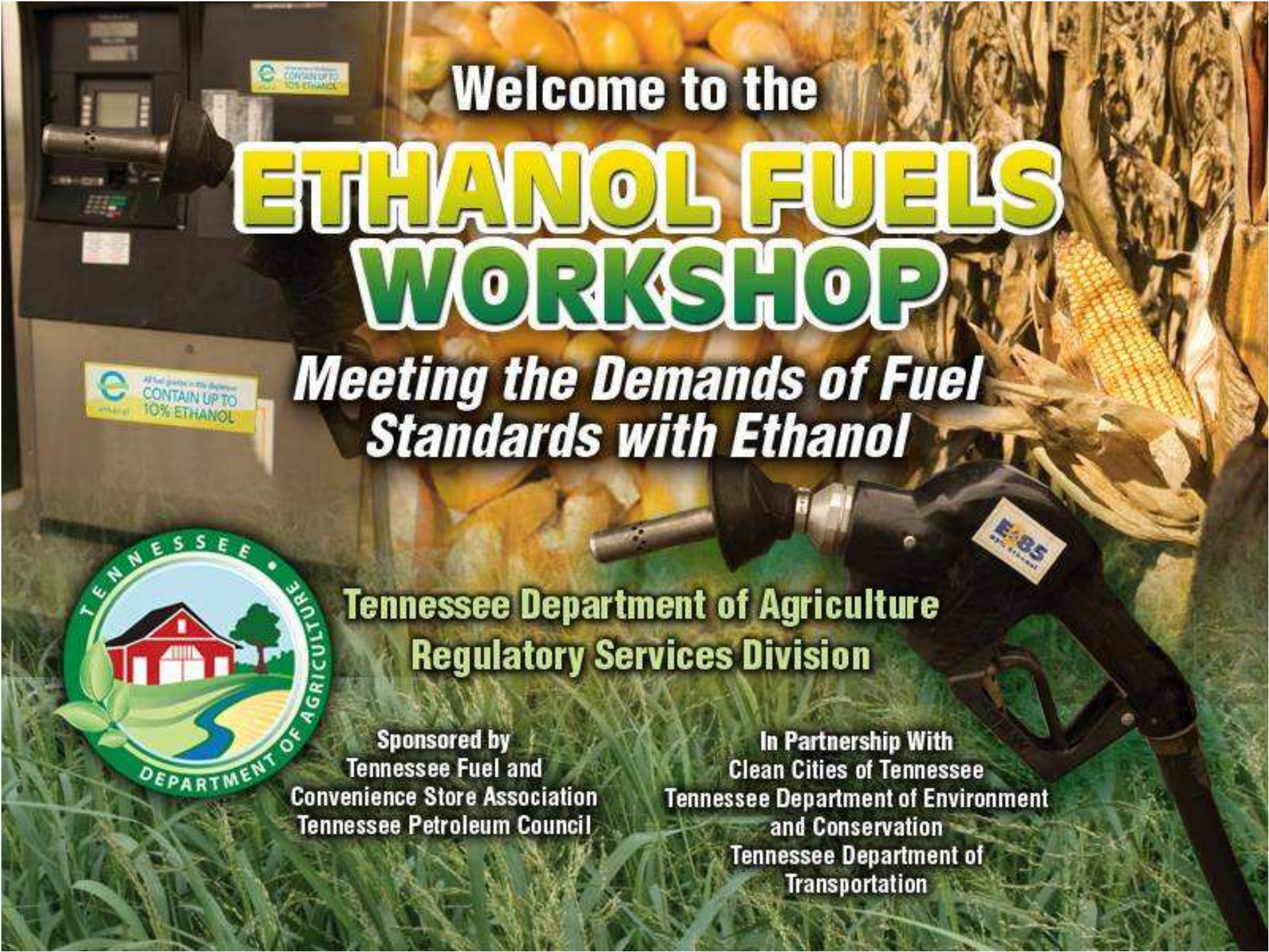




Welcome to the

ETHANOL FUELS WORKSHOP

*Meeting the Demands of Fuel
Standards with Ethanol*



**Tennessee Department of Agriculture
Regulatory Services Division**

**Sponsored by
Tennessee Fuel and
Convenience Store Association
Tennessee Petroleum Council**

**In Partnership With
Clean Cities of Tennessee
Tennessee Department of Environment
and Conservation
Tennessee Department of
Transportation**



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E10 Fuels – Issues and Solutions

- ✓ Review Fundamental Requirements for Ethanol Blends
- ✓ Summer Volatility Control Period
- ✓ Ethanol and Octane Boost – An Advantage for Ethanol
- ✓ Ethanol and Vapor Pressure Boost – A Disadvantage for Ethanol
- ✓ Phase Separation – The Most Critical Control for E10 Blends
- ✓ Violation Trends
- ✓ Pump Labels and UST Marking Requirements



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E10 Fuels Requirements

- ✓ All Fuel Standards in TN are based on ASTM International Standards and Tennessee Rules
 - ASTM D4814 is the governing document for Automotive Spark-Ignition Engine Fuel, i.e., gasoline and gasoline-ethanol blends.
 - Covers important parameters such as volatility and workmanship (water, sediment, and other adulterants), gum formation, and corrosion, and 10th percentile temperatures for phase separation.
 - References all Standard Test Methods that are to be used to verify the characteristics of the fuel – from distillation to octane.
- ✓ Legislative Authority T.C.A. 47-18-1301 et seq.





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Summer Volatility Control Period Coming Up Soon!

- ✓ Summer EPA Control Period: **May 1 – September 15**
- ✓ Tennessee Maximum Vapor Pressure is **9.0 psi**, except for the following counties:
 - **Davidson, Rutherford, Sumner, Williamson, Wilson and Shelby**

These counties have a **Maximum VP of 7.8 psi**



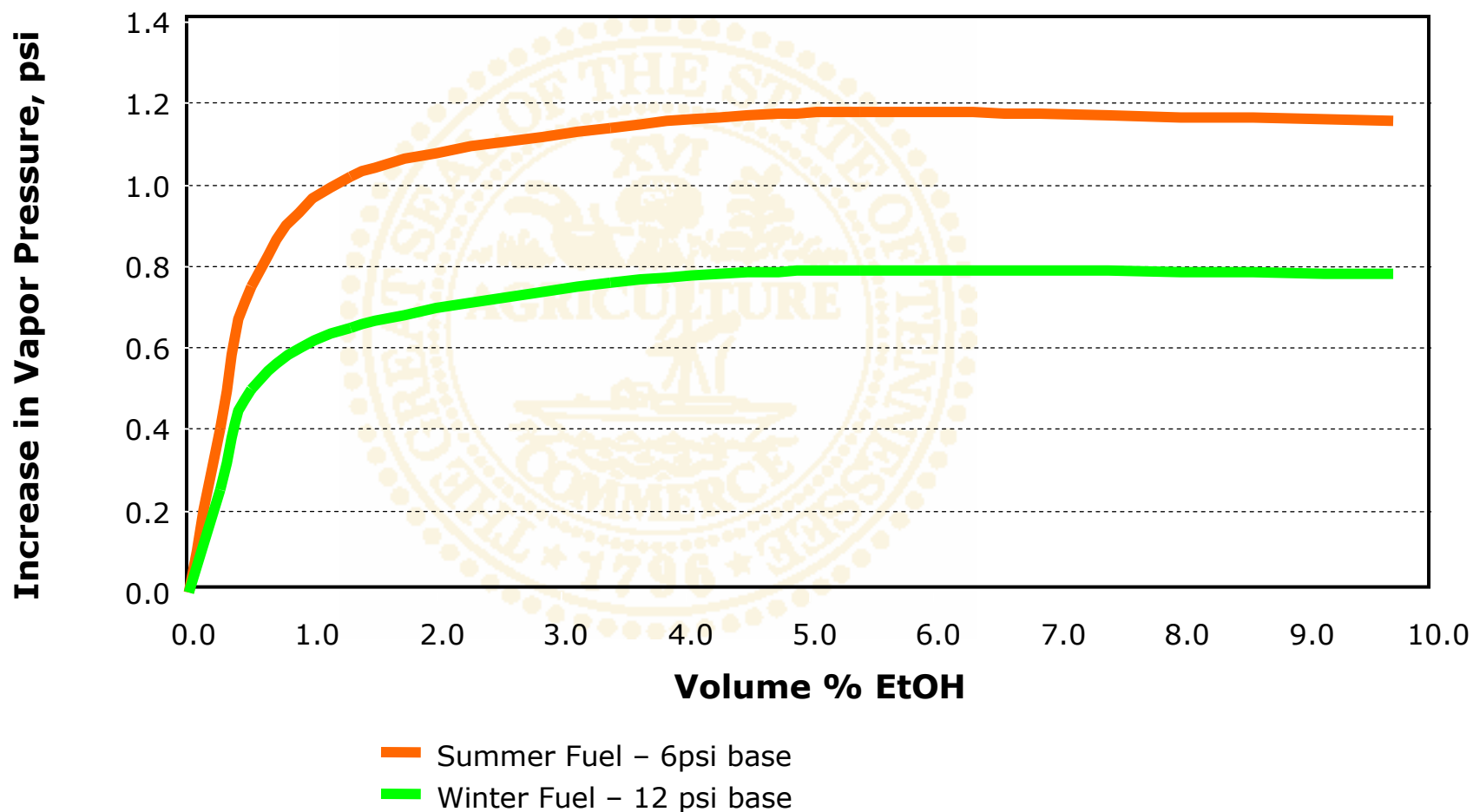
Ethanol blends have a 1 psi exemption;
HOWEVER, to qualify **the ethanol content must be between 9 and 10 volume %!**



