A REVIEW ON MULTISTAGE THERMOELECTRIC REFRIGERATION SYSTEM

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ABSTRACT

A single-stage thermoelectric refrigerator will lose its effectiveness with increase in the temperature ratio of heat source and heat sink is large (>70 K). Thus, various ways of improving the coefficient of performance (COP) of the thermoelectric refrigeration system are to be found out.The most efficient way for improving the co-efficient of performance is to dissipate the heat at the sink effectivelyby application various methods such as use of phase change materials, two- or multi-stage combined thermoelectric refrigerator is an important method of improving performance of thermoelectric refrigerators.

Keywords: Peltier-effect, See-back effect, Thermo-electric Refrigeration, Multi-staging

I INTRODUCTION

As per globally increasing demand for refrigeration, food preservations, vaccine storage, air conditioning of the space, medical services, cooling of electronic device led consumption of more electricity and ultimately more release of CO_2 in the environment causing global warming. By considering the above effects the Thermoelectric refrigerators (TERs) offer several advantages over vapor-compression refrigerators such as free of moving parts, acoustically silent, reliable, and lightweight. But because of their low efficiency and peak heat flux capabilities have precluded their use in more widespread applications. Peltier effect and Seeback effect were first discovered to present in metals as early as1820s–1830s, but the low thermoelectric performances of metal made these two effects fall on deaf ears all the time. Until 1950s, the advent of doped semiconductor materials with small band gap, large Seeback coefficients, good electrical conductivities, and poor thermal conductivities were found to have much bigger thermoelectric performances than the pure metals, thus revived the interest in this field.

II REVIEW OF SOME RESEARCHERS

2.1 Jincan Chenaet al.,[1]:-In this research models of single-stage and two-stage semiconductor thermoelectric refrigeration based on non-equilibrium thermodynamics were experimentally investigated. By using the coefficient of performance (COP), the rate of the rate of refrigeration, and the power input we can drive the general expressions performances of the two-stage thermoelectric refrigeration system. It was concluded that when the temperature ratio of the heat sink to the cooled space is small, the maximum COP of a two-stage thermoelectric refrigeration system is larger than that of a single-stage thermoelectric refrigeration system;

however maximum rate of refrigeration is smaller than that of a single-stage thermoelectric refrigeration system. In this research the result were found that on theoretical basis for optimal design and operation.

2.2 X.C. Xuanet al., [2]:-Inthis research it was experimentally investigated Optimizations for the two-stage TE coolers was arranged practically in two design configuration and it can be extended to other multi stage designs for obtaining the Optimizations methods.Optimizations for the two-stage TE coolers were performed for both namely, the point of maximum cooling capacity and maximum COP. By keeping the total number of modules constant in both design the optimum current between the stages was experimentally was found out. It was concluded that by using the commercial thermo electric materials the optimum current was found out to be 2.5–3 Amp.

2.3 Jun Luoet al., [3]:-The performance of a thermoelectric refrigerator using finite time thermodynamics theory, with multi-elements was analysed. The ratio of the heat transfer surface area of the high temperature side heat exchanger to the total heat transfer surface area of the heat exchangers was optimized for maximizing the cooling load and the coefficient of performance of the thermoelectric refrigerator. The effects of the number of thermoelectric refrigerating elements, the Seebeck coefficients, internal heat conductance, the heat source temperature and internal electrical resistance on the optimum performance were analysed. The influences of total heat transfer surface area and working electrical current on the optimum performance were also analysed. They found out by experimentation that the total heat transfer surface area and working electrical current have great influences on the cooling load and the COP of the thermoelectric refrigerator. Their experimental results provided guides for designing and applications of practical thermoelectric refrigerators.

2.4 D. Astrainet al.,[4]The author in this paper designed a device for the dissipation the heat from the hot side of Peltier pellets in thermoelectric refrigeration, based on the principle of a thermosyphon with phase change. They constructed two prototypes of thermoelectric domestic refrigerators, one of them with the device developed, and the other with a conventional fins dissipater. They concluded that the thermosyphon with phase change in a thermoelectric refrigerator proved that the COP increases in 26% at an ambient temperature of 293 K, achieving 36.5% of improvement at 303 K.

2.5 Yuzhuo Pan, et al, [5]In this paper an irreversible multi-couple thermoelectric refrigerator operating between two heat-reservoirs at constant temperatures was designed and analysed. The influences of the external and internal irreversibilities of the thermoelectric refrigeration device on the performance of the system were also analysed. By experiments they specified some important performance parameters of the maximum coefficient of performance for thermoelectric refrigeration. The results obtained revealed some general performance characteristics of real multi-couple thermoelectric refrigeration systems operating at various conditions which could be used to guide the optimal design and manufacture of real thermoelectric refrigerators.

2.6 Hongxia Xi.et al, [6]In this paper the reviewer made a survey on solar-based driven thermoelectric technologies. Initially, they brieflyanalysed the environmental problems related to the use of conventional technologies and, energy sources werepresented. The benefits offered by thermoelectric technologies and renewable energy systems were also outlined. The development and applications of two solar-driven thermoelectric technologies i.e. solar driven refrigerator and solar driven thermoelectric power generation devices were discussed and also the existing drawbacks of solar driven thermoelectric technologies were focused as well as methods for improving the performance were discussed.

2.7 SuwitJugsujindaet al, [7] In this paper the researcher had fabricated a thermoelectric refrigeration system by using a thermoelectric cooler which was applied to electrical power of 40W without using a cooling fan. In this paper the current, coefficient of performance, time, and different temperature were experimentally analysed.During the observation of 1 hour they obtained the temperature of the cold plate decreased form 30°C to -4.5°C. The maximum coefficient of performance of the thermoelectric cooler (TEC) and thermoelectricrefrigerator (TER) were found out to be 3 and 0.65

2.8 S.A.Omer et al, [8]Byintegrating the phase change material in this paper the researcher carried out the analysis with thermosyphon in thermoelectric refrigeration system.First the experiment was carried out by using a conventional heat sink system at the cold end. By encapsulating the phase change material (PCM) at cold end the system was reconstructed to improve the performance as well as storage capacity. It was concluded that during the cooling by using thermosyphon method between the phase change material (PCM) and the thermoelectric cell had a similar cooling effect as that employing phase change material (PCM) attached directly to cold end of thermoelectric cells.

III CONCLUSION

From this review, various ways of improving the coefficient of performance (COP) of the thermoelectric refrigeration system were pointed out. The most efficient way for improving the co-efficient of performance is to dissipate the heat at the sink effectively. This can be done by various methods such as using the phase change material(PCM) we can increased the performance of refrigeration system in different applications. Second method to improve the performance of the thermoelectric refrigeration system can be done by multistaging of the thermoelectric modules.

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