NYSEARCH
Natural Gas RD&D

SwRI
SOUTHWEST RESEARCH INSTITUTE

PRCI LEADING PIPELINE RESEARCH
Pipeline Research Council International

REX2024
PRCI Research Exchange

Hydrogen-Blended Natural Gas Flow Measurement Challenges for Local Distribution

Based on NYSEARCH Funded Testing at SwRI

Matthew Godush

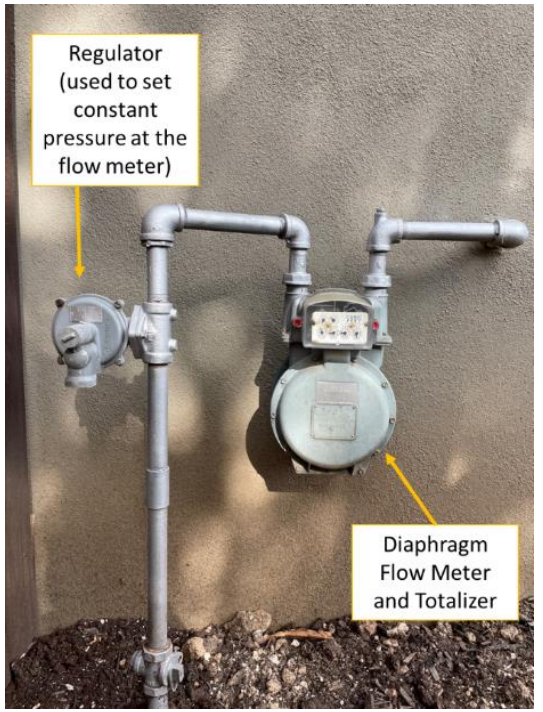
San Diego, California

February 27, 2024

4:30 – 5:00 PM, California Ballroom A

Background

- **Blending hydrogen into natural gas will utilize existing infrastructure, but the components, calculations, and assumptions need to be evaluated**
- **Specifically, with regards to gas distribution and measuring delivered energy**
  - Are the equations of state valid for significant hydrogen content in blended gas?
    - How is the expected mass density affected?
    - How is the heat of combustion affected?
  - Are the flow meters used in the field compatible and accurate at measuring blended gas?



Example field meter installation

Project Setup & Goals

- **Research from 2022 – present, funded by NYSEARCH – Northeast Gas Association**
  - Funded by a group of LDCs
- **Direct evaluation of hydrogen's impact on blended gas with respect to**
  - Gas properties
    - Mass density
    - Heat of combustion
  - Flow meter performance

$$Therms = Q_{volumetric} \times \rho_{gas\ blend} \times HOC \times time$$

Gas sold to customer	Gas measured by flow meter	Density of gas blend	Heat of Combustion for blended gas	Billing cycle

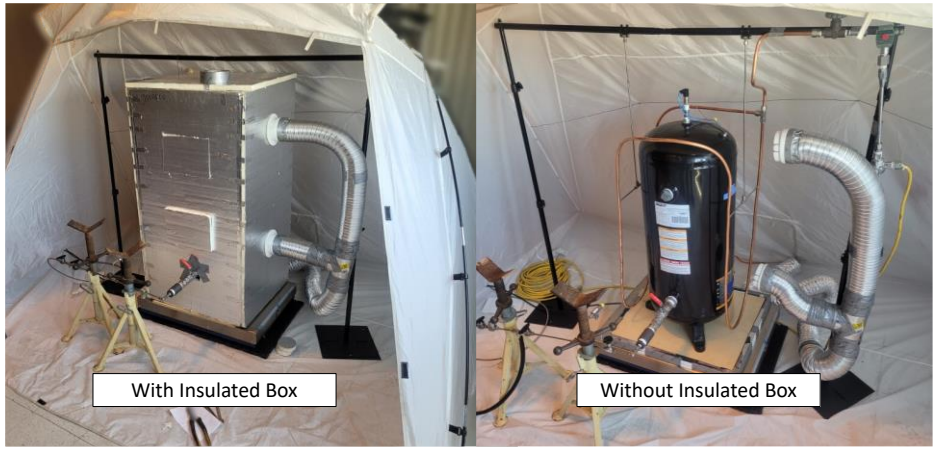
Test Facilities

- **Flow meter testing performed in a single-pass system**
  - Blended gas test facility developed under this project
  - Branched off from MRF High Pressure Loop, used to supply natural gas stream
- **Gas Properties testing performed in MRF Weigh-Tank Room**

Metering Research Facility (MRF) at SwRI, comprised of a high-pressure loop, low-pressure loop, blended gas test facility, wet-gas loop, and weigh-tank room