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Effects of Ethanol on Vapor Pressure

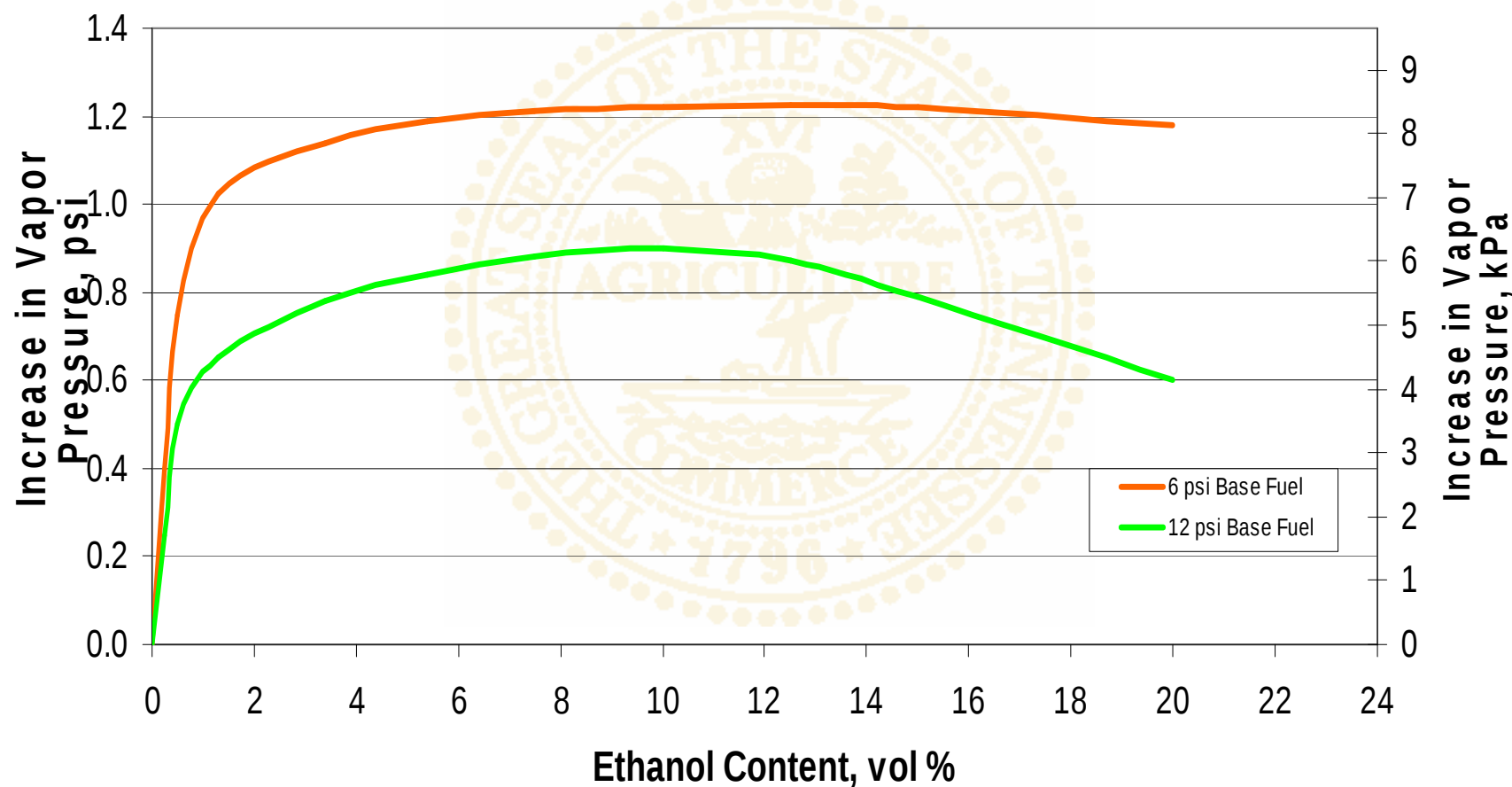




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Effect of Ethanol on Vapor Pressure





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Preparing for the Summer Volatility Control Period

- ✓ Check with your suppliers on anticipated delivery of 7.8 and 9.0 psi fuel.
- ✓ If blending EtOH, make sure that you maintain a 9-10% blend level.
- ✓ Run your retail tanks Low as you approach June 1 and begin to dilute with summer volatility fuel.
- ✓ Know Your Customers and Serve Their Needs:
 - Begin to advise retail owners on the need to take minimal delivery of pre-summer grade fuel prior to the availability 7.8/9.0 fuel.
 - Especially critical of Low Volume and Seasonal locations
 - Boat docks, small retailers, along with their suppliers, face penalties each year that could have been avoided.

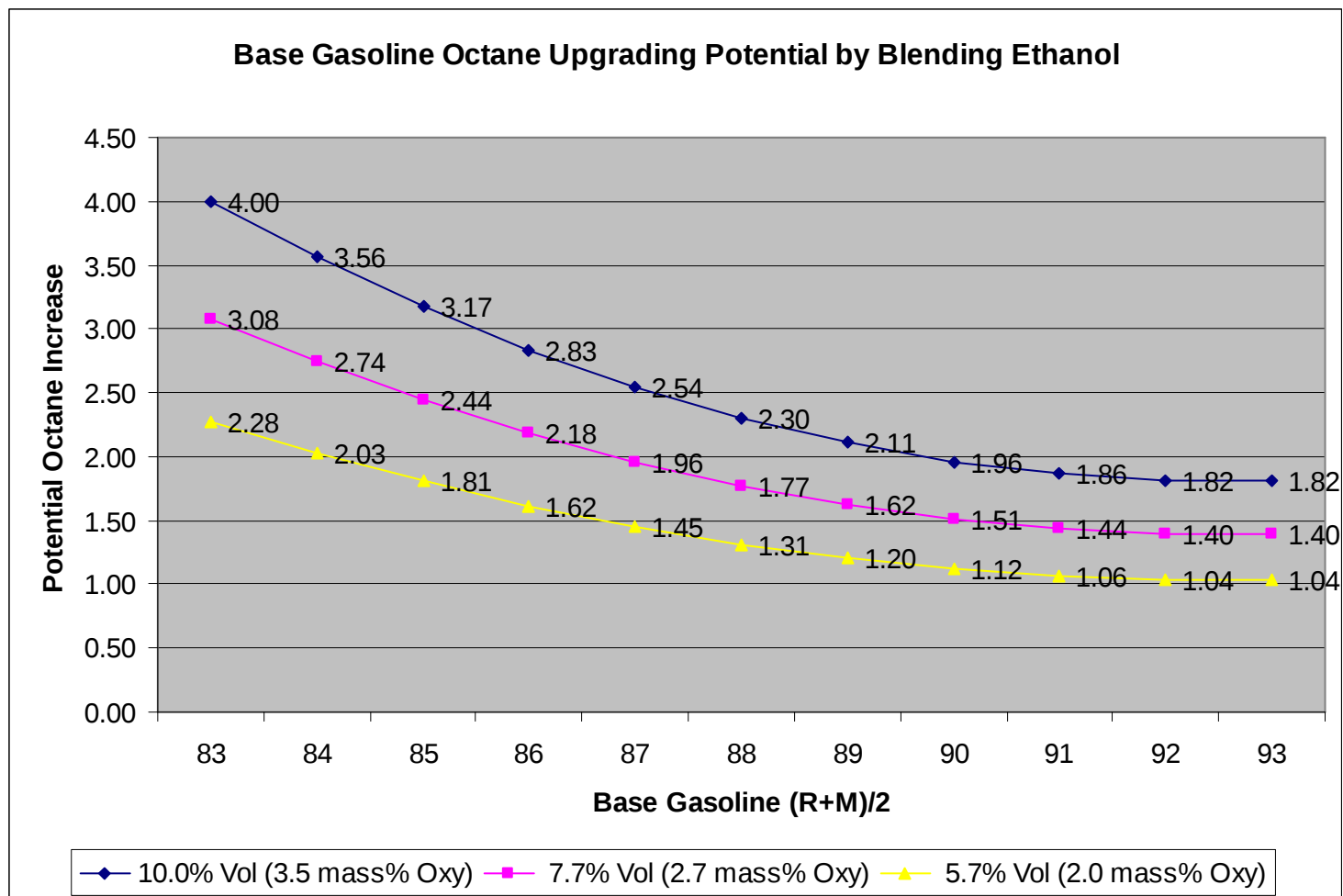




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Blending Ethanol & Octane Boost

