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**Simulations of supersonic highly under-expanded hydrogen jets**

ANA MIARNAU MARIN, CHENG-NIAN XIAO, FABIAN DENNER, BEREND VAN WACHEM, Imperial College London — The pressure drop across choke valves required to transport natural gas can be in the order of several hundred bars, leading to the development of supersonic under-expanded jets. When considering a real gas, the gas can cool upon expansion, a phenomenon which can be explained by the Joule-Thomson effect. This study compares the effects of using ideal and real gas equations of state, using a computational model in which hydrogen is released from a high-pressure tank, through a converging nozzle, into a chamber containing hydrogen at near-atmospheric conditions. The initial studies were carried out using an ideal gas assumption and nozzle pressure ratios of 10, 30 and 70 and the results were validated against existing literature. To account for the Joule-Thomson effect, ideal and real gas simulations were then carried out with a pressure ratio of 70. For the real gas model, the Peng-Robinson equation of state was chosen. At the nozzle exit, the ideal gas model underestimates the velocity and overestimates the temperature and density; as the flow expands, the flow properties are the same up to the Mach disk, at which point the ideal gas underestimates the Mach number and predicts a higher temperature and density than the Peng-Robinson model due to the absence of cooling.

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