



Cleaning Crude Oil Tank Cars for Denatured Fuel Ethanol Service

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Introduction:

For nearly 30 years, legacy DOT-111A tank cars typically have remained in ethanol dedicated service, meaning there was continual transport of identical product. Recently affecting the industry standard of a dedicated ethanol rail fleet, the legacy DOT-111A tank car, the most common type of general-purpose tank car, has been utilized for transporting crude oil and unrefined products between oil shale and tar sands production areas and crude oil refineries. This is especially prominent in fracking areas, where in most cases, there is no access to oil refinery supply pipelines, the historical transportation mode for crude oil. Prior to 2010, commodities that were identified by RFA as acceptable prior commodities for denatured fuel ethanol included: ethanol, denatured fuel ethanol, gasoline and gasoline components; (e.g. unleaded gasoline, unleaded RBOB, unleaded CBOB, unleaded CARBOB, and natural gasoline) all fully refined products. Recently, RFA received a request from the industry to assist with the development of guidelines for preparing tank cars previously in crude oil service for future denatured fuel ethanol service.

One way to understand the great difference in these two commodities: crude oil is a feedstock that will undergo intensive processing; denatured fuel ethanol is a fully refined product ready for blending with gasoline to produce fuel for consumer vehicle's gas

tanks. One tank car full of denatured fuel ethanol, when blended with gasoline, could fill up 14,500 cars.

Physical, Chemical Comparison: Crude Oil, Ethanol

An important first consideration: petroleum crude oil is a very different product than denatured fuel ethanol. Crude oils vary greatly in viscosity and composition, ranging from light thru medium ending with heavy and extra heavy designations. The common rating system for crude oil uses the API gravity scale (a scale from 0-140, with 0 being the heaviest density). Light crudes are expected to have an API gravity greater than 31.1; Canadian tar sand crude oil is expected to have an API gravity of <20, Asphalt on average has an API gravity of 8.

Crude oils contain varying concentrations of tars and waxes which have no solubility in water. The following is a general designation of crude oils from Petroleum.co.uk:

- Denatured Fuel Ethanol- API Gravity ~50
- Gasoline- API Gravity 40-50
- Light Crude – API gravity > 31.1
- Medium Crude – API gravity between 22.3 and 31.1
- Heavy Crude– API gravity < 22.3
- Extra Heavy Crude– API gravity < 10.0

Denatured fuel ethanol is typically a water white product having a pleasant odor with an API gravity of 50, and less than 10 parts per million (ppm) sulfur. Crude oils and other unrefined products exist with a wide range of sulfur concentrations from sweet crude containing less than 0.5 % sulfur to a very sour crude with sulfur concentrations over 2 %. Some of the sulfur species that can be present in these unrefined products are extremely corrosive.

Denatured fuel ethanol has excellent solvent characteristics which require the complete removal of any residual crude oil or unrefined product from a transport vessel. Even a slight residue from crude oil would contaminate denatured fuel ethanol and render the ethanol unsuitable for fuel applications. Due to continued concerns expressed by railcar wash facilities, RFA is providing this guideline to increase the awareness of possible pitting and corrosion evidence in legacy DOT-111A railcars after being placed in crude oil service, even for a short time. It is critical to develop proper cleanup and inspection procedures for converting a rail car from crude oil service to denatured fuel ethanol service.

Conversion Considerations

There are several conversion process elements that must be taken into consideration for transportation vessels which may have crude oil residue and intended future denatured fuel ethanol service, such as legacy DOT-111A tank cars.

1. Cleaning Instructions.

- a. Removal of the crude oil residue.
 - b. Cleaning and preparation for denatured fuel ethanol service.
2. Confirmation of appropriate wash conversion.
 3. Inspection, maintenance and release of tank car.

This industry guideline was developed with assistance from industry experts, railcar service and cleaning companies and fleet managers. Proper transportation procedures are critical to ensuring the denatured fuel ethanol remains on specification and fit for purpose through delivery activities. These guidelines should be used when transportation equipment has been used to deliver other commodities, such as crude oil and other unrefined products, that could contaminate denatured fuel ethanol without proper cleaning and inspection.

Notice: Equipment used to haul other commodities should not be used to transport denatured fuel ethanol unless the equipment has been properly cleaned. The extent of cleaning necessary depends on the prior commodity. All equipment, regardless of prior commodities, should be inspected prior to transporting denatured fuel ethanol.

Cleaning Instructions for Denatured Fuel Ethanol Shipments

This procedure is to be used as a guideline for the removal of crude oil residue, washing/cleaning of equipment, inspection protocols and ultimately confirmation of appropriate cleaning for future denatured fuel ethanol shipment. Typical railcars hauling ethanol-related products are constructed of carbon steel and unlined (legacy DOT-111A tank cars). To cover any special cleaning requirements, special hazards of the prior cargo, and any other general concerns, the prior contents of an empty vessel need to be discussed with the cleaning contractor before any work is initiated. Air used for blowing a compartment dry must be oil-free. Compartment product heel, steam condensate or rinse water must not be rinsed into the wash water return cycle.

All hazards must be identified, and applicable safety procedures must be followed.

Inspection

1. Open manway for a visual inspection of the interior.
2. If performing an inspection only, inspect the interior for cleanliness and any cleanliness deficiency. After inspection, place seals on all vessel openings.

Strip

3. Remove the residual product from the railcar with strong suction, which can include pumps, mechanical vacuums, etc. Be sure to open the eduction valves to release any product in the piping.
4. Properly dispose of any residual material.