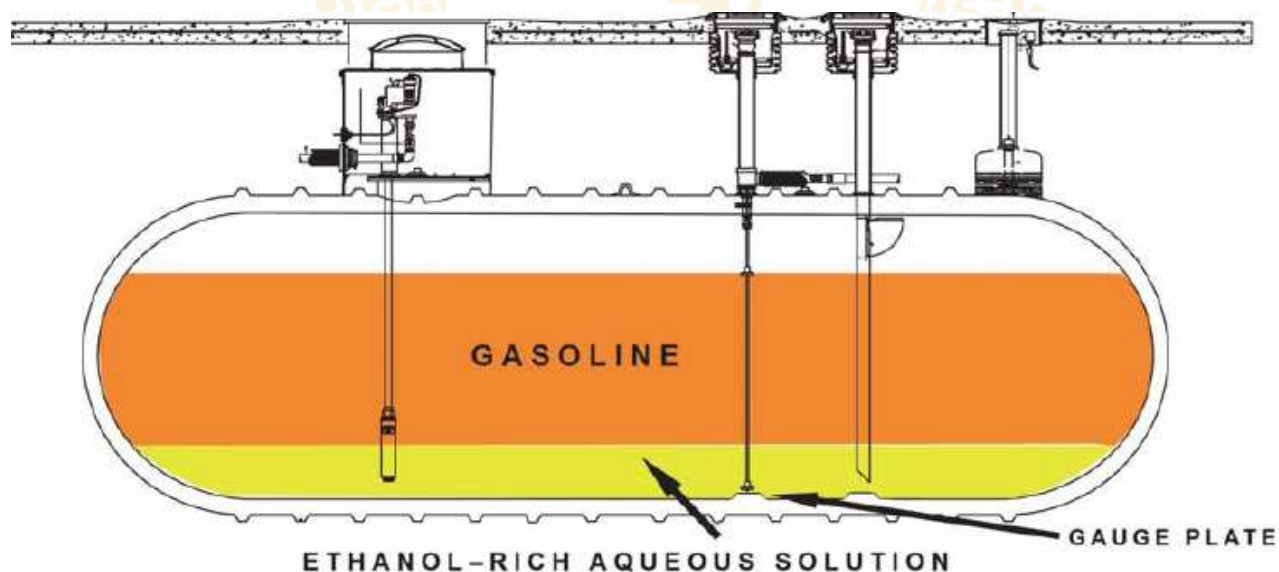




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Phase Separation

- ✓ E10 can remain stable at up to its saturation point with water; after the saturation point is reached the water and ethanol will begin to separate from solution. Stability decreases with cold weather and lower aromatic fuels.
- ✓ The Phase separation solution is more dense than gasoline, is polar, and will separate and sink to the bottom of the tank.





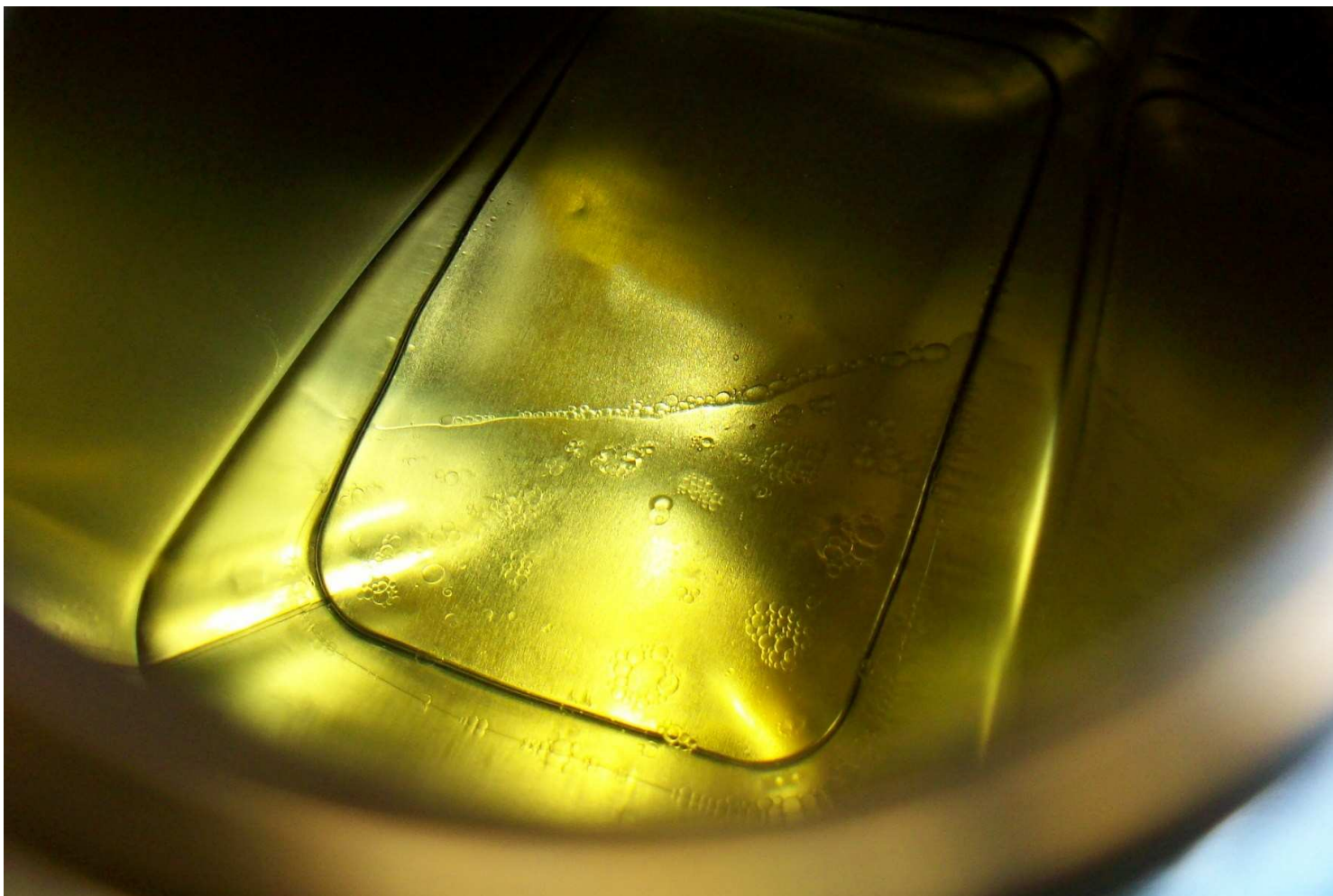
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Phase Separation – What TDA Sees in the Field





