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C1Or1C-02: Numerical Modeling and Loss Analysis of Pneumatically-Driven Gifford-McMahon Cryocooler

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Pneumatically-driven displacer mechanisms are widely used in Gifford-McMahon (G-M) cryocoolers. Particularly for large size G-M cryocoolers, this type of drive is preferable compared to the scotch yoke type, as only a small motor is required for driving the rotary valve and, therefore, the entire cryocooler can be very compact. Though various numerical models of G-M cryocoolers have been presented in the past, modeling of the pneumatically-driven type has rarely been done in previous works. This work presents a one-dimensional numerical model of a pneumatically-driven single stage G-M cryocooler running at 80 K and related studies. The transient model is developed by solving mass, simplified momentum and energy equations numerically in both spatial and temporal domains. In addition, the model predicts the movement of the displacer simultaneously and uses it as an input to simulate the cryocooler performance. The impact of displacer movement on cycle performance is studied first. Then this model is further used to analyze and quantify various losses in the defined cryocooler.

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