Codifying Use of Density Correction for Gasoline-Ethanol Blends in Liquid Measuring Devices

LMD-26.1 S.2. Measuring Elements, S.4. Marking Requirements, N.4. Testing Procedures, T.5. Density Correction Systems, UR.3.6. Temperature Compensation and Volume Correction, Wholesale

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Density Correction of Gasoline-Ethanol Blends

Fact: The volume of gasoline and ethanol when blended is more than the volume of the two liquids measured separately.

Some terminals measure the blended product in the custody transfer meter, while others use multiple custody transfer meters to measure the gasoline and ethanol and do not capture the volume gain.

Issue: An inequity occurs because of this difference between the terminals.

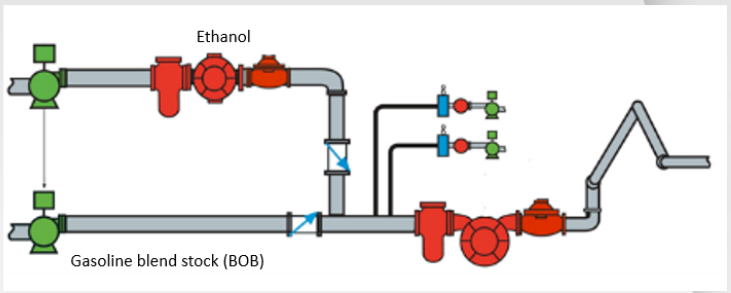
Solution: For terminals that don't measure the volume growth in the final blended product, they can apply the same industry standard that is used to calculate net temperature compensation to calculate the gain in volume due to the density change.

Density Correction

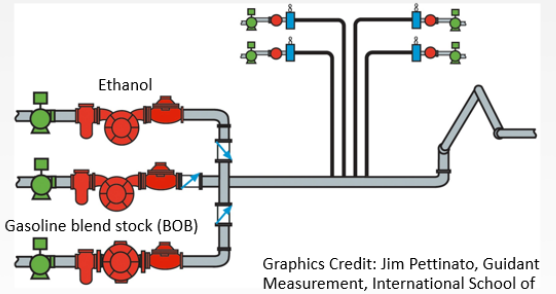
- Gasoline blended with ethanol expands about 0.2% (range 0.08% to 0.3% dependent on BOB density and ethanol blend percentage)
- Ratio Blending terminals do not measure this expansion while Side-Stream does
- Application of API Standard (MPMS Ch. 11.3.4) corrects the inequity without replumbing terminal rack