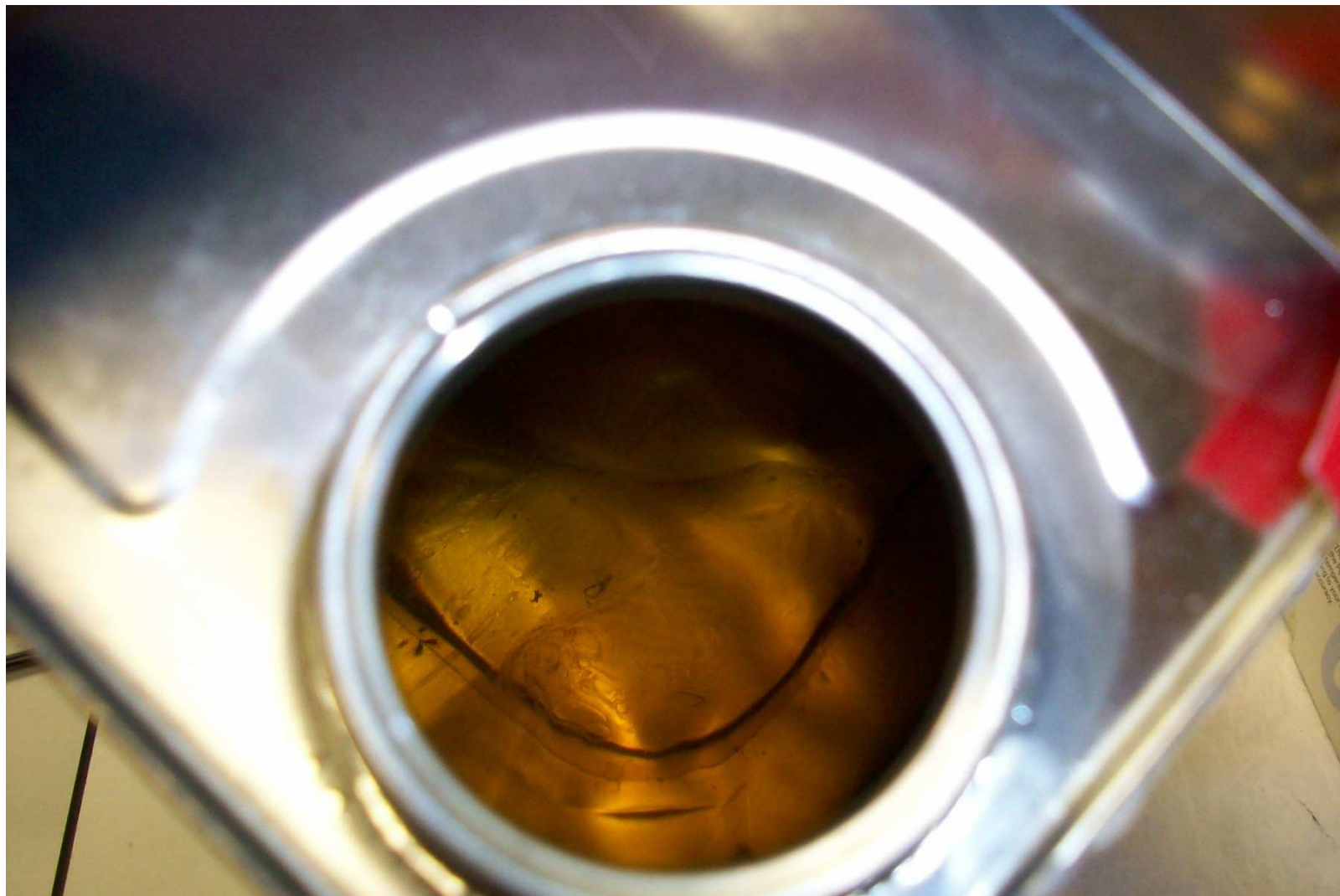
Phase Separation – What TDA Sees in the Field





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Phase Separation – What TDA Sees in the Field





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Tennessee Phase Separation Seasonal Temperatures

10th Percentile 6-h minimum

(The highest temperature of the six coldest consecutive hourly temperature readings in a 24 h period)

Month	Temp, Deg. C (F)
January	-11 (12.2)
February	-8 (17.6)
March	-4 (24.8)
April	2 (35.6)
May	8 (46.4)
June-September	10 (50.0)
October	5 (41.0)
November	-3 (26.6)
December	-7 (19.4)



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Phase Separation Project Initiated to help in remediation advice

- ✓ Created a batch of E10 gasoline - blended from gasoline and EtOH samples taken from terminal.
- ✓ Two 1 Gal cans labeled as batch 1 & 2 observed with no signs of phase sep.
- ✓ EtOH used to make blends was pretested and contained 0.629% water.
- ✓ After hand blending to 10% DFE, batch 1 and 2 verified for EtOH – 9.43, 9.42%, respectively.





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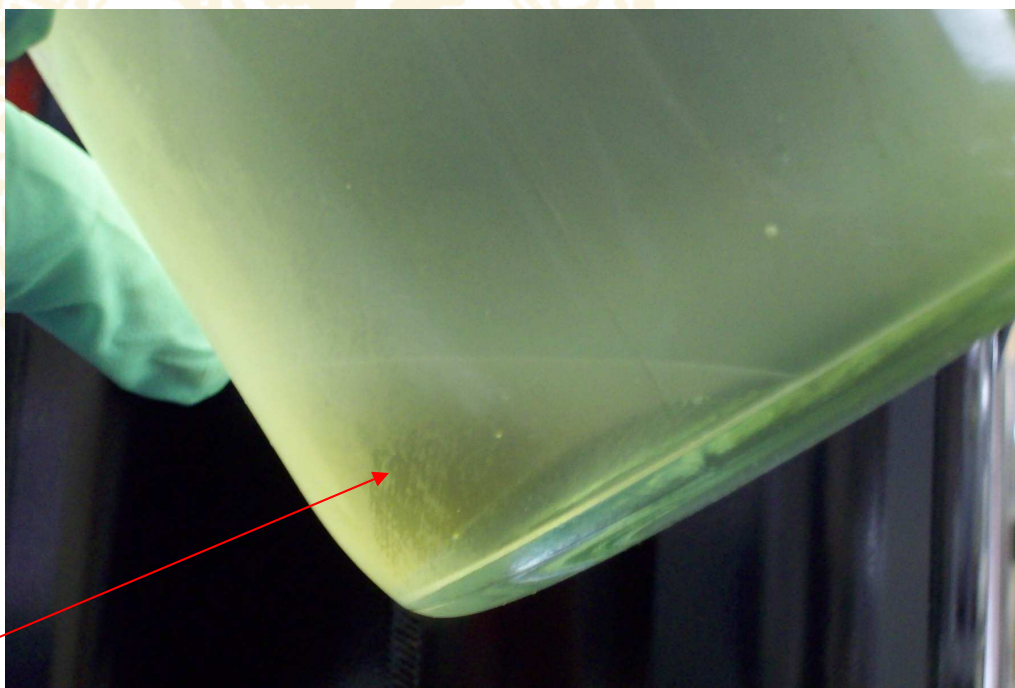
Phase Separation Project – Protocol 1

Objective – Determine a reasonable remediation step for minor phase separation

- ✓ Three samples selected to represent typical phase sep findings at retail.
- ✓ Sample chilled and shaken to mix then transferred to 1 qt. bottle.



Sample after chilling and shaking to bring fallout into solution. Hazy and phase observed at bottom.





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Phase Separation Project Results – Protocol 1

- ✓ 400 mL of phased sample measured into graduated cylinder – transferred to another 1 qt. bottle and left to stand – phase was observed.
- ✓ 400 mL of E10 batch 1 was added and mixed for 20 s.
- ✓ After mixing under these conditions, the 1:1 mix was observed to be clear & bright.



Sample after 1:1 at ~ 5 deg. C.

Results indicate that the 'typical' phase problems that we routinely encounter can be corrected by dilution of 1:1 with fresh E10.

NOTE: This is not a catastrophic phase separation solution!



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Phase Separation Project Results – Protocol 1

1:1 dilution vs. “as received” – Note phase sep remains in “as received”

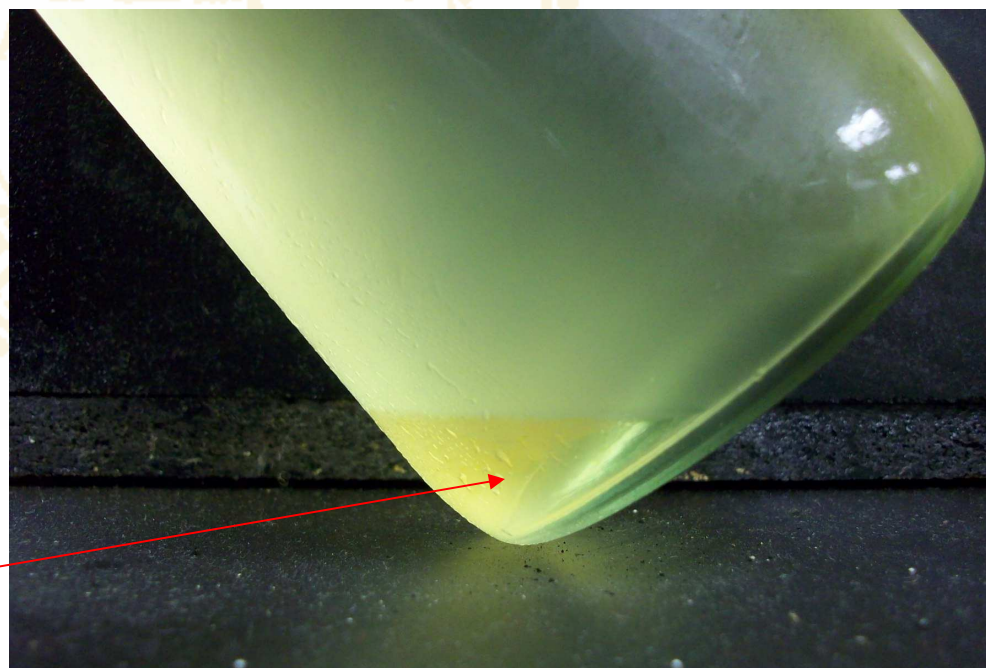




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Phase Separation Project Results – Protocol 1

- ✓ A 2nd 'as received' sample was chilled, shaken, and transferred to glass bottle.
- ✓ Photos illustrate hazy and water condensation in corner of tilted bottle.





