

## Design Optimisation of a Novel Cross Vane Expander-Compressor Unit for Refrigeration System

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**Abstract :** In recent years, environmental issue has been a hot topic in the world, especially the global warming effect caused by conventional non-environmentally friendly refrigerants has increased. Several studies of a more energy-efficient and environmentally friendly refrigeration system have been conducted in order to tackle the issue. In search of a better refrigeration system, CO<sub>2</sub> refrigeration system has been proposed as a better option. However, the high throttling loss involved during the expansion process of the refrigeration cycle leads to a relatively low efficiency and thus the system is impractical. In order to improve the efficiency of the refrigeration system, it is suggested by replacing the conventional expansion valve in the refrigeration system with an expander. Based on this issue, a new type of expander-compressor combined unit, named Cross Vane Expander-Compressor (CVEC) was introduced to replace the compressor and the expansion valve of a conventional refrigeration system. A mathematical model was developed to calculate the performance of CVEC, and it was found that the machine is capable of saving the energy consumption of a refrigeration system by as much as 18%. Apart from energy saving, CVEC is also geometrically simpler and more compact. To further improve its efficiency, optimization study of the device is carried out. In this report, several design parameters of CVEC were chosen to be the variables of optimization study. This optimization study was done in a simulation program by using complex optimization method, which is a direct search, multi-variables and constrained optimization method. It was found that the main design parameters, which was shaft radius was reduced around 8% while the inner cylinder radius was remained unchanged at its lower limit after optimization. Furthermore, the port sizes were increased to their upper limit after optimization. The changes of these design parameters have resulted in reduction of around 12% in the total frictional loss and reduction of 4% in power consumption. Eventually, the optimization study has resulted in an improvement in the mechanical efficiency CVEC by 4% and improvement in COP by 6%.

**Keywords :** complex optimization method, COP, cross vane expander-compressor, CVEC, design optimization, direct search, energy saving, improvement, mechanical efficiency, multi variables

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