Two Examples of Terminal Blending Configurations

1. Side-Stream blending with Custody Transfer Meter after the gasoline and ethanol are blended.

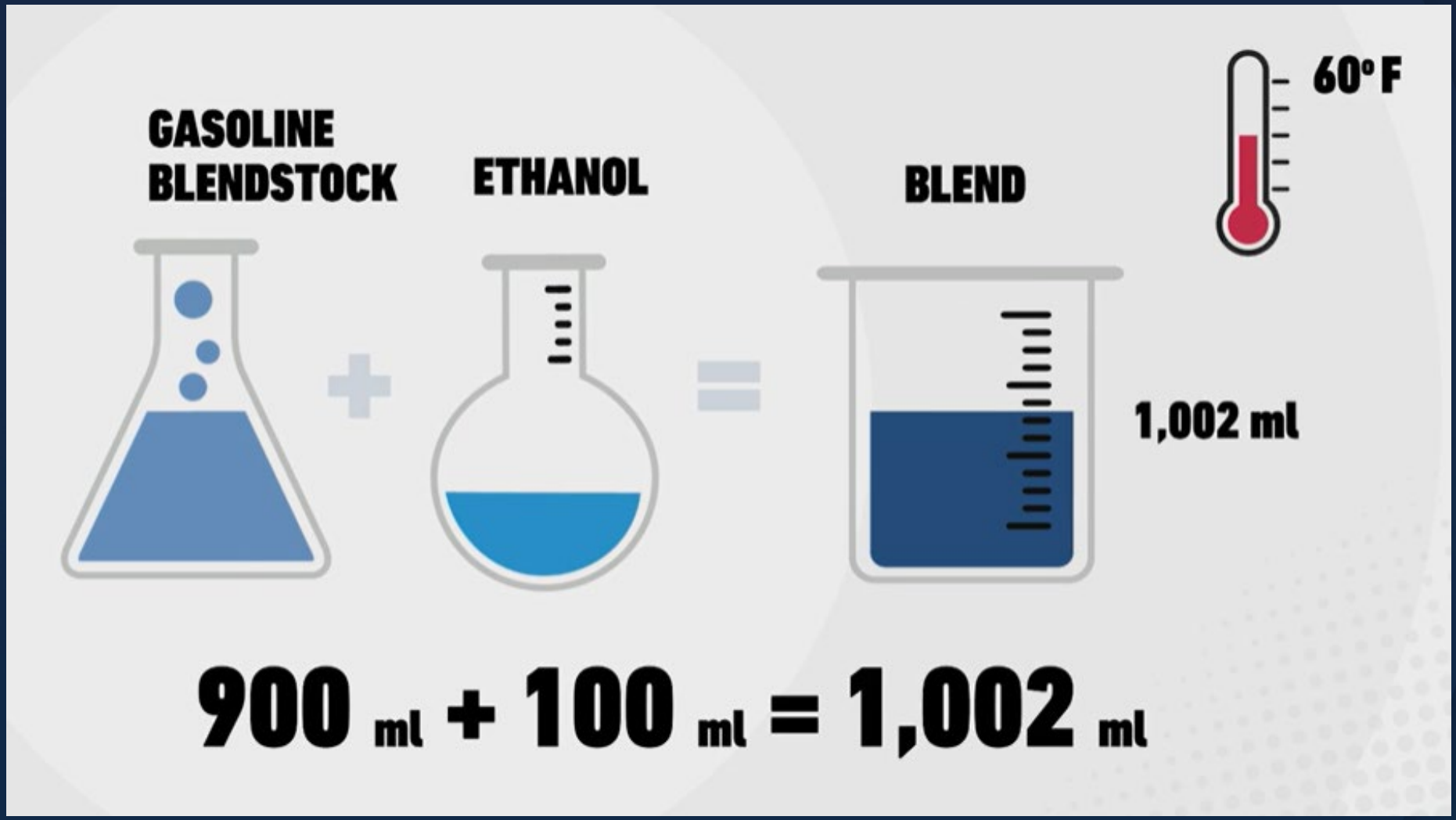


2. Ratio Blending with Custody Transfer Meter on gasoline blendstock and ethanol



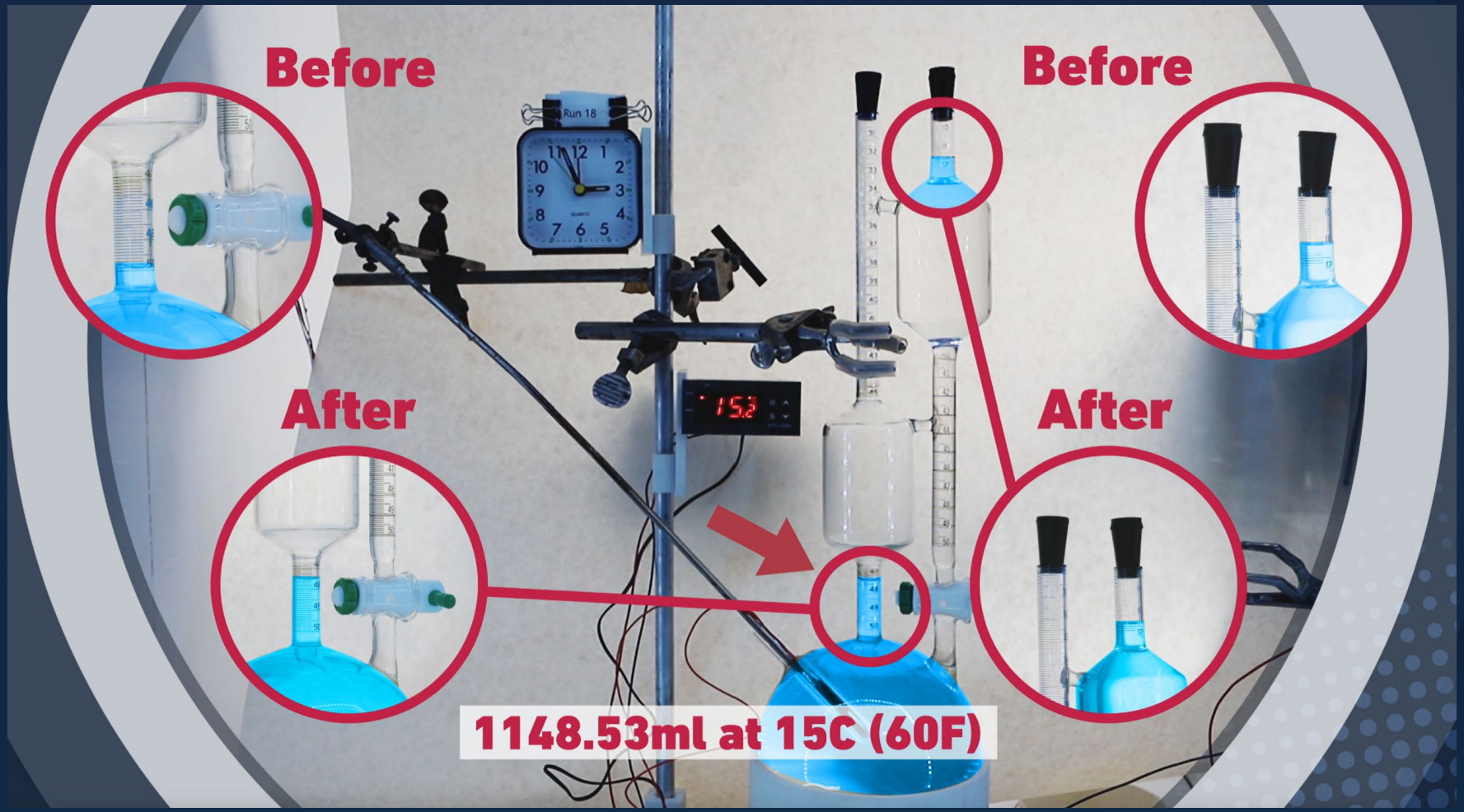
Graphics Credit: Jim Pettinato, Guidant Measurement, International School of Hydrocarbon Measurement.