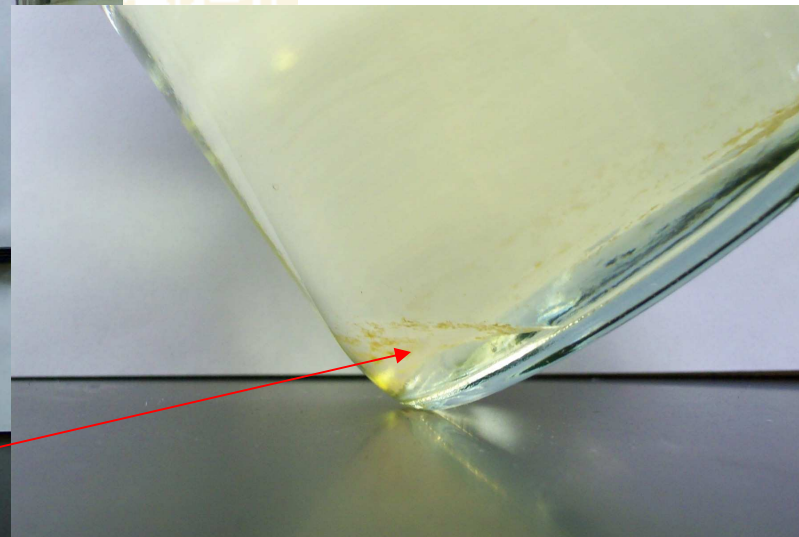
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Phase Separation Project Results – Protocol 1

- ✓ Again, the 1:1 dilution corrected the problem with this fuel sample.
- ✓ A 3rd sample was tested and corrective actions were successful again.



Key Takeaway: 1:1 dilution with fresh, dry E10 corrects minor phase sep problems.





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Phase Separation Project – Protocol 2

Objective – Determine if there are practical solutions to catastrophic phase separation issues.

- ✓ 4 L of E10 gasoline made from ethanol and terminal gasoline.
- ✓ Batch labeled as #3 - chilled – no phase separation observed.
- ✓ 10% water contamination introduced into a sample.
- ✓ Evaluation of Upper Phase for remediation attempted
- ✓ Fresh fuel was added up to 25:1 in an attempt to dilute the phase separation.

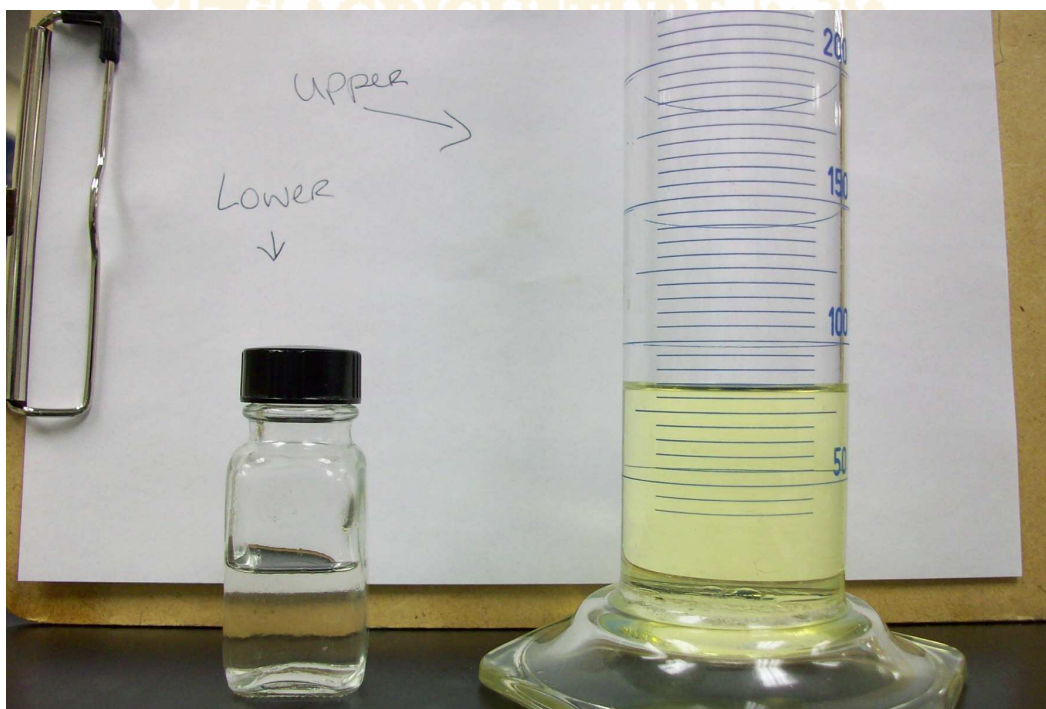




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Phase Separation Project – Protocol 2

- ✓ Density determined on lower phase:
 - Lower phase 0.9417 @ 15C (water is 0.9991 – EtOH used was 0.7948).
- ✓ Upper phase tested for water and EtOH:
 - Water content was 382 ppm, mass
 - EtOH content was 1.34% mass

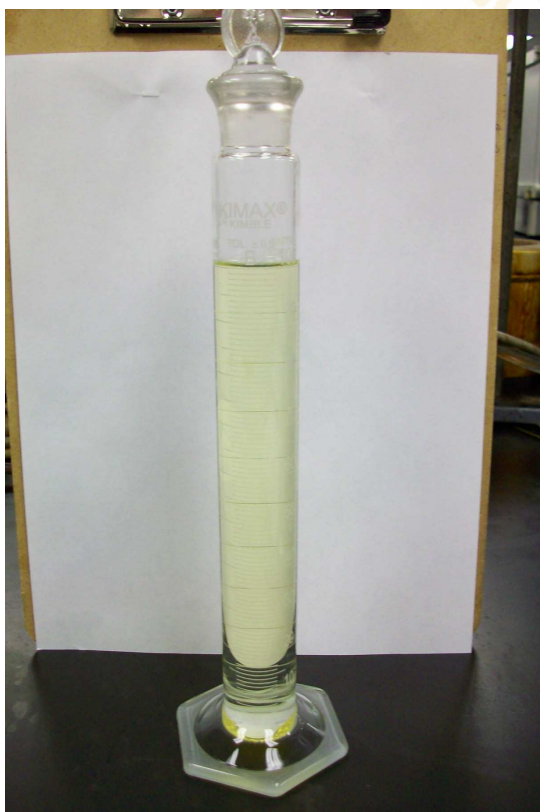




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Phase Separation Project – Protocol 2

- ✓ 1:1 dilution of fresh batch #3 E10 was added to the UPPER phase of the 10% contamination batch.
- ✓ Sample was chilled and remained clear and bright.



Key Takeaway: When catastrophic phase separation occurs, upper and lower phases can be separated, and upper phase salvaged.

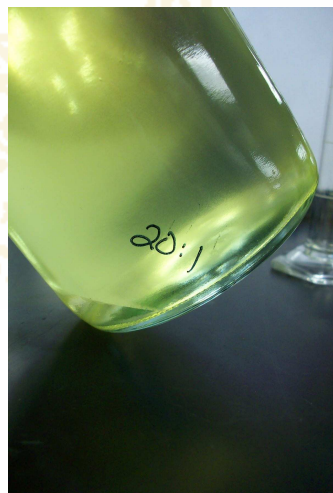
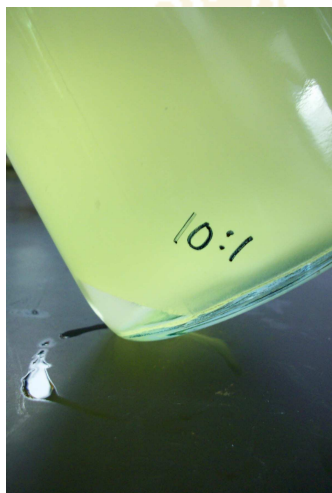
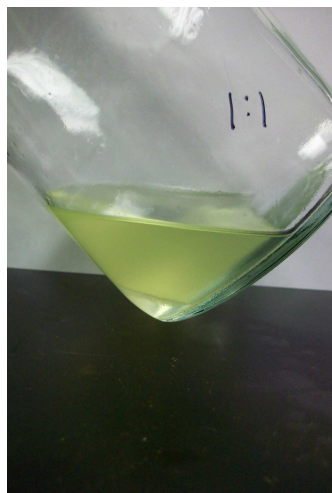
NOTE: The loss of EtOH means loss of AKI. Laboratory analysis will have to be done to determine the exact blending to hit your target product grade!



