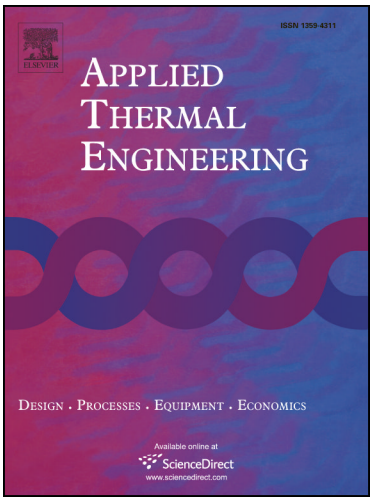

Research Paper

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Enhancement of Refrigeration Performance by Energy Transfer of Shock Wave

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Abstract

The objective of this paper is to enhance the refrigeration performance by energy transfer of shock wave. The matching of shock compression and expansion refrigeration is the key to research. Firstly, the efficiency of shock wave transfer energy is discussed. Then, a two dimensional numerical model of wave rotor refrigeration is established. And wave diagram is drawn by numerical calculation, which reveals the principle of refrigeration and the relationship between pressurization and refrigeration. Finally, an experimental platform was established and experiment work is carried out to obtain performance parameters. The results show that shock wave compression is close to isentropic compression. Using the shock wave, the expansion work of refrigeration can be efficiently recovered. Under the design condition, about 50% of pressure energy could be restored. There are three main shock waves in the channels. Only shock wave S1 can be exploited to enhance refrigeration and other shock waves should be avoided. There is an optimum value for the pressure of high temperature port, which observably affects the temperature drop of the novel refrigerator. Under the experimental condition, the performance curves of the refrigerator and temperature distribution in refrigerator are obtained.

Keywords: energy transfer, wave rotor, shock wave, refrigerator

1. Introduction

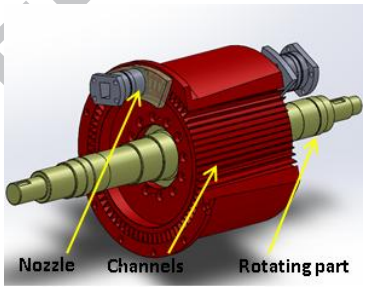

Fig.1. the structure schematic of wave rotor

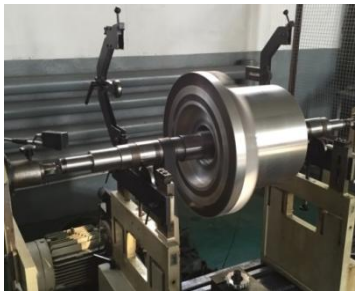

Fig.2. the dynamic balance test

The wave rotor is a nonstationary flow device that utilizes different types of waves to exchange energy directly between fluids [1]. By now, the Comprex® and a modern version called Hyprex® [2] are the distinguished and commercially valuable wave rotor devices. The key structure of the wave rotor is that a series of channels are fixed on a rotating shaft which is arranged in a circumferential direction, as showed in Fig.1 and the essential dynamic balance test is shown in Fig.2. When the shaft rotates at a fixed speed, each channel is connected with different