ASHRAE HVAC&R Student Competition 2022

Diagnosing and Remote Sealing of Leakage in Low-Pressure Sections of Natural Gas Distribution Networks

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BACKGROUND

- Natural Gas is constituted mainly of Methane (90%)
- Residential sector contributes to 15% of California's natural gas emissions
- California's ambitious climate change goals of reducing the GHG emissions by 40% below the 1990 levels by 2030

RESEARCH QUESTIONS

- How Leaky is our residential natural gas infrastructure?
- Can we remotely and non-invasively seal post-meter natural gas leaks?

METHODOLOGY

1) Leakage Diagnosis

- Steady state leak testing in the lab to characterize the relationship between flow and pressure
- Field Testing of leakage in 10 natural gas networks

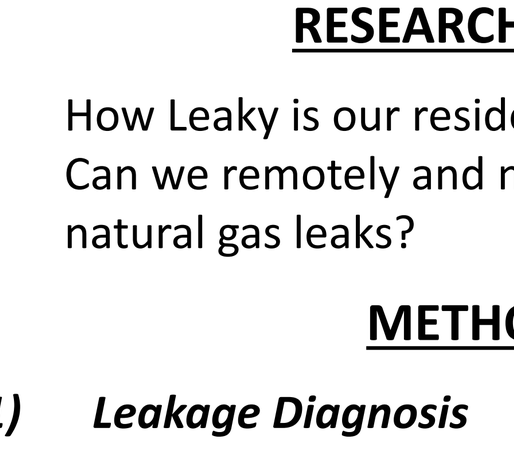


Fig 1. Lab testing apparatus

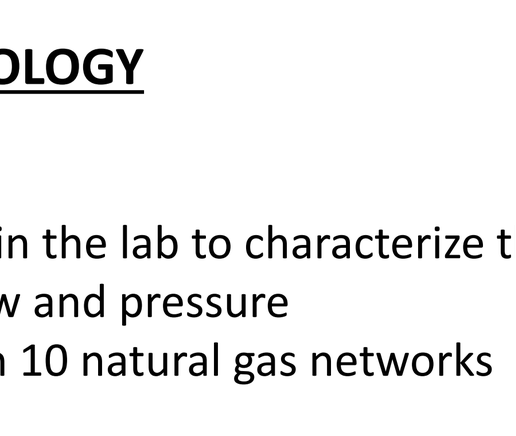
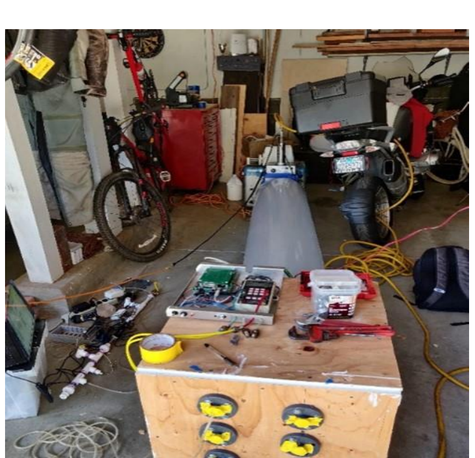


Fig 2. Field testing apparatus

2) Leakage Sealing

- Remote and non-invasive sealing of an example network
- Measuring the leakage before and after sealing



a.

b.

Fig 3. Pipe Sealing Apparatus

MAJOR FINDINGS

1) Leakage Diagnosis

- Identified a linear relationship between mass flow rate and pressure
- Leakage in 8 out of 10 gas networks in the field was below the detection limit
- Highest leakage detected in the natural gas networks tested was 23.2 standard mL/day/Pa

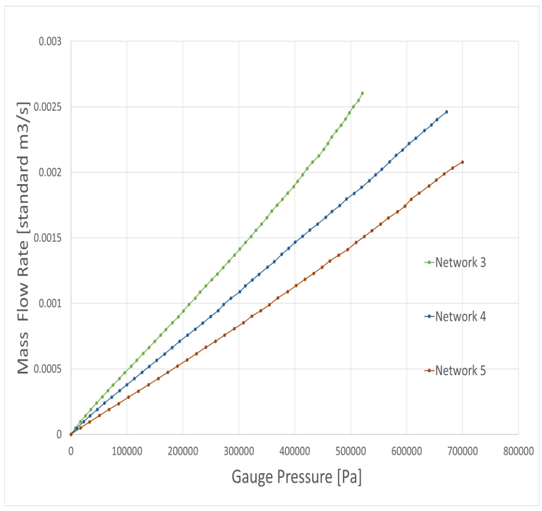


Fig 4. Mass flow rate versus pressure

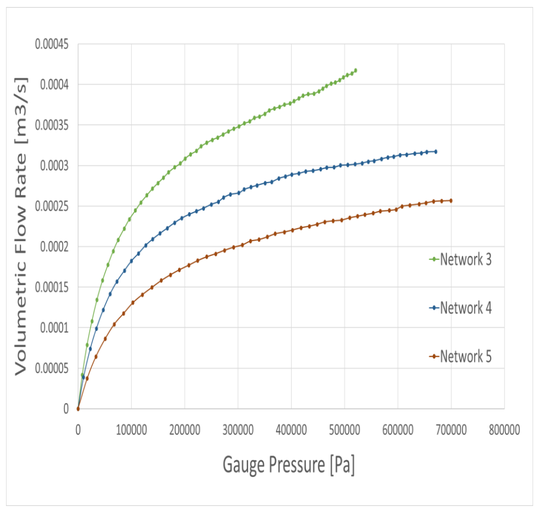


Fig 5. Volume flow rate versus pressure

Fig 6. A leaky shutoff valve observed in the field

2) Leakage Sealing

- Observed a 50 % of reduction in leakage after sealing
- Leakage after sealing was still 74 times the highest leakage detected in the field

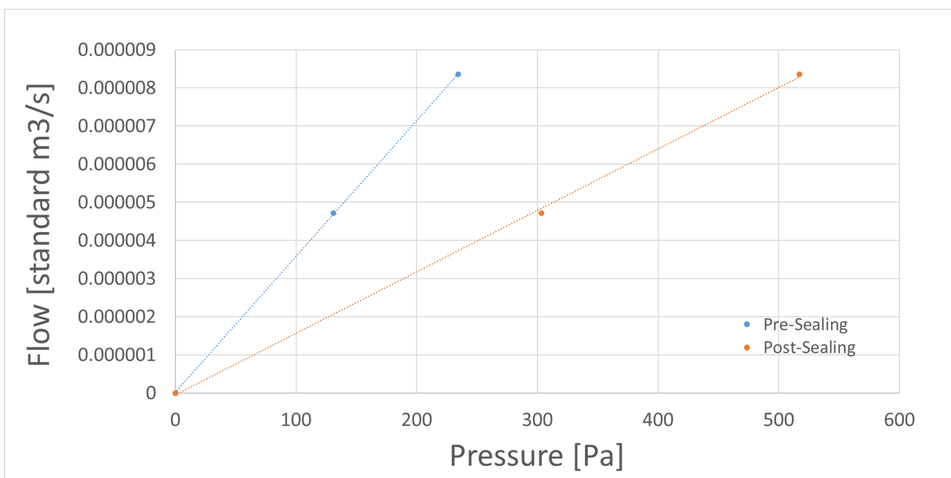


Fig 7. Comparison of leakage before and after sealing

KEY TAKEAWAYS

- Gas temperature variations affect leakage measurements
- Room for improvement in the aerosol sealing process
- If technology comes to fruition, it may have a positive impact in reducing GHG emissions