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# *Comparison of Experimental and Modeling Results for Mixture Optimization of a Mixed-Gas Joule-Thomson Cycle*

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This research experimentally validates a computational tool that is used to optimize the gas mixture composition for a Joule-Thomson (JT) cycle for specified operating parameters. A mixture optimization model was previously developed which is capable of determining optimal three-component mixtures based on the analysis of the maximum value of the minimum isothermal enthalpy change, $\Delta h\_T$, that occurs over the operating temperature range coupled with an evaluation of the percent of the heat exchanger that exists in a two-phase state within that range. A more detailed heat exchanger performance model has also been developed that considers the effect of operating parameters, geometry, mixture composition and quality on the conductance and pressure loss. This detailed model is capable of making more precise predictions of the performance and is also used as a design tool for the cryostat. A prototype mixed gas JT cryocooler was constructed and installed in a test facility to investigate optimal mixture selection, particularly in the 120-150K cold head temperature range. The test facility is capable of providing a range of gas composition, mass flow rate, and pressures. The prototype has been operated while charged with several gas mixtures over a range of operating pressures. The experimental mass flow rate, temperature at the outlet of the JT valve, and cooling load are compared to the expected values based on the modeling tools. These results are used to refine the model in order to enable reliable mixture optimization as well as cryostat design.