PERFORMANCE ANALYSIS OF QUANTUM STIRLING ENGINE WITH BOSE-EINSTEIN CONDENSATE

UNDERGRADUATE THESIS

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ABSTRACT

The realization of quantum Carnot engine in ideal conditions is still not feasible in practice, as an infinite time is required to reach this limit of efficiency even with high performance. However, quantum Stirling engine under real conditions has the possibility to reach Carnot's efficiency. To maximize the performance of the engine in experiment, this research analyzes the endoreversible quantum Stirling engine using Bose-Einstein Condensate (BEC) as the working medium, trapped in 3D generic law potential. The engine operates with endoreversible cycle in order to capture a realistic condition, where the temperature of the working medium depends on the heating and cooling stroke times. The Fourier's conduction law governs the rate of heat transfer between the system and thermal reservoir in finite time, whilst in isoenergetic strokes, infinite time is required to accomplish the thermal equilibrium. The results show that the condensed phase of BEC can enhance the efficiency of the engine. Since BEC is applicable under ultra-cold conditions, adjusting the initial temperature near absolute zero will increase efficiency. As consequence, raising the temperature ratio and volume ratio will raise the output power. Nevertheless, the output power is higher in shorter time than when the stroke occurred longer. In this condition, raising the temperature and volume ratio can also achieve higher output power. This model hopefully becomes a stepping-stone to show that the Stirling engine with BEC is able to offer high efficiency and power with minimal use of time.

Keyword: quantum Stirling engine, Bose-Einstein Condensate, endoreversible, 3D generic law potential, Fourier's conduction law.