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Second-Law Analysis of a Cascade Joule-Thomson Microcooler

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Cascade Joule-Thomson Microcoolers have been proposed in literature in which different compressors with low values of pressure ratio of order four using different working fluids are anticipated to drive the microcooler. A cascade of five stages is expected to provide cooling at a load temperature of 150 K. In this study a second-law analysis of such a microcooler is performed to quantify the effect of important design parameters representing the basic components and processes of the microcooler on its performance. The effects of several important design parameters including the effectiveness of all heat exchangers as well as the effect of possible pressure drop in the recuperative heat exchanger on cooling power and the exergetic efficiency of the microcooler are obtained. The inefficiency of the compressors is included using an exergetic efficiency parameter for the compressors. The heat transfer from each stage to other stages is modelled using an effectiveness parameter for the heat exchangers that can be varied to investigate their influence on cooling power and the efficiency of the microcooler.

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