



NREL UL Fuel Dispensing Infrastructure Intermediate Blends Performance Testing



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Goal Statement

- **Determine compatibility and safe performance of installed fuel dispensing infrastructure with E15**
- **NREL's UL Fuel Dispensing Performance Testing Project applies to several key focus areas of OBP's Infrastructure platform:**
 - Examine the impact of intermediate ethanol blends on infrastructure
 - Identify safe and low-cost biofuels delivery infrastructure
 - Determine materials compatibility through testing
 - Facilitate development of infrastructure for RFS
 - Meet major milestone of testing and characterizing infrastructure with E15
- **This project meets OBP Programs mission of biofuels deployment support & programmatic goal of supporting the RFS**

Timeline, Budget, Barriers, & Partners

Timeline

Project start date: October 2009
Project end date: November 2010
Percent complete: 100%

Budget

Total project funding

- DOE share: 100%

Funding for FY10: \$500,000

Barriers Addressed

- Dt-B Codes, Standards, and Approvals for Use
- Dt-C Materials Compatibility
- Dt-F Limited Understanding of Downstream Infrastructure Needs
- Mm-A. Level of Industry & Consumer Acceptance & Awareness

Project Participants

Underwriters Laboratory
ORNL

Project Overview

History

- Spring 2007 – DOE kicks off intermediate blends test program
- October 2007 – UL develops E85 Fuel Dispensing Test Protocol
- December 2007 – EISA sets RFS

Context

- Ethanol is a near-term solution for meeting RFS requirements
- E10 is blended into 90% gasoline; blend wall approaching
- Fueling infrastructure intended for blends up to E10
- Limited vehicles and fueling infrastructure for E85