Gasoline & Ethanol Blending Explained



- https://cdn.api.org/videos/API-Ethanol-Blending-Long-Full-Video.mp4

Physical Demonstration – Volume of finished gasoline-ethanol fuel after blending



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LMD-26.1 – Changes Made to Address Input Shared at Regional Meetings

- Retroactive vs. Nonretroactive
- S.2 Measuring Elements – Requires ATC if one is using Density Correction (DC) – Changes made for clarification
  - Focuses on “wholesale” added “register” and specify the use for gasoline and ethanol blends
  - Deleted paragraph S.2.9.1(b) redundant and
  - Deactivation is possible to allow for indication of uncorrected volume (S.2.9.2)
  - Deleted sealing provision S.2.9.3 – Already required in G-S.8 and 3.30 S.2.2.
- S.4 Marking Requirements – Requires clear labeling on indicating elements to show adjustment that has been made
- N.4 Testing Procedures – requires comparison of indicated device to temperature corrected volume
  - Added reference standard ASTM D1250, *Guide for the Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1* (which incorporates API Ch. 11.3.4, specifically)
  - Identifies testing for Activated DC and Deactivated DC

LMD-26.1 – Changes to Address Concerns Heard at Regional Meetings

- T.5. Tolerances Density Correction Systems
  - Revised to add reference to ASTM D1250 (which incorporates API Ch. 11.3.4, specifically)
  - Clarifies difference is between net final blended (including excess volume) and the calculated excess volume

- UR.3.6. Temperature Compensation and Volume Correction, Wholesale – Requires language on invoice for TC for each metered component and DC, Requires statement, **"Volume delivered has been adjusted to the volume at 15 °C (60 °F) and for changes in density."**
  - For DC – Includes requirements for ATC (i.e., API Gravity, Temperature, gross reading), how many gallons gained and total of ATC plus additional gallons

Ratio Blending Rack – What's involved in adding a meter?

- Engineering Design
  - Pump design
  - Piping reconfiguration
  - Piping size from storage tanks
  - Flow control valve, Metering, RTD
- Equipment procurement
- Availability of skilled labor
- Permitting
  - Raze facility - permitting might not be possible to rebuild
- Shut down for rebuild
  - Operational costs of shutting down
  - Impact to fuel supply during shutdown (longer lines for tank trucks to load)

LMD-26.1

- Net volume temperature compensation
  - Proving the individual components (BOB and Ethanol) to 60° F requires the implementation of multiple API standards including API MPMS Ch. 11.1, 11.3.3, and 11.3.4., 4.x and 12.
  - Proving tools include spreadsheet, lookup tables, or commercial software
- Volume expansion when blending gasoline and ethanol
  - Proving the volume expansion when the components are blended uses API MPMS Ch. 11.3.4.
  - Proving volume expansion uses same variables as proving net temperature compensation plus the ideal fraction of ethanol

Questions?

