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Experimental Investigation on the Optimal Operating Frequency of a Thermoacoustic Refrigerator

Authors : Kriengkrai Assawamartbunlue, Channarong Wantha

Abstract : This paper presents the effects of the mean operating pressure on the optimal operating frequency based on temperature differences across stack ends in a thermoacoustic refrigerator. In addition to the length of the resonance tube, components of the thermoacoustic refrigerator have an influence on the operating frequency due to their acoustic properties, i.e. absorptivity, reflectivity and transmissivity. The interference of waves incurs and distorts the original frequency generated by the driver so that the optimal operating frequency differs from the designs. These acoustic properties are not parameters in the designs and it is very complicated to infer their responses. A prototype thermoacoustic refrigerator is constructed and used to investigate its optimal operating frequency compared to the design at various operating pressures. Helium and air are used as working fluids during the experiments. The results indicate that the optimal operating frequency of the prototype thermoacoustic refrigerator using helium is at 6 bar and 490Hz or approximately 20% away from the design frequency. The optimal operating frequency at other mean pressures differs from the design in an unpredictable manner, however, the optimal operating frequency and pressure can be identified by testing.

Keywords : acoustic properties, Carnot’s efficiency, interference of waves, operating pressure, optimal operating frequency, stack performance, standing wave, thermoacoustic refrigerator
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