Steam/Wash

5. Steam may be necessary to lower the viscosity of the crude oil residue to assist with removal, place a steam hose with a distribution nozzle in the railcar for a minimum of 30 minutes. This process needs to make the shell interior of the railcar compartment sweat out the prior contents.

An alternate procedure would include utilizing a compatible solvent to rinse out the crude oil residue. Compatible solvents would include more refined products such as on road- diesel fuel, gasoline, and denatured fuel ethanol. Properly dispose of all used solvents.

In some cases, it may be necessary to use a combination of steam and/ or solvent rinse to effectively remove the residual sludge from the crude oil.

6. Once crude oil residue is removed, apply detergent/cleaner/degreaser, whichever is necessary, for complete removal of the remaining residue from the railcar.

Note: Be sure to actuate the bottom outlet valve during wash procedure to fully remove any prior commodity in valve body.

7. Use the butterworth or rotating nozzle cleaning head again through the manway to fully rinse the interior. Be sure to hook up the water source to eduction tube to rinse piping.

IT IS IMPERATIVE THAT ANY AND ALL TRACES OF CRUDE OIL ARE REMOVED FROM THE TANKCAR.

Rinse/ Dry

8. Drop the butterworth or rotating nozzle-cleaning head in through the manway to fully rinse the interior. Water used in cleaning must be heated to >140°F, pressurized to approximately 100 psi, and not recycled.
9. Wash the manway and replace the manway and bottom outlet gaskets.
10. Hook up the air hose to railcar piping and blow completely dry. Blow interior completely dry with air horns/movers, etc. Nitrogen blanketing the railcar will also prevent the creation of rust on the newly washed interior walls.

Confirmation of Cleaning Procedure

Because of the range of gravities and sulfur contents of crude oils and unrefined products, it is critical to validate the cleaning procedure for the specific type of product that needs to be removed. The validations will include several steps and should be documented. Several times during the cleaning conversion process, confirmation of the effectiveness of the cleaning procedure should be completed.

- A thorough visual inspection of the exterior, interior and operating equipment of the tank car should be performed.

- Use of a black light for interior inspection post removal and steam/ wash of the crude oil residue can ensure the maximum elimination of the prior commodity. There should be no fluorescence on the interior of the car from the black light.
- Performing several solvent wall washes, from different locations on the interior wall of the railcar is also a proven verification that sulfur, gums, tars or waxes are no longer present from the prior crude oil service. A third-party laboratory can assist with both the wall wash and analysis of the wall wash samples. There should be an increase in sulfur, gums, tars or waxes compared to the original wall wash solvent.
- A cleaning certificate, together with photos taken of the interior and exterior of the tank car, should be received prior to acceptance of railcars.

A cleaning certificate should provide sufficient detail and confirmation of all wash and inspection actions that have been performed. The certificate should be certified by a qualified person at the facility performing the cleaning conversion.

Inspection, Maintenance and Release for Service

All equipment, regardless of prior commodities, should be inspected prior to transporting denatured fuel ethanol. Recent transportation of crude oil has created concern for pitting or corrosion on the interior of carbon steel tank cars due to the release of hydrogen sulfide (H₂S) or other aggressive components. Special attention should be given to the education pipe, bottom outlet valve, pressure relief valves and vacuum relief valves. Crude oil may contain abrasive components, such as sand and other minerals, that could damage the bottom outlet valve and valve seat. These appurtenances could also hide small amounts of residual crude oil which would lead to contamination of denatured fuel ethanol. Important inspection techniques to ensure safe and leak-free shipment include:

- Examine the interior surface of the tank car, both lined and unlined interiors, for signs of pitting, cracking or other corrosion concerns.
 - Signs of cracking or excessive pitting indicate the need for a more detailed evaluation procedure to confirm the cars are still fit for service.
- Examine the bottom outlet valve and any safety valves for imperfections, damaged gasket grooves and detrimental residue on sealing surfaces. Dents, gouges, pits, scratches and radial defects (those that run from the inside diameter to the outside diameter of the nozzle) are detrimental.¹

Removal of railcar devices may be necessary to perform a detailed inspection for potential damage. Pressure testing the railcar, after cleaning, may be helpful to ensure proper condition of the railcar outlets. When an unacceptable condition is found on a tank car, the shipper may not offer the car into transportation until the condition is corrected. Unacceptable conditions, such as repairs to the manway or bottom outlet valve, may require repair by a properly certified tank car facility and compliance with the

¹ Renewable Fuels Association Guidelines for Hinged and Bolted Manway Assembly, Assembly Instructions for the Ethanol Industry. May 2025 Available at www.ethanolrfa.org.

Association of American Railroads' [Manual of Standards and Recommended Practices, Section C. Part III, Specifications for Tank Cars.](#)

There is a wide range of crude oils under production and limited experience preparing rail tank cars to transition from crude oil service to denatured ethanol service. This memo is based on professional opinions and expectations for the necessary procedures. The RFA Technical committee will periodically review the information from real world experience transitioning these tank cars from crude oil service to denatured fuel ethanol service. This memo will be updated as warranted based on that experience.

For additional information on transportation and conversion procedures for transportation equipment, refer to RFA's Fuel Ethanol Industry Guideline available at www.ethanolrfa.org. RFA will continue to monitor any new industry developments and provide guidance to ensure a safe, efficient and suitable means to ensure ethanol arrives on specification for the marketplace.

Note (2025 Revision):

This document has been reviewed and updated by the Renewable Fuels Association in 2025. References to legacy DOT-111A tank cars are retained for historical context. However, these cars are no longer authorized for use in hazardous material service. All ethanol shipments must now comply with DOT-117J tank car standards. This version reflects current regulatory expectations and industry's best practices.