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Background

Proposed Changes to HB 130 and HB 44

- **HB 130 - MOS-26.3**
  - Section 2.20 Gasoline and Gasoline Oxygenate Blends Section
- **HB 44 – LMD-26.1**
  - S.2. Measuring Elements
  - S.4. Marking Requirements
  - N.4. Testing Procedures
  - T.5. Density Correction Systems
  - UR.3.6. Temperature Compensation and Volume Correction, Wholesale

Committee of Petroleum Measurement

- Responsible for the Manual of Petroleum Measurement Standards (MPMS)— the most widely cited standards by regulators addressing global custody transfer operations
- Over 200 standards used throughout industry
- Multiple API standards used to measure gross volume and more than 10 standards used at terminal rack for net calculation

Subcommittees include:

- Measurement Education and Training
- Evaporation Loss Estimation
- Production Measurement Allocation
- Measurement Accountability
- Measurement Quality
- Gas Fluid Measurement
- Liquid Measurement

API standards used in terminal measurement systems:

Established trade and customs to measure finished gasoline

- Ch. 8.1 Manual Sampling of Petroleum Products
- Ch. 5.x Metering
- Ch. 6.x – Metering Systems
- Ch. 4.x Proving Systems
- Ch. 7.4 Dynamic Temperature Measurement
- Ch. 11 Physical Properties Data
  - Chapter 11.1 - Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils (ASTM D1250 Adjunct standard for volume correction factors)
  - Ch. 11.3.3 Miscellaneous Hydrocarbon Product Properties—Denatured Ethanol Density and Volume Correction Factor
  - Ch. 11.3.4 Miscellaneous Hydrocarbon Properties - Denatured Ethanol and Gasoline Component
  - Ch. 11.4.1 Density of Water and Water Volumetric Correction Factors for Water Calibration of Volumetric Provers
- Ch. 12.2 Calculation of Petroleum Quantities using Dynamic Measurements
- Ch. 21.2 Electronic Liquid Measurement

Variable	Net Volume Temp Compensation	Density Correction (Additional Volume)
Reference Density of Gasoline (BOB) in API gravity units	✓ (API MPMS 11.1)	✓ (API MPMS 11.1)
Reference Density of Ethanol in API gravity units	✓ (API MPMS 11.3.3)	✓ (API MPMS 11.3.3)
Gross Meter Readings	✓ (API MPMS 12.2)	✓ (API MPMS 12.2)
Product Temperature (load average)	✓ (API MPMS 7.4)	✓ (API MPMS 7.4)
Net Meter Readings	(output from Temp Comp)	✓
Ideal Fraction Ethanol (i.e., ethanol blend percentage)		✓ (API MPMS 11.3.4)

Proving at the terminal

- Net volume temperature compensation
  - Proving the individual components (BOB and Ethanol) to 60° F requires the implementation of multiple API standards including API MPMS Ch. 11.1, 11.3.3, and 11.3.4., 4.x and 12.
  - Proving tools include spreadsheet, lookup tables, or commercial software
- Volume expansion when blending gasoline and ethanol
  - Proving the volume expansion when the components are blended uses API MPMS Ch. 11.3.4. which is part of Ch. 11.1.
  - Proving volume expansion uses same variables as proving net temperature compensation plus the ideal fraction of ethanol
- Gasoline BOB $_{(\text{net volume})}$ + Ethanol $_{(\text{net volume})}$ ≠ Gasoline-Ethanol Blend $_{(\text{net volume})}$
  - Thus, the need for using MPMS 11.3.4

Density Correction

- 9 meetings held about every two weeks from March – Aug
- Developed final wording and submitted Form 15 to NCWM on August 15 deadline
- Regional Meetings
- Interim Meeting in January
- Goal to vote at NCWM Annual meeting July 2026

Density Correction Work Group

- 5 States represented – IL, OR, TX, KS, MO
- 2 NIST staff
- 2 Retailer reps
- 5 Meter manufacturers
- 12 Terminal operator companies
- 3 Consultants