Marathon Petroleum Troubleshooting Guide for Jet Fuel Thermal Stability

Last Update 05/14/18

Typical Causes to Jet Fuel Thermal Stability Degradation/Failure	Testing	Concernable Levels/Commentary
Low Level Metals	ICP/MS for Cu, Cd, Zn, Fe, Co, Pb	**Copper** Levels between 10-50 ppb can degrade D3241 Tube Ratings ; above 50 ppb copper, failures can be expected. Literature cites the other metals concern level can vary but in general >100 ppb in concert with appreciable copper can cause issue. Sources of metals can be from feedstocks, refinery heat exchangers, sampling devices, and etc.
Reactive Sulfur and Nitrogen Species	D4629 or D5762 for total Nitrogen; Nitrogen Speciation(Chromatography/Chemilescence method). D5453, D2622, D4294 for total Sulfur Content; Sulfur Speciation is D5623	Literature shows that at ≥ 100 ppm nitrogen thermal stability issues could occur. But even lower levels of 10-50 ppm in combination with copper, acids, and/or certain reactive sulfur compounds may cause D3241 degradation; Jet Fuel derived from shale oil can contain very high levels of nitrogen. Amines, related to H2S Scavenger additives, should not be present but could contribute to thermal stability degradation.
	Determine Basic Nitrogen Content of Jet Fuel after Acid wash. Basic Nitrogen can be determined by initially determining the Nitrogen Content and subtracting the Nitrogen Content after acid washing of the Jet Fuel.	Book by Robert N. Hazlett, "Thermal Oxidation Stability of Aviation Turbine Fuels" discusses possible negative interaction between certain classes of nitrogen and sulfur containing compounds
Microbes	See D6469	Low molecular weight acids produced by microbial activity can negatively impact thermal stability. Source refinery, barge compartments, and terminal tanks should be considered. Test for aerobic and anaerobic bacteria
Other Possible Causes to Thermal Stability Degradation/Failure	**Testing**	**Comment**
Low Levels of Red Dye	D6756 or D6258	CRC Report 639 shows that at 1 ppm red dye D3241 failures occurred and that at <0.4ppm red dye the fuel passes D3241
FAME	IP 585, IP 590, IP 599, or D7797	Levels of >400ppm FAME could be detrimental to D3241 tube ratings
Polynuclear Aromatics	HPLC	Jet Fuel/Kero typically contains only iso-paraffins and 1 and 2-Ring aromatics but not 3-4 ring aromatics
Organic Contamination	GCMS	GCMS is semi-quantitative but can be used to analyze for the presence of organic materials atypical to Jet Fuel. For example, high levels of phenolic compounds (>400 ppm), unapproved additives, diesel, gasoline, and etc.

Unapproved Additives	GCMS	Exxon reported at the December 2017 ASTM meetings that cetane improver additive (2-ethylhexyl nitrate) could negatively impact JFTOT ratings. Accidental injection or pipeline trailback could be sources of 2-EHN.
Chlorinated Solvents	D7359, Standard Test Method for Total Fluorine, Chlorine and Sulfur in Aromatic Hydrocarbons and Their Mixtures by Oxidative Pyrohydrolytic Combustion followed by Ion Chromatography Detection	There have been issues with failing D3241 linked to chlorinated solvents used to clean barges
MDA Depletion	Additive supplier would have specific test for the presence of MDA (N,N-disalicylidiene-1,2 propane diamine)	Refiners and distributors are required to report MDA usage per D1655, Table 2 Note "D 1-4" and API 1595 Section 15.3.4. **There is possibility that MDA could be "lost" or depleted on metal across the distribution system.
Phosphorus Content	ICP	>1 ppm offers a concern. Past work shows that phosphorus can contribute to increased fouling rates, expecially in kerosene range products. Source potentially being in drilling mud additives used in shale oil extractions
Jet Fuel Processing Scheme		Processing of jet fuel could consist of hydrocracking, hydrotreating, caustic treating, acid washing, lead sweetening techiniques, and others. ***It is important to understand the possible concerns with these processing methods***
Pb Content	ICP/MS	Specific to the lead-sweetening process, Pb content should be analyzed as literature does indicate levels > 200ppb could be cause for D3241 concern
Olefin Content	D1159 Bromine # and or D1319 FIA for Olefin Content	Bromine #s <1.0 are considered acceptable. Olefin content of <1.5% is typical
Di-Olefin Content	D2163; **Capable to analyze up to C14	Di-olefin content should be considered as presence could cause/contribute to D3241 failures
Sampling devices, sample spigot/taps and fitting construction	ICP/MS test for metals	***Ensure sampling devices do NOT have a copper component (no brass) and that metallic based thread sealers are NOT used .*** Some metallic based thread sealers contain Copper, Lead, and/or Zinc which are all known detriments to thermal stability
Barge Priors, Pipeline Head-end and Tail-end wraps		Always consider barge priors or PL movements not only to include the commodity but also source tank of priors and additives which may have been used. ***<u>Per EI 1530, NEVER use a new barge for first shipment of Jet Fuel.</u>***
Determine what feedstocks are being used and if change has occurred	Crude, Condensate, Cracked Stocks, Alternative Jet Fuel (D7566), other	Depending on the feedstocks and level of hydrotreating or processing scheme used, some low level of the aformentioned materials may be present in the final jet fuel

Determine what D3241 testing instrument was used	See Table 1 of D3241	The equivalency of the various JFTOT thermal stability instruments is undergoing further evaluation