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## Design of Pressurized Metered Dose Inhalers Modeling of Internal Flow and Atomization

**Henk Versteeg** and Abdul Qaiyum Shaik
*Loughborough University*

Pressurized metered-dose inhalers (pMDIs) have been the most effective therapeutic treatment for controlling lung diseases such as asthma and COPD. The flow through a two-orifice system of pMDI is very complex and poorly understood. Previous experimental work has shown that metastability may play a significant role in determining the flow conditions inside pMDIs. In this paper, we present the findings of a homogeneous equilibrium model with those of a delayed equilibrium model (DEM) accounting for propellant metastability. These results are compared with the available experimental and numerical predictions Further, the DEM was applied with HFA propellants R134A and R227, and the results were compared with traditional propellant R12.

## A Testbed for Multilumen Steerable Needle Experiments

**Jadav Das,** D. Caleb Rucker, and Robert J. Webster III
*Vanderbilt University*

Steerable needles offer the potential to turn corners during insertion, thereby avoiding obstacles, reducing tip placement error and enabling a less invasive access to challenging anatomical locations. In this paper, we describe an experimental testbed designed to facilitate experiments with several popular steering mechanisms. One such mechanism makes use of asymmetric forces generated by a bevel tip for actuating steerable needles, and another uses multiple concentric precurved tubes that can change the needle shaft shape by rotating within one another and extending telescopically. The experimental testbed consists of a new robotic actuation unit for controlling axial rotation and linear translation of multiple tubes. It also includes stereo-optical cameras and a magnetic tracking system for the feedback of needle shape and tip location. The setup can be used in future work for model validation and closed-loop feedback control of steerable needles and cannulae.

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