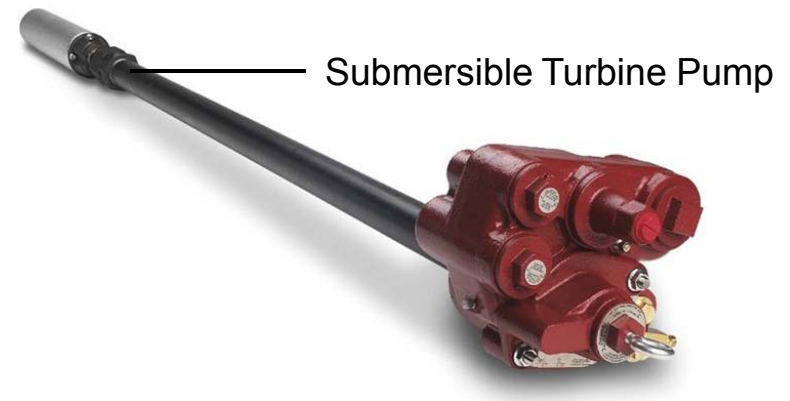
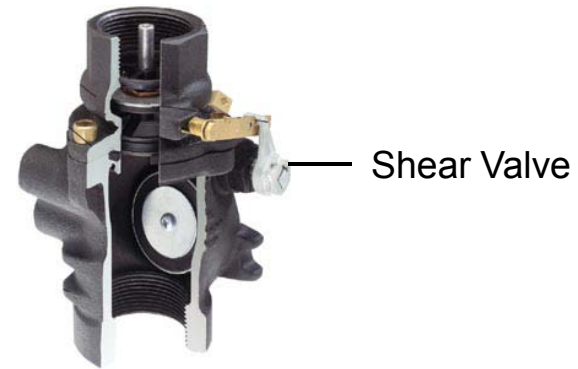
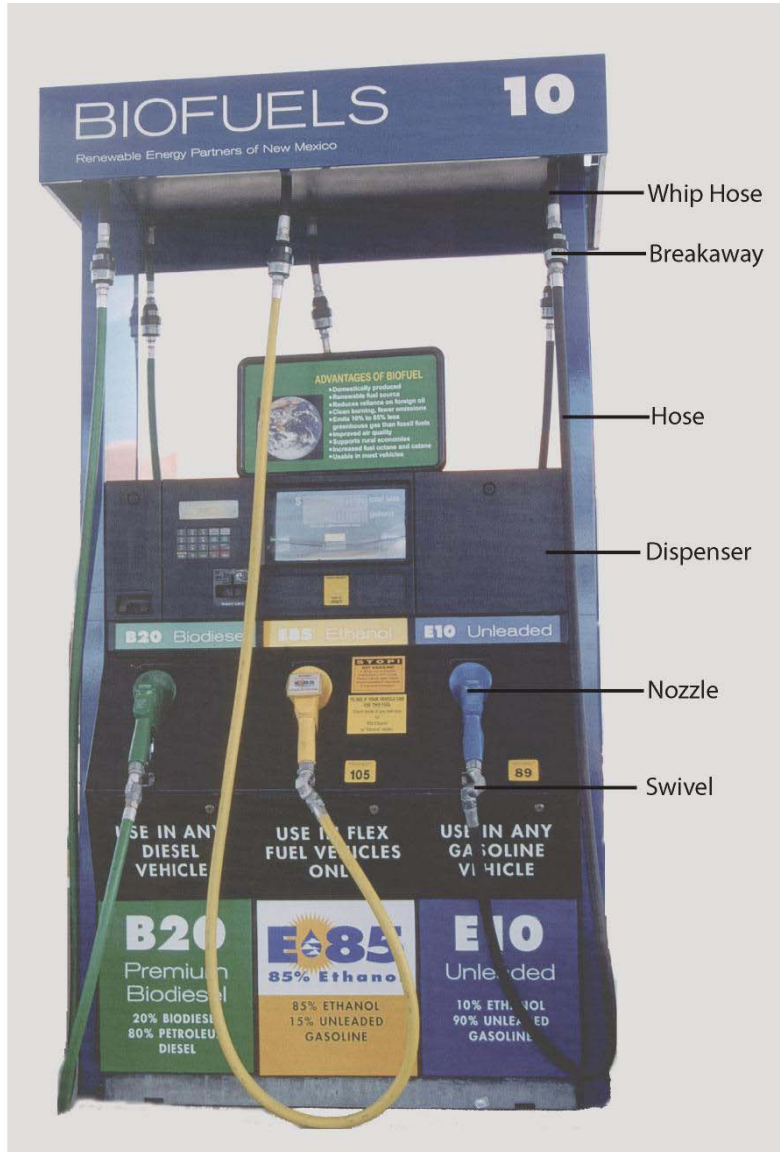
Objectives

- Determine compatibility and performance of installed fuel dispensing equipment with E15

Approach

- **Testing protocol: UL Subject 87A-E25**
 - 15 week conditioning test at 60°C to simulate aging
 - Performance tests for each equipment type (days to two weeks)
 - The testing protocol states that the test end when a failure occurs; NREL modified the test to continue after failure in order to gather more data
- **Testing fluid CE17A SAE J1681**
 - 83% ASTM Reference Fuel C (50% toluene; 50% isooctane) & 17% ethanol with the addition of water, salt, and acid
 - E17 selected rather than E25 certification fuel; E25 is toughest test fluid for this equipment type; E17 accounts for over blending
- **Equipment Test List**
 - Identified best selling equipment overtime with assistance from PEI, API, Manufacturers, Distributors, and Volume Buyers
 - Equipment tested represents 80% of marketplace
 - No repetitions; one of each equipment make and model was tested; this is how UL handles listings; limited lab space
- Monthly status reports on progress; updated to weekly discussions after unexpected results during performance tests

Equipment Tested



Technical Accomplishments/ Progress/Results

- **Status-Results were published in November 2010**
- **Post-mortem and materials analysis on completed work continues**
- **Study results directly apply to OBP's Infrastructure Program MYPP milestone of testing and characterization of infrastructure with E15 by FY11**
- **Results from NREL and ORNL studies highlight materials best suited for ethanol/gasoline blends**
 - This will lead to low cost solutions for introducing more biofuels into the marketplace

