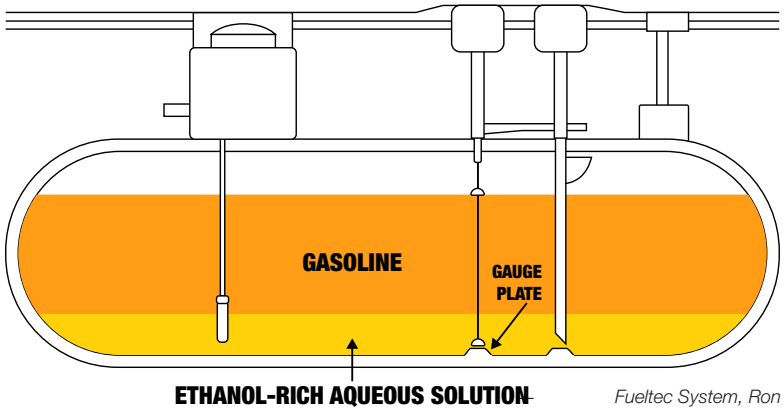
# Phase Separation in Gasoline-Ethanol Blends

## What is Phase Separation?

In gasoline-ethanol blends, phase separation occurs only when the water content exceeds the "water tolerance" or the amount of water the ethanol in the blend can absorb. (NOTE: Phase separation can also occur in gasoline if the content of water entrained with it is high enough.) Phase separation is exceedingly rare and there is no evidence it occurs more or less frequently in gasoline-ethanol blends than in gasoline.

When phase separation occurs in an underground storage tank (UST), a water-ethanol layer is formed and settles at the bottom of the tank, which is where the pump typically draws from. So, this water mixture will likely be what is dispensed to the vehicles. This mixture will not meet specifications for the vehicle's engine, nor will the gasoline layer on top of it, which can be off-spec for the critical properties of octane, vapor pressure and distillation.

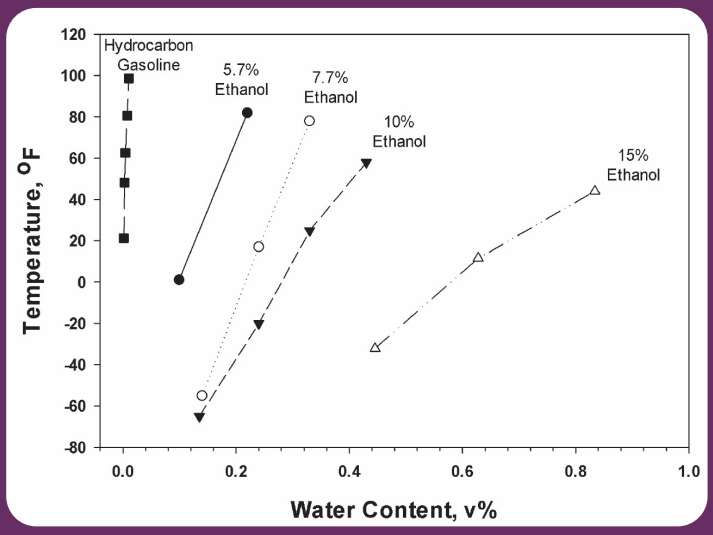



*Fueltec System, Ron Lenz*

## What is Water Tolerance?

Ethanol tends to absorb water (hygroscopic). In small amounts, the water can be harmlessly carried through the engine. However, there is a limit to how much water ethanol can absorb before phase separation occurs. This is the "water tolerance" for the blend and it is a function of the level of ethanol in the blend, as well as the temperature.

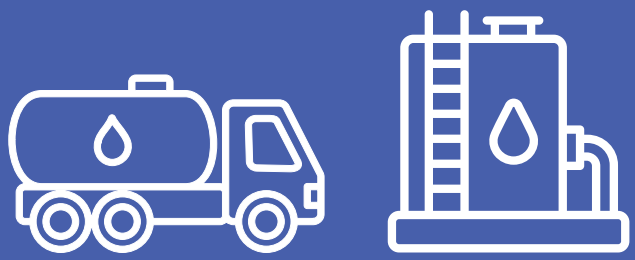
- **The more ethanol in the blend, the better the water tolerance**
- **Water tolerance of a given blend increases with temperature**
- **Water from atmospheric moisture is not enough to exceed the water tolerance**




Source: E15 Retailer Handbook, RFA, 2013

## Avoiding Phase Separation

- Prevent water intrusion in the gasoline-ethanol blend throughout the supply chain:
  - Maintain regular storage equipment/inspection to prevent and detect leaks
  - Avoid storing fuel for long periods of time, especially during seasonal changes which are usually accompanied by large temperature changes
  - Implement inspections and/or cleaning protocols prior to loading during transportation
  - Use transport equipment previously used with other commodities only if these are deemed as acceptable backhaul
  - Avoid water ingress into the fuel system while filling fuel tanks or operating the engine
- Minimize human error that could result in water contamination:
  - Train terminal operators and technicians on blending procedures
  - Train drivers on loading and unloading procedures
- Unfortunately, phase separation cannot be prevented by the use of "additives."
- In the U.S., good practices are promoted by government agencies and ethanol industry groups through publications, as in guidelines/handbooks and recommended practices. Note that these practices and procedures are applied to gasoline without ethanol as well; regular inspections and following best practices is standard for all transportation fuels.



## What Actions Can Be Taken in Case of Phase Separation?

If the extent of contamination is low such that the water phase has not significantly affected the fuel quality, new fuel can be added to bring the fuel back to specification. This remediation/correction approach may only work with low inventories of contaminated fuel.

If the fuel quality cannot be brought back into specification with the above approach, the out-of-spec fuel can be returned to a refinery for re-processing or disposed of.

## Need Support?

Reach out to the U.S. Grains & BioProducts Council's D.C. Team for more information on water tolerance and phase separation in gasoline-ethanol blends.

## Selected References:


[1] E15 Retailer Handbook (RFA, 2015) – E15 Gasoline Blends Industry Guidelines, Specifications and Procedures, Retail Operations

[2] Handbook for Handling, Storing and Dispensing E85 and Other Gasoline-Ethanol Blends (DOE, Feb 2016)

[3] Fuel Ethanol Industry Guidelines, Specifications and Procedures, pp. 48-50 (Materials Compatibility Information for Commonly Used Materials with Ethanol and Gasoline / Ethanol Blended Fuels), RFA, 2018