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Phase Separation Project – Protocol 2

- ✓ Another 10% contamination sample of 40 mL was created.
- ✓ 40 mL increments of fresh batch #3 E10 was added until the dilution ratio was up to 25:1.
- ✓ At 25:1 phase separation was not observed at room temperature, **but after chilling the sample for 30 minutes, phase separation was observed!**
 - **We could not stabilize the contaminated fuel without first removing the lower phase.**



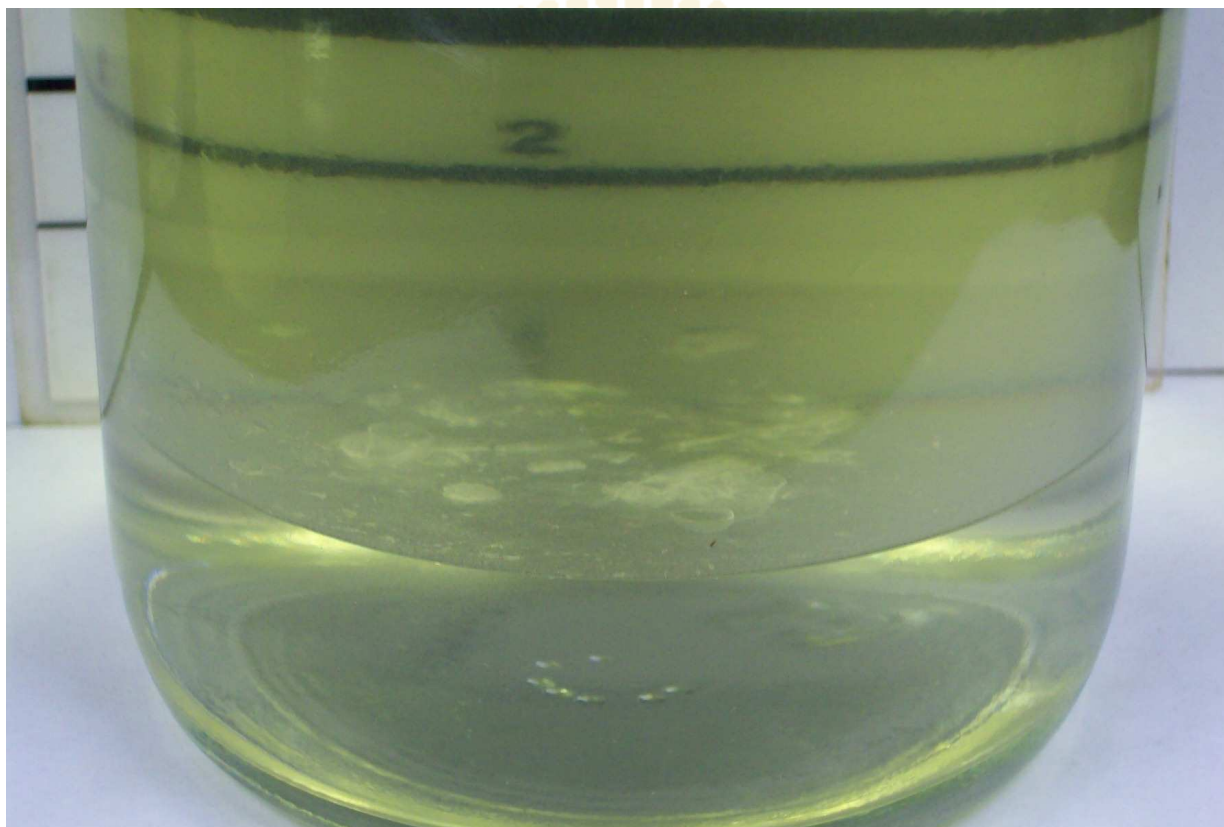


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Phase Separation Project Results – Protocol 3

Objective – Evaluate 0.3 – 10% water contamination

E10 hand blends checked for phase sep – both clear & bright after chilling.



A close up of 10% contamination after resting at room temp. Is there a 3rd phase?



Phase Separation Project Results – Protocol 3

A portion was contaminated with **1% DI water**.



Immediately after mixing.

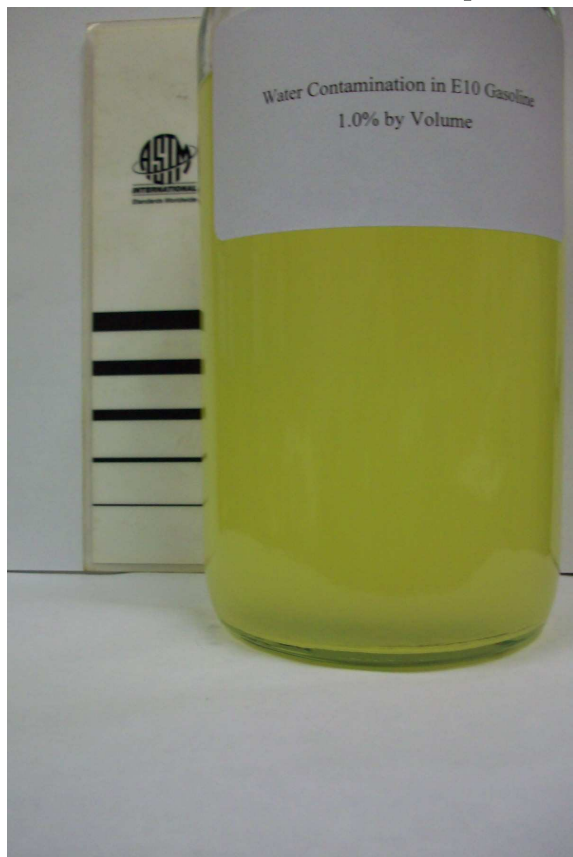


After shaking.

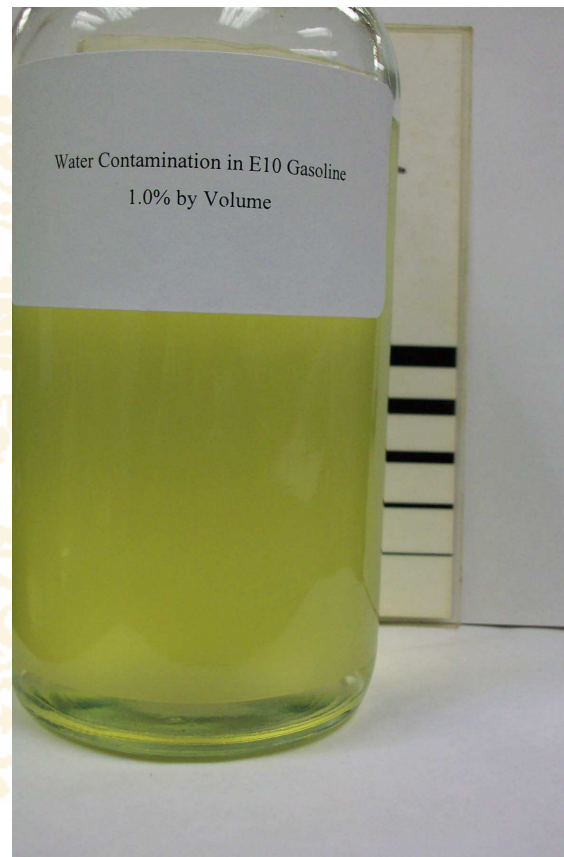


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Phase Separation Project Results – Protocol 3



1% sample after warming to room temp and agitated.



1% sample after warming to room temp and resting.
Sample remains hazy and bottom phase forms.