Gas Properties Testing

- **Mass density testing conducted via pressurized control volume**
  - Similar function to primary MRF weigh tanks, used as ultra-low uncertainty references for nozzle testing
  - Test plan includes controls and data points for temperature, pressure, composition, and %H_2
- **Heat of Combustion testing to be completed in Q2 of 2024**
  - Initial testing with adiabatic jacket calorimeter
  - Ongoing testing with burning flame BTU analyzer

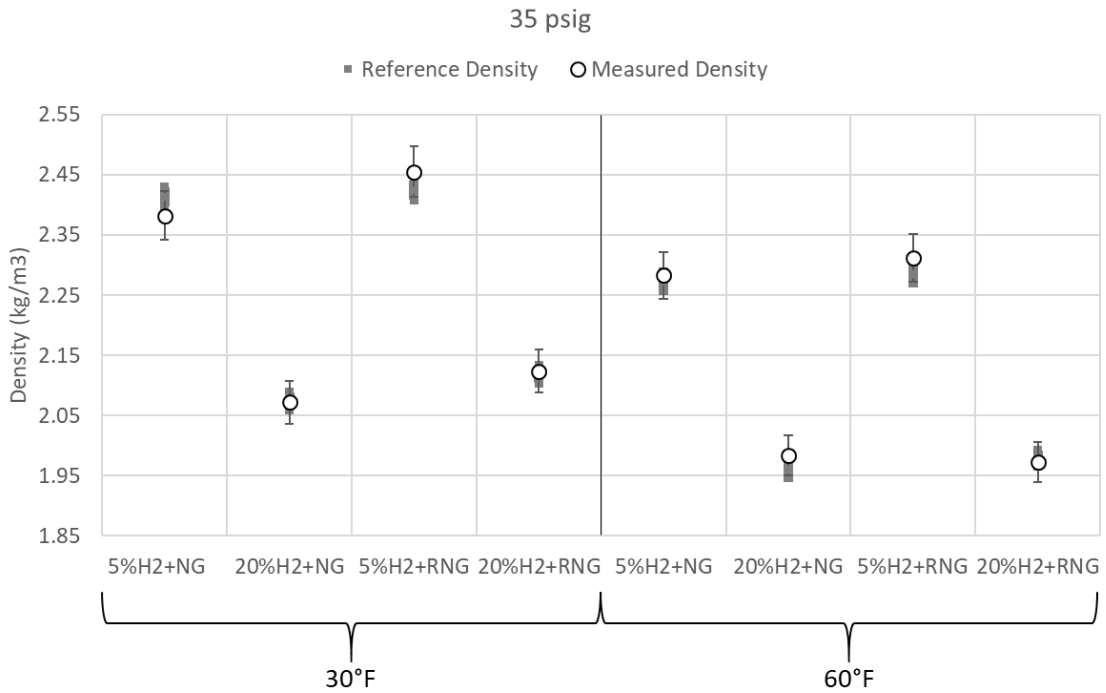


Blended gas weigh-tank system used for measuring mass and calculating gas density

Main MRF gas weigh-tank during initial setup

Gas Properties Testing – Results

- **Results compared to AGA-8 and GERG equations of state**
- **Test conditions include**
  - Pressures tested from near atmospheric to 35 psig
  - Temperatures from 15°F to 60°F
  - Compositions of distribution-grade natural gas and synthesized RNG
- **Sample data shown demonstrate agreeance between measured and reference densities**



Measured density vs reference calculations (AGA-8) at 35 psig for natural gas and RNG blended with H_2

