Review Paper on Air-Conditioner Using Peltier Effect

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Abstract - A simple model system is generated to derive explicit thermoelectric effect expressions for Peltier, Seebeck and Thomson.The present air-conditioning system produces cooling effect by refrigerants like Freon, Ammonia, etc. .Using these refrigerants can get maximum output but one of the major disadvantages is harmful gas emission and global warming. These problem can be overcome by using thermoelectric modules (Peltier effect) air-conditioner and their by protecting the environment. The present paper deals with the study of Thermoelectric air conditioner using different modules is discussed. Thermoelectric cooling systems have advantages over conventional cooling devices, such as compact in size, light in weight, high reliability, no mechanical moving parts and no working fluid .

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I. INTRODUCTION

Thermoelectric cooling, commonly referred to as cooling technology using thermoelectric coolers (TECs), has advantages of high reliability, no mechanical moving parts, compact in size and light in weight, and no working fluid. In addition, it possesses advantage that it can be powered by direct current (DC) electric sources. When a voltage or DC current is applied to two dissimilar conductors, a circuit can be created that allows for continuous heat transport between the conductors's junctions this is the principle of thermoelectric air-condition. Air conditioning is a process of removing heat from a room or other applications. Many ways of producing a cooling effect by like vapour compression and vapour absorption air condition. These air conditioners are producing cooling effect by using refrigerants like Freon and ammonia etc. It gives maximum output but, one of the disadvantage is producing harmful gases to the atmosphere.

The harmful gases are cluro fluro carbon and some other gases are present. A conventional cooling system contains three fundamental parts - the evaporator, compressor and condenser. The evaporator or cold section is the part where the pressurized refrigerant is allowed to expand, boil and evaporate. During this change of state from liquid to gas, energy (heat) is absorbed. The compressor acts as the refrigerant pump and recompresses the gas to a liquid. The condenser expels the heat absorbed in the evaporator plus the heat produced during compression, into the environment or ambient. A thermoelectric has analogous parts. At the cold junction, energy (heat) is absorbed by electrons as they pass from a low energy level in the p-type semiconductor element, to a higher energy level in the n-type semiconductor element. The power supply provides the energy to move the electrons through the system. At the hot junction, energy is expelled to a heat sink as electrons move from a high energy level element (n-type) to a lower energy level element (p-type).

II. LITERATURE REVIEWs

Matthieu Cosnier [1] presented an experimental and numerical study of a thermoelectric air-cooling and air-heating system. They have reached a cooling power of 50W per module, with a COP between 1.5 and 2, by supplying an electrical intensity of 4A and maintaining the 5°C temperature difference between the hot and cold sides. Suwit Jugsujinda [2] conducted a study on analyzing thermoelectric refrigerator performance. The refrigeration system of thermoelectric refrigerator (TER; 25 × 25 × 35 cm3) was fabricated by using a thermoelectric cooler (TEC; 4 × 4 cm2) and applied electrical power of 40 W. The TER was decreased from 30 ºC to 20 ºC for 1 hr and slowly decreasing temperature for 24 hrs. The maximum COP of TEC and TER were 3.0 and 0.65. Wei He [3] Conducted did Numerical study of Theoretical and experimental investigation of a thermoelectric cooling and heating system driven by solar. In summer, the thermoelectric device works as a Peltier cooler when electrical power supplied by PV/T modules is applied on it. The minimum temperature 17 degree C is achieved, with COP of the thermoelectric device higher than 0.45.Then comparing simulation result and experimental data.Riff and Guoquan [4] Conducted an experimental study of comparative investigation of thermoelectric air conditioners versus vapour compression and absorption air conditioners. Three types of domestic air conditioners are compared and compact air conditioner was fabricated. Riffat and Qiu **[5]**compared performances of thermoelectric and conventional vapor compression air-conditioners. Results show that the actual COPs of vapor compression and thermoelectric air-conditioners are in the range of 2.6-3.0 and 0.38-0.45, respectively. However, thermoelectric air conditioners have several advantageous features compared to their vapor-compression counterparts. Astrain, Vian & Domınguez [6] conducted an experimental investigation of the COP in the thermoelectric refrigeration by the optimization of heat dissipation. In thermoelectric refrigeration based on the principle of a thermo syphon with phase change is presented. In the experimental optimization phase, a prototype of thermo syphon with a thermal resistance of 0.110 K/W has been developed ,dissipating the heat of a Peltier pellet with the size of 40*40*3.9 cm ,Experimentally proved that the use of thermo syphon with phase change increases the coefficient of performance up to 32%. Shen, Xiao [7] investigated a novel thermoelectric radiant air-conditioning system (TE-RAC). The system employs thermoelectric modules as radiant panels for indoor cooling, as well as for space heating by easily reversing the input current. Based on the analysis of a commercial thermoelectric module they have obtained a maximum cooling COP of 1.77 when applying an electric current of 1.2 A and maintaining cold side temperature at 20°C. [8] Virjoghe, Diana conducted an numerical investigation of thermoelectric System. The thermoelectric systems have attracted renewed interest as concerns with the efficient use of energy resources, and the minimization of environmental damage, have become important current issues. This paper presents of numerical simulation for several the thermoelectric materials. Numerical simulation is carried out by using a finite element package ANSYS. Maneewan [9] conducted an experimental investigation of thermal comfort study of compact thermoelectric air conditioner. In this paper analyse the cooling performance of compact thermoelectric air-conditioner. TEC1-12708 type thermoelectric modules used for heating and cooling application. The compact TE air conditioners COP was calculated to its optimum parameters. Then analyse the cop with respect to time and calculated cop at various considerations. Manoj and Walke [10] conducted an experimental study of thermoelectric air cooling for cars. They are trying to overcome these demerits by replacing the existing HVAC system with newly emerging thermoelectric couple or cooler which works on peltier and seebeck effect.