Technical Accomplishments/ Progress/Results 2

Equipment	New-Pass	Used-Pass	Overall-Pass
Breakaways	2 of 5	1 of 4	3 of 9
Flow limiters	1 of 1		1 of 1
Hose/Hose Assemblies	8 of 9	4 of 6	12 of 15
Nozzles	3 of 6	1 of 4	4 of 10
Swivels*	3 of 4	3 of 5	6 of 9
Dispenser Meter/Manifold/Valve Assemblies	0 of 2	0 of 4	0 of 6
Shear Valves	3 of 3		3 of 3
Submersible Turbine Pumps	1 of 1		1 of 1
Pass includes fully compliant and inconclusive test results that showed no safety hazzard or leakage			
*Includes swivels integral to hose assemblies			

- **No clear trends were established;** 68% of new equipment and 47% of used equipment passed
- Some equipment performed well: hoses & hose assemblies; shear valves; submersible turbine pump
- Some equipment performed poorly: dispenser meter assemblies; breakaways and nozzles

Technical Accomplishments/ Progress/Results 3

- **Most failures occurred during performance testing**
- **Metals performed well; no impacts observed**
- **Failures occurred in sealing materials:**
 - Gasoline ethanol blends cause gaskets to swell—this may impact performance over the life of the gasket; swelling beyond 20% is problematic
 - More appropriate sealing materials and methods are expected to perform better
 - Test fluid was extracted during the conditioning phase
 - Analysis found organic compounds in extracted fluids
- **Dispenser meter failures significant due to life and cost of dispensers (~15 years; ~\$15,000)**

Relevance

Meeting OBP Missions and Goals of contributing to volumetric targets in RFS & Meeting Infrastructure Milestone of E15 Testing

- The findings of this scoping study reveal additional work is needed to introduce E15 into the marketplace and meet RFS volumes
- The project identified potential issues with increasing ethanol content in installed fuel dispensing equipment; specifically, sealing materials & methods
- The project highlighted equipment that performed well and may be able to pass UL certification for E25 with minimal, low cost materials upgrades
- Results were communicated to manufacturers and related industries; manufacturers are considering altering materials specs to move towards products compatible with ethanol/gasoline blends

Benefits and Expected Outcomes

- **Study findings highlight areas for improved fuel dispensing products that will enable higher ethanol blends with low costs for modifications**
- **Manufacturers appreciate the research and dataset from this study**
- **DOE & National labs recently met with manufacturers to address solutions to outcomes of this study to move forward in deploying more biofuels**
- **Targeting specific equipment parts with low cost modifications for better performance**
 - **Engineered materials compatible with ethanol/gasoline blends may cost five times more but may only add ~\$500 to a dispenser (~\$15,000) of a few dollars to hanging hardware equipment**

Summary

Relevance

- RFS and impending blend wall necessitated a need to determine compatibility of existing fueling infrastructure with E15

Approach

- A proven test methodology and an approved test fluid were used to test performance of best selling new & used equipment

Technical Accomplishments

- Study is complete highlighting areas for improvement in fuel dispensing equipment to accommodate E15

Success Factors and Challenges

- Identification of low cost changes to improve performance & significant industry participation

Technology Transfer and Future Work

- Retrofit kits; workshops with manufacturers; Analysis with ORNL & UL

Additional Slides-Results Statistics

Equipment	Statistics on Passing Results		
	New	Used	Overall
breakaways	40%	25%	33%
flow limiter	100%	--	100%
Hoses	89%	67%	80%
Dispenser Meter/Manifold/Valve Assemblies	0%	0%	0%
nozzles	50%	25%	40%
shear valves	100%	--	100%
swivels	75%	60%	67%
STP	100%	--	100%