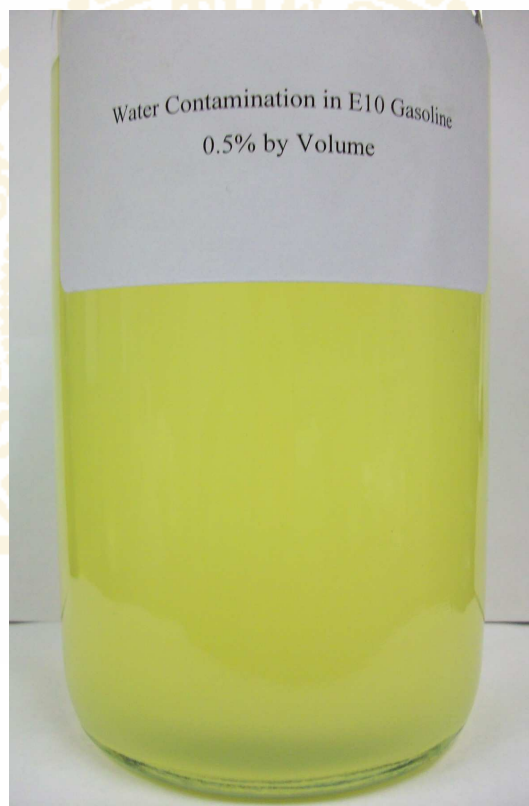
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Phase Separation Project Results – Protocol 3

A portion was contaminated with **0.5%** DI water.



Immediately after mixing.



After shaking.



After resting.

Sample remains hazy and visible phase layers are observed.



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Phase Separation Project Results – Protocol 3

A portion was contaminated with **0.3%** DI water.



Immediately after mixing.



After shaking.



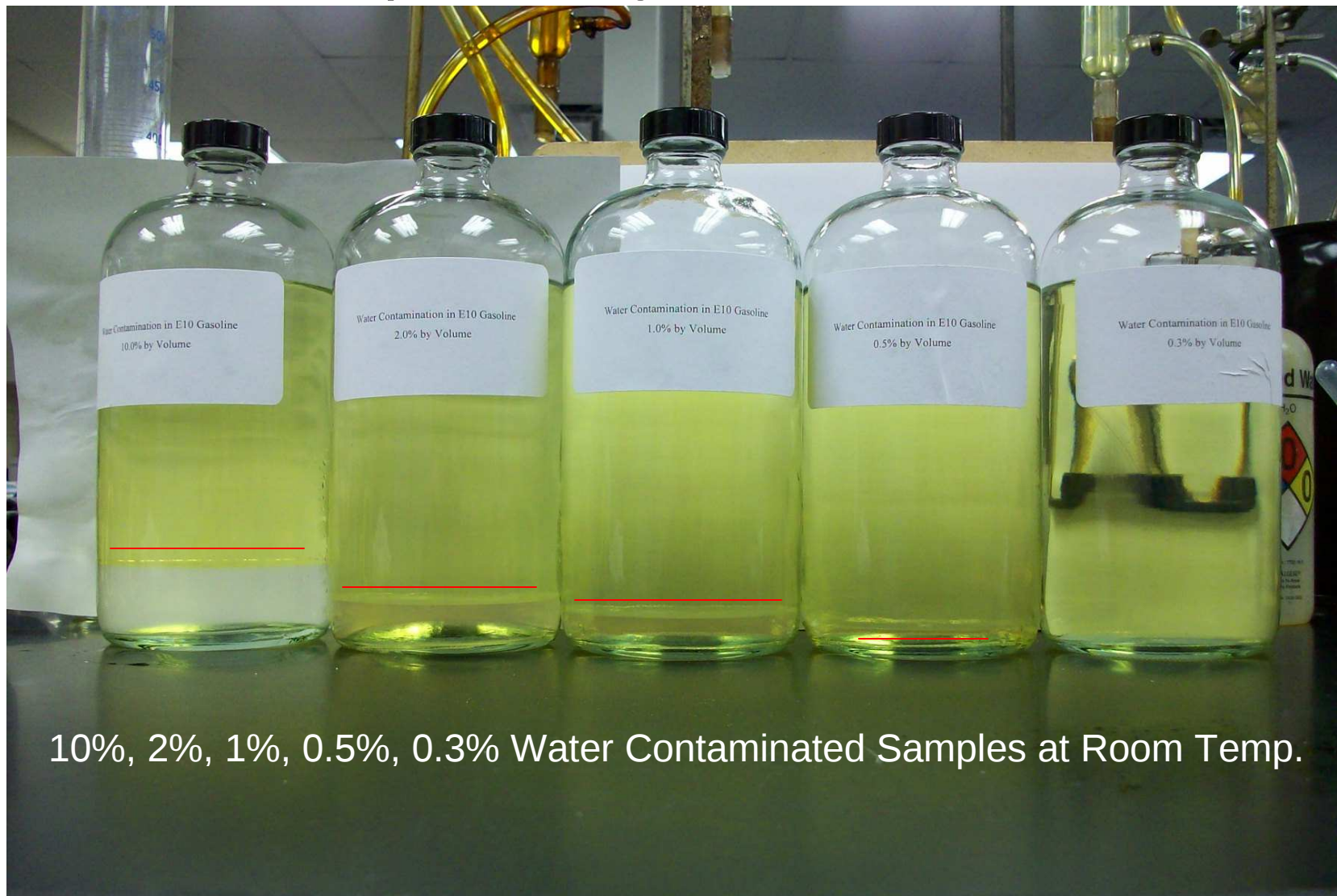
After resting.

Sample remains clear with no phase separation at 3000 ppm water.



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Phase Separation Project Results – Protocol 3



10%, 2%, 1%, 0.5%, 0.3% Water Contaminated Samples at Room Temp.



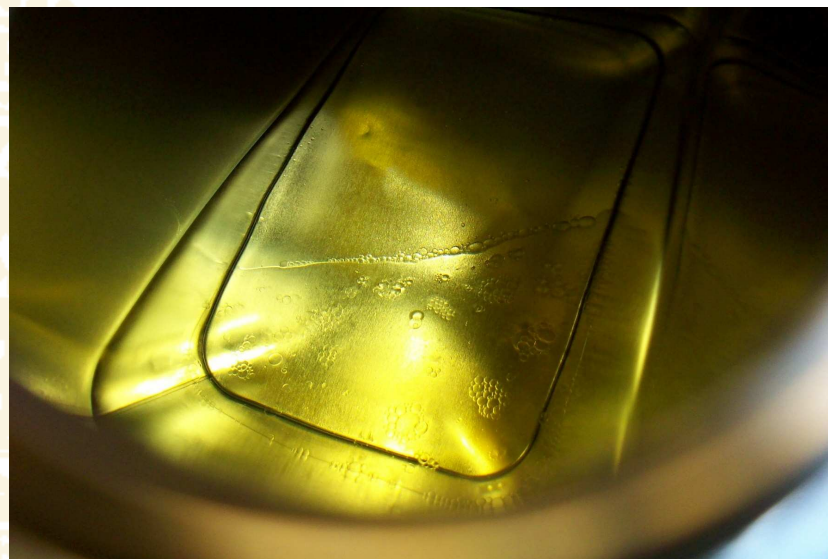
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Remediation of Phase Separated Fuel

For a problem like this:

Check both ends of tank for moisture.

1. Completely remove any signs of water/phase separated material.
2. Water/EtOH Phase to be removed and disposed of.
3. Blend 1:1 Minimum with Fresh E10 Fuel – Retest for compliance before delivering for sale.
4. Inspect filters – replace as needed.



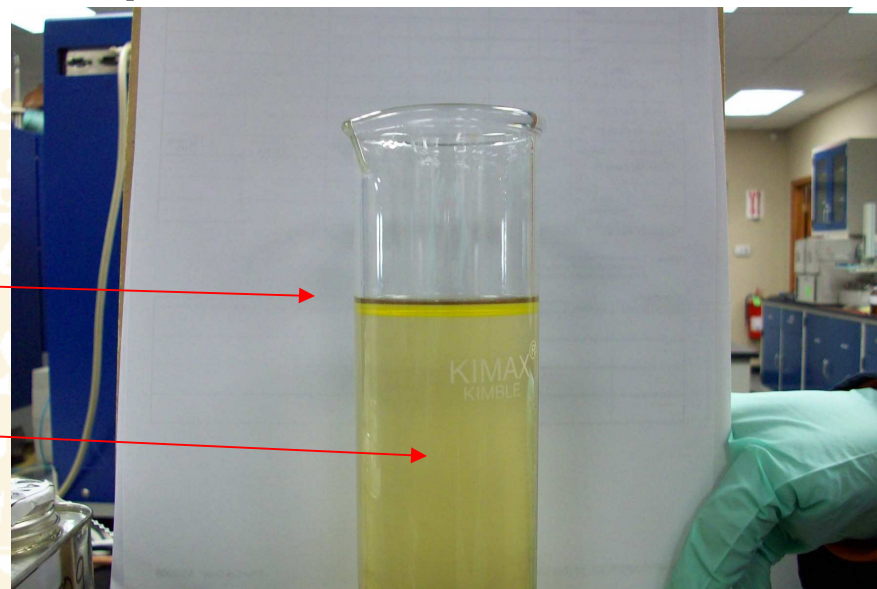


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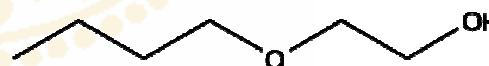
Remediation of Phase Separated Fuel

For a problem this severe:

1. Empty Tank and have all moisture removed.
2. Collect top portion of product.
3. Water/EtOH Phase must be removed and disposed of.
4. Determine the critical parameters of the gasoline phase – AKI, EtOH %.
5. Blend 1:1 Minimum with Fresh E10 Fuel – Retest for compliance before delivering for sale.
6. Replace all filters and purge lines.



