

CHAPTER 5 CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

Bose-Einstein Condensate (BEC) as working substance in 3D generic law potential with endoreversible model significantly contributes to enhance the efficiency of quantum Stirling engine. By utilizing the initial temperature T_1 of the system near absolute zero, it considerably improves the efficiency of the engine since boson in condensed phase as BEC has a unique collective behavior. The efficiency increases as long as the temperature and volume ratio increase, where the effect of temperature predictively more dominant than volume against power and efficiency. Despite of using endoreversible model, the expression of efficiency is identically resembling the efficiency of Stirling classic $T_1 \rightarrow 0$, due to the system experienced quantum fluctuation suppression. The majority of boson particles condense to the ground state as the energy distribution becomes submissive and only one energy state dominates with the Bose function as a constant. As a result, the energy expression evolves into a simple function of $T^{5/2}$. Since some bosons occupy the ground state, no more energy is excited to the higher state as a consequence of the BEC phenomenon. Additionally, the power output increases as long as the initial temperature increases, yet decreases in a longer time cycle, which means the effect of thermalization does not play any role to influence the performance of the engine.

5.2 Suggestions

This study has demonstrated how temperature and volume ratios influenced the efficiency and power of quantum Stirling engine. However, the parameters that used to explore the efficiency and power output are not enough to perceived the effect of partial thermalization. Since then, a further study is needed to investigate and assembles the efficiency at maximum power (EMP).