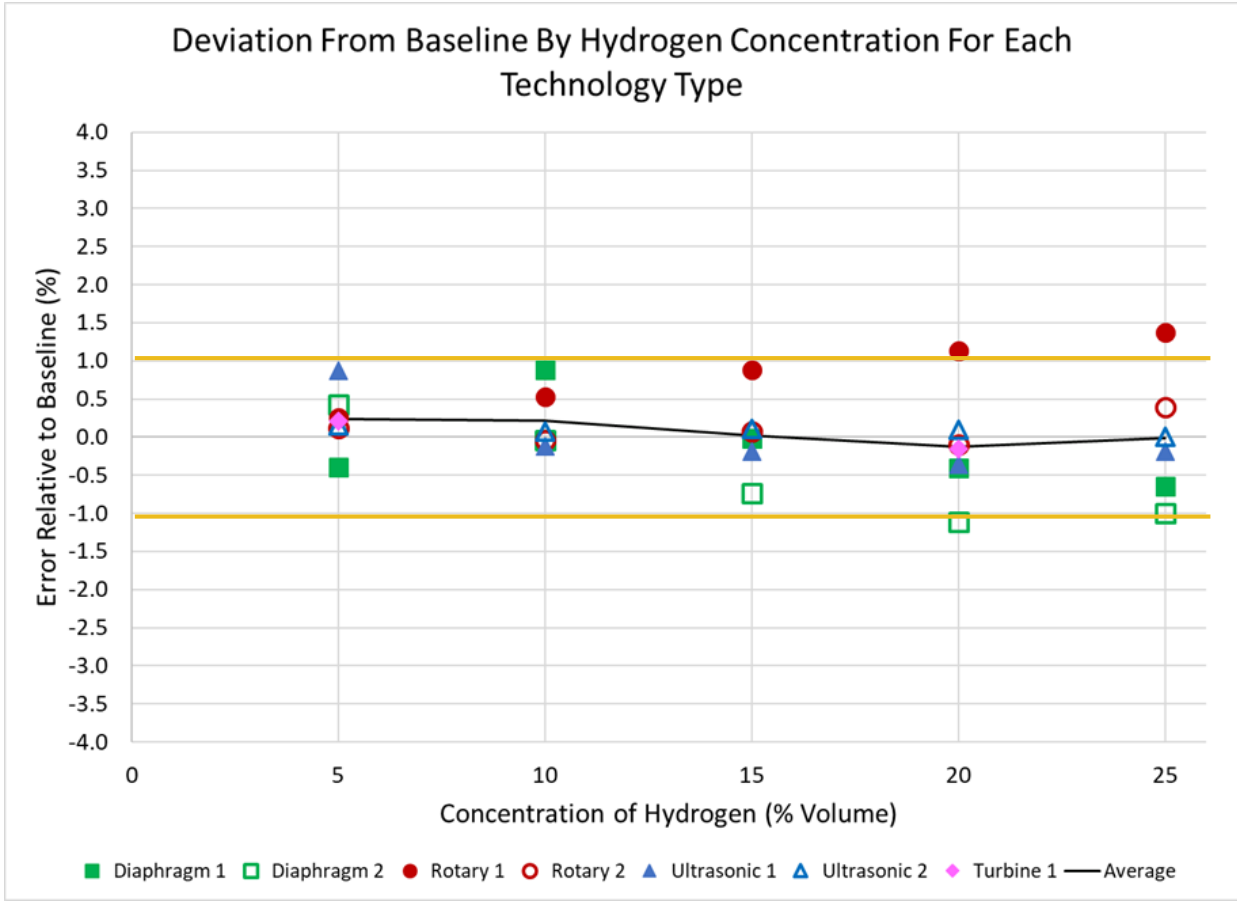
Flow Meter Performance Testing

- **Flow meters tested in blended gas environments ranging from 5% – 25% H_2 by volume**
  - Independent references used for each gas stream
  - Pressure controlled to model field conditions
- **Four technologies tested across two project phases**
  - Ultrasonic, turbine, rotary, and diaphragm
  - Multiple units tested of each technology type

Flow measurement team at the Blended Gas Test Facility at SwRI

Flow Meter Performance Testing – Results

- **Overall deviation from baseline (0% H_2) was not significant**
  - 29/32 data points within ±1%
  - One rotary meter showed small positive trend with increasing H_2
- **Each data point represents data collected over 1 – 5 flow rates for each meter at each H_2 concentration**
  - Sampling times designed to adequately eliminate short-term transient effects



Flow Meter Case Study

- **Based on funder-provided data on meter types present in the field**
  - Residential and commercial
  - Large majority of meters are diaphragm
  - Ultrasonic and turbine meters are less common, but each unit typically sees higher flow rates of gas
- **This data will be used along with results from gas properties and flow testing to estimate total impact of discrepancies**

Rainbow in background of turbine flow meter testing

Conclusions

- **Gas density values relatively in line with equations of state for <20% H_2**
  - Further testing is not being pursued at this time
- **Further testing is ongoing for heat of combustion**
  - New setup should yield results in Q2 of 2024
- **Flow meter performances generally within acceptable limits for <25% H_2**
  - Combining uncertainties with meters' repeatability values and observed baseline behavior relative to reference, the results were not cause for concern
  - There is more variability in performance at higher concentrations
- **Discussions with NYSEARCH are ongoing regarding more extensive testing**

thank you

REX2024
PRCI Research Exchange

Matthew Godush
Research Engineer, SwRI

210-522-5742

Matthew.Godush@swri.org