Huang. B[11]conducted an experimental study of design method of thermoelectric cooler. They are fabricated the thermoelectric cooler and analyse various considerations. The system simulation shows that there exists a cheapest heat sink for the design of a thermoelectric cooler. It is also shown that the system simulation coincides with experimental data of a thermoelectric cooler.

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Equations

The Peltier effect is the production or absorption of heat at a junction between two different conductors when electric charge flows through it [1]. The rate dQ/dt of heat produced or absorbed at a junction between conductors A and B is:

$dQdt/ =(\Pi A- \Pi B)I$,

where I is the electric current and are Peltier's coefficients of the conductors.

The Seebeck effect is the production of EMF, electromotive force, with junctions of two different conductors. Two junctions connected back to back are held at two different temperatures TH and TC and an EMF V appears between their free contacts:

$V=-S(TH- TC)$.

S is Seebeck's coefficient.

$\Pi=T S$, (4)

where: $\Pi= \Pi A- \Pi B$, and:

$K=T\ dS/dT$.

includes links to updated literature on thermoelectric effects. Although these three main thermoelectric effects have been well known for a long time, it is difficult to find explicit expressions in the literature for their three coefficients in terms of more fundamental physical quantities, though some calculations do exist. Advanced sources apply Onsager's theory of irreversible processes to calculate the coefficients in terms of Onsager's linear coefficients. However, these coefficients are not more fundamental than the thermoelectric coefficients, and they are also difficult to find.

The purpose of this page is to generate a simple system and calculate for it explicit expressions of the thermoelectric coefficients.

Electrons in conductors occupy energy levels in pairs of opposite spins. Lower levels are fully occupied and upper levels are empty and the level population is determined by Fermi-Dirac statistics. In order to move in the conductor an electron that occupies some level must be scattered to an empty level. For this reason low energy electrons do not contribute to electric current because their nearby levels are all occupied. The Fermi level is the energy where the electron occupation probability is 0.5. Only electrons with energies near this level contribute to the current. The Maxwell-Boltzmann distribution of the electron velocity is not applicable in this case Consider two pieces of n-type semiconductor with higher nL and lower nR electron densities, where nL and nR are equal to the corresponding donor densities. Therefore, these densities are temperature independent. If the two pieces are brought into contact to form a junction, electrons will start to diffuse from the left higher nL to the right lower nR density. The diffusion generates a space charge region, electric field, and potential difference Vc between the two pieces, that stops further electron diffusion. Vc is the contact potential. It is not directly measureable by a voltmeter, for example, because the voltmeter probes make their own contact potentials with the two ends of the junction. The sum of all the junction potentials is then zero.

If the two pieces are separated after being in contact, their capacity will drop, the voltage between them will go up and it will then be measureable. The contact potential is calculated

$e- eVc/kT=nR/nL$,

$Vc\ = (kTe/\ )\ln(nLnR/\ )$.The electric current through a semi-conductor with a temperature gradient is calculated in appendix-C by applying Boltzmann transport equation. This equation yields expressions for the currents that are similar to Onsager's linear equations that relate forces to flows, but with the advantage that there are no unknown linear coefficients. If the charge carrier density does not depend on the position, then the electric current Jq will be $Jq=\sigma[E- (k2e/\ )dTdx/$

where σ is the electrical conductivity (40) and E is the electric field.For zero current may be integrated to yield:

$V=(k2e/\ )\Delta T$.

By using the values of k and e a voltage gradient of 43 microvolt/degree, independent of the charge density, is developed between the cold and hot ends of the conductor.

III. CONCLUSION

Charge flow within a conductor involves two irreversible processes where energy gained from the electric field is transferred to the conductor, heat conduction and Thomson heating. The Thomson effect takes place in a steady state system of heat flow rather than in an equilibrium system. However, reversing the current direction will reverse the direction of Thomson heat flow. This property is shared with a reversible process.

Seebeck's EMF varies linearly with the temperature difference and its corresponding coefficient is a constant that does not depend on the temperature. According to the second Thomson relation there should not be Thomson heat for a linear effect. But yet, when charge carriers enter a wire at a cold end, and leave it at a hot end, their heat content changes and they must cool it or absorb heat from its vicinity.

Thermoelectric effects in systems are much more complicated than the simple model presented here. In metals only electrons with energy within a few *kT* around the Fermi energy contribute to the current, and their number is strongly temperature dependent, mainly at low temperatures. In addition, their thermal energy is not that of free particles. Yet, Seebeck effect and Peltier effect are basically reversible thermodynamic processes. Discussing them in terms of non-equilibrium irreversible theories is meaningless. The literature regarding the investigation of Thermoelectric air conditioner using different modules has been thoroughly reviewed .From the review of the pertinent literature presented above, it can be inferred that thermoelectric technology using different modules used for cooling as well as heating application has considerable attention. Many researchers try to improve the COP of the thermoelectric air-conditioner using different material. Thermoelectric coolers to be practical and competitive with more traditional forms of technology, the thermoelectric devices must reach a comparable level of efficiency at converting between thermal and electric energy.

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