Additional Slides-Extracted Dispenser Test Fluids

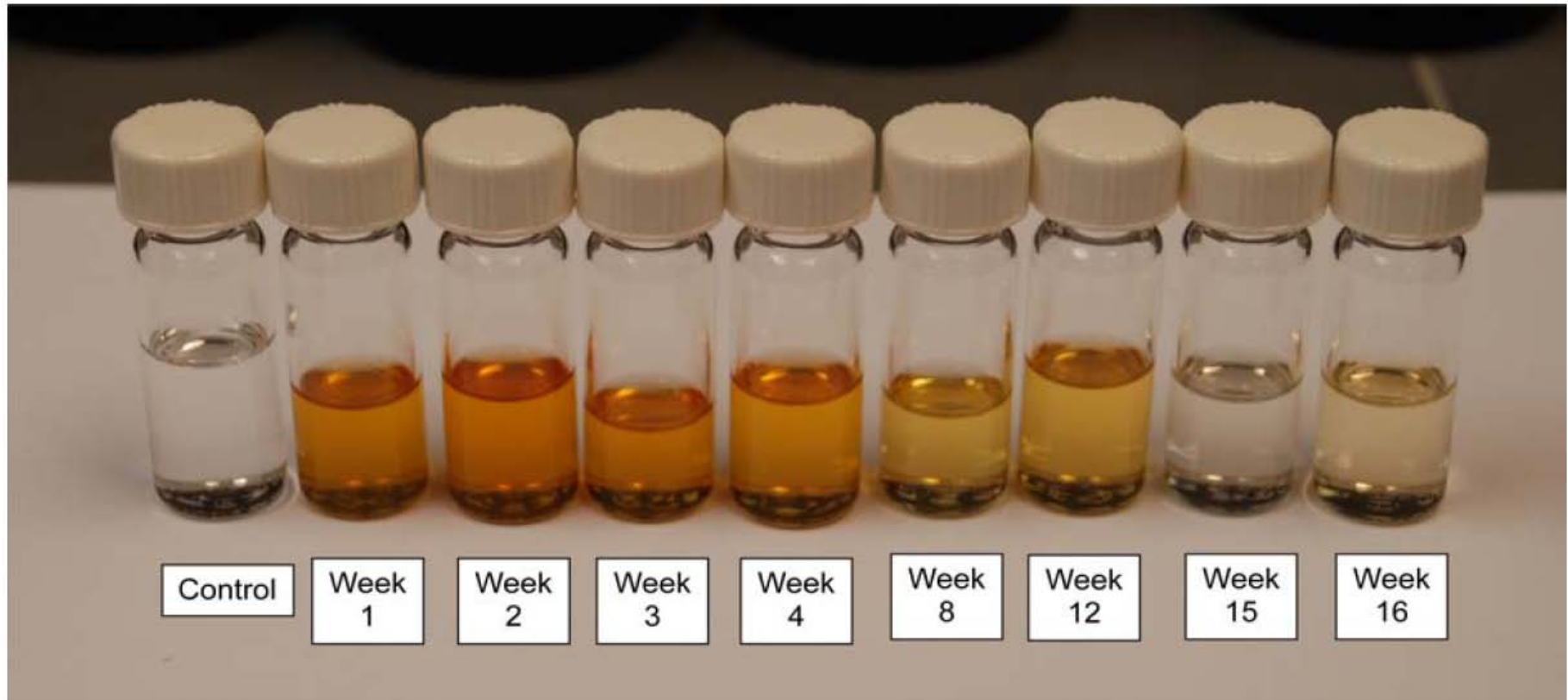


Figure. 1. Photograph showing the weekly change in appearance of fluid extracted from Unit 1.

Additional Slides-Example of Failure



Additional Slides-UL Conditioning Lab



Publications and Presentations

Reports

- “Dispensing Equipment Testing With Mid-Level Ethanol/Gasoline Test Fluid” NREL/SR-7A20-49187, November 2010

Presentations

- SAE Government Industry, January 2011
- API Industry Stakeholder Meeting, January 2011
- DOE, National Labs, Fuel Dispensing OEM Meeting, January 2011