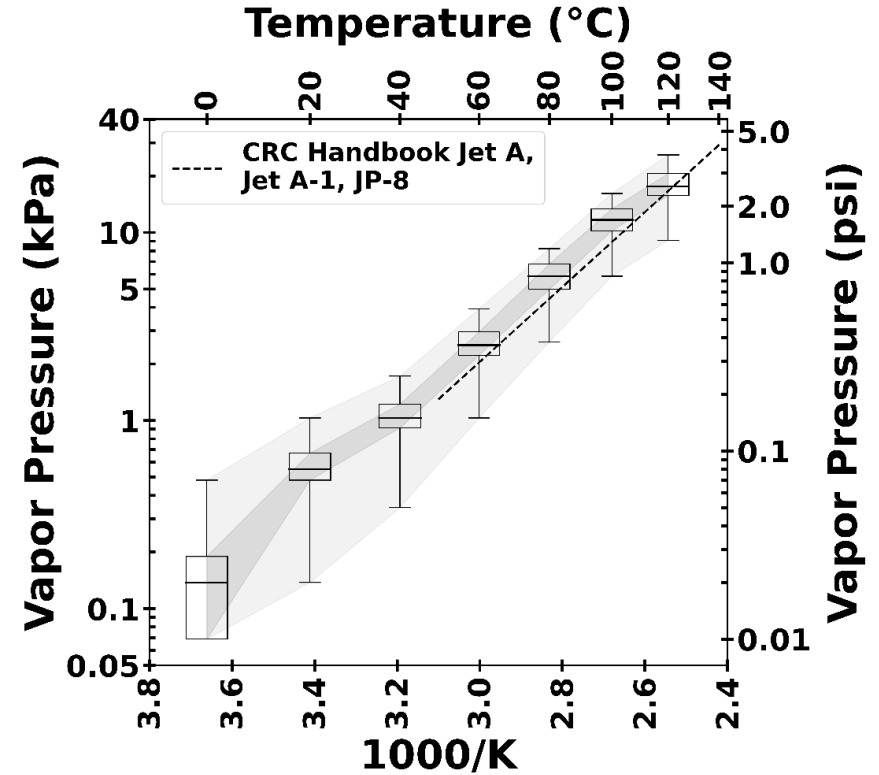


FIG. A1.11 Typical True Vapor Pressure of Jet Fuel

PROPOSED



[New] Figure A1.12: Distillation

Updates: Figure (data + visualization)

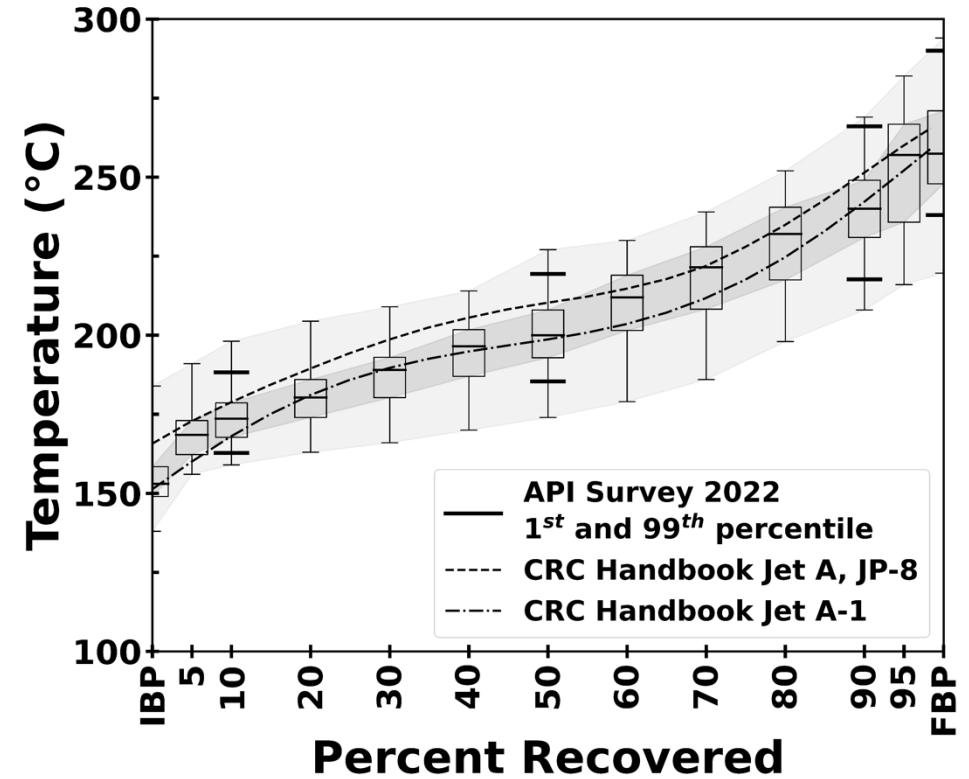
CURRENT

BULK PHYSICAL AND PERFORMANCE PROPERTIES				
Boiling point distribution	ASTM D86	°C		
Initial Boiling Point		°C	Report	
10 % Recovery (T10)		°C	150	205
20 % Recovery		°C	Report	Report
30 % Recovery		°C	Report	Report
40 % Recovery		°C	Report	Report
50 % Recovery (T50)		°C	165	229
60 % Recovery		°C	Report	Report
70 % Recovery		°C	Report	Report
80 % Recovery		°C	Report	Report
90 % Recovery (T90)		°C	190	262
Final Boiling Point		°C		300
T50 - T10		°C	15	—
T90 - T10		°C	40	—
Simulated Distillation	ASTM D2887		Report Full Range	

PROPOSED

Supporting Information

Box plot data is from CRC Report 647 (ASTM D86) and CRC AV-33-22 (ASTM D86). The solid lines with dots represent the 1st and 99th °C from the API Jet Fuel Survey 2022 (ASTM D86). The dashed and dash-dot lines were calculated using the equations for Figure 2-10 in the CRC Handbook (CRC Report 663). CRC Report 647 had distillation reported at 0, 10, 20, 50, 90, and 100% recovered, while CRC AV-33-22 had distillation reported at all the percent recovered values depicted.



Summary

- First tranche of data is PUBLISHED
 - Report CRC AV-33-22 available online: <https://crcao.org/crc-project-no-av-33-22/>
- Next steps
 - Work through ASTM Task Force AC635 to Update ASTM D4054
 - Continue with fuel/data collection → increased samples to ensure proper knowledge base scope captured (iterate D4054 update)
- Future direction
 - Entertaining additional ideas, e.g., survey SBCs, downstream sampling...



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