Self-Pressurizing Propellant Tank Dynamics

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Self-Pressurizing Propellants

Nitrous Oxide ($\text{N}_2\text{O}$)
- Storable, non-toxic
- Saturation pressure of 736 psia at 25 °C
- Critical point: 36.4 °C, 1051 psia
- $I_{sp}$ performance similar to $\text{H}_2\text{O}_2$ or $\text{HNO}_3$
Experimental System

- **ID:** 1.0 in
- **Wall thickness:** 0.25 in
- **Length:** 14 in
- **Volume:** 11 in$^3$
- **Material:** quartz
Videos

Gravity

Liquid

Vapor

Exit

Thermocouple probes

Liquid level

Valve

Playback speed: 1/20
Typical Results
Net Results to Date

Parameters varied:
- flow rate
- fill level
- temperature
- temperature field
- nucleation site density
- initial bubble population

Two temporal regimes:
- Early times: transient bubble nucleation
- Later times: phase equilibrium
Summary & Next Steps

**Problem**
- Early times: transient bubble nucleation
- Later times: phase equilibrium
- Parameter variations do not affect fundamentals

**Approach**

**Results**

**Next Steps**
- Experiments: evaluate scaling effects with larger system
- Modeling: use population balances coupled with 1D discretization

**Conclusions**
- Early times: transient bubble nucleation
- Later times: phase equilibrium
- Parameter variations do not affect fundamentals

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