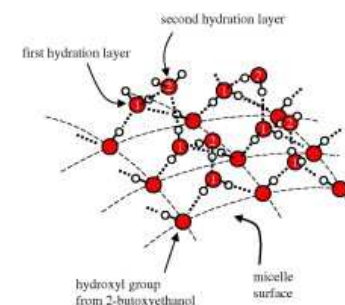
Additives To Correct: Be Cautious!



Some compounds introduced into gasoline-ethanol blends in an attempt to un-do the phase separation can be risky. High treat rates can cause the total mass % oxygen to exceed federal limits!

2-butoxyethanol is 27.08% oxygen (EtOH 34.74%)

Used as a solvent commercially





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Phase Separation Maintenance Steps

- ✓ Select maximum 10 micron filters. We suggest using Alcohol Monitor filtration that will slow down the dispenser when catastrophic phase separation is occurring.
- ✓ Periodically have tanks swept to remove any accumulated moisture. TN Rules allow up to 0.25" in an ethanol tank; however, we strongly recommend drying tanks when any moisture is present. The presence of any water may be contributing to our problems!
- ✓ Be sure that you are using water finding paste that is designed for ethanol blends.
- ✓ Inspect fill and vapor caps for damage and missing gaskets, replacing if necessary. They must be water tight. Seals and latches must be in excellent condition.



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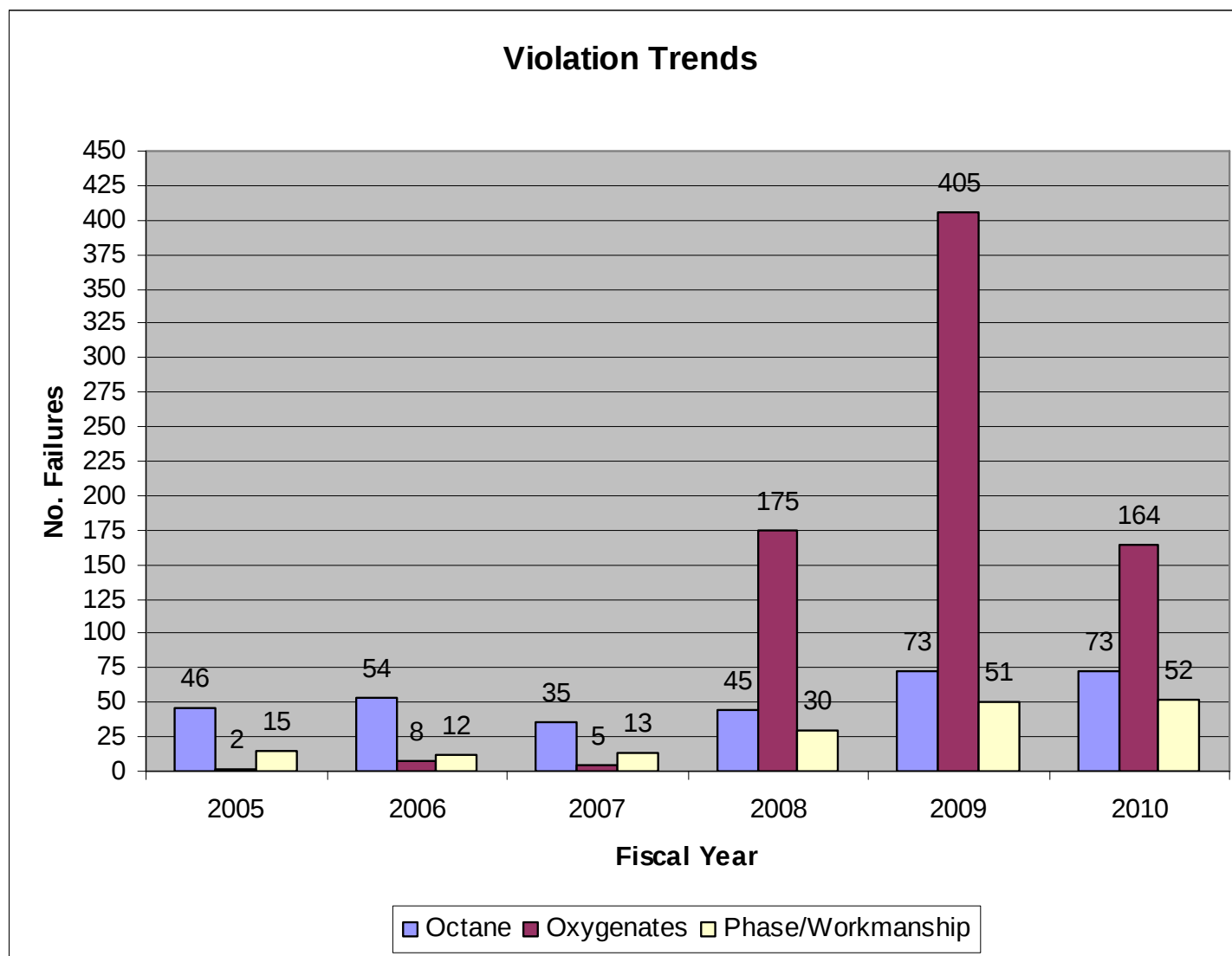
Phase Separation Maintenance Steps

- ✓ Inspect tanks daily – always before and after fuel drop. If any water is present, have your employee contact QC officer and advise.
- ✓ Check vent pipes. They must have rain caps that allow ventilation yet prohibit rain water from entering the system. Do not overlook this item!
- ✓ Inspect product and spill containment buckets – if water is present, do not drain it into the tank but instead, remove and properly dispose of the water.
- ✓ Collect your own samples for visual inspection. Chill samples and look for any presence of water separation.



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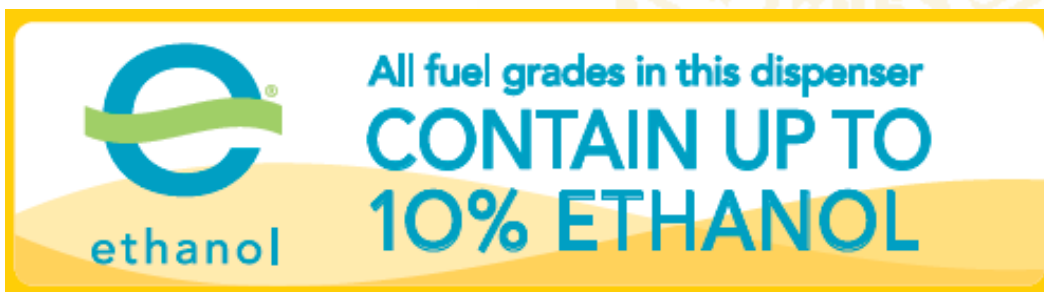




E10 and Lower Blend Requirements

Classification and Method of Sale Requirements

- ✓ Declare ethanol on PTD if greater than 1.5 Mass % Oxygen (~ 4 Vol.% EtOH)
- ✓ Label Dispensers if greater than 1.5 Mass % Oxygen (~ 4 Vol.% EtOH)
 - Label as "with" or "containing" (or similar wording) Ethanol. The label must be posted on the upper 50 percent of the dispenser front panel in a position clear and conspicuous from the driver's position in a type at least 12.7 mm (½ in) in height, 1.5 mm (1/16 in) stroke (width of type).





Product Storage Identification

"Fill Connection Labeling," the fill connection for any petroleum product storage tank or vessel supplying engine-fuel devices shall be permanently, plainly, and visibly marked as to the product contained by means of:

- (a) A permanently attached tag or label and;
- (b) American Petroleum Institute color codes as specified and published in "API Recommended Practice 1637".



NOTE: For locations storing both blended and unblended gasoline, according to the practice, use the appropriate gasoline symbol surrounded by a white circle for PU and MG, and a black circle for RU to indicate gasoline containing ethanol.



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Questions?



Rules & More Information Can Be Found At:

<http://state.tn.us/agriculture/regulatory/petroleum.html>