IMPLEMENTATION OF THERMOELECTRIC AIR CONDITIONER SYSTEM USING CFC'S AND HCFC'S

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Abstract

Our project concerns about the destruction of the global environment by chlorofluorocarbon (CFC) fluids. It has become an impetus in searching for alternative non-CFC refrigerants and cooling methods.while some alternative refrigerants have been identified, they are not considered as lasting solution eventual phase-out. In view of this dilemma, environmentally acceptable alternative cooling methods have become important. The Main aim of our project is to replace the conventional cooling process. Most modern air conditioners in use today utilize compressors, condesers, refrigerants etc. But our system replaces these components with dc power source, heatsink and semiconductors respectively. Cooling is achieved by using a solid state semiconductor device called thermoelectric module which consists of an array of bismuth telluride (Bi2te3) pellets. By applying a low voltage DC power source to a module, heat will be moved through the module from one side to the other.one face, therefore, will be cooled while the opposite face simultaneously is heated. consequently, a thermoelectric cooler may be used for both heating and cooling by resersing the polarity (changing the direction of the applied current). There are no moving parts, so it is more reliable and little maintenance is enough. Lack
of noxious refrigerants such as CFC, CCL2F2 leads this to an eco-friendly products.

Introduction

Air Conditioning

Air conditioning is the achievement of temperatures below that of the local environment. The main purpose of refrigeration is thermal conditioning (e.g. for food preservation or air conditioning), and the basic apparatus is a refrigerators, a thermal machine producing cold. Other names for special types of refrigerators are freezers, chillers, cryo-coolers, as well as the informal word fridge. Small refrigeration usually comprise the cabinet to be cooled (e.g. the fridge), but larger refrigerators are placed in machinery rooms outside the cold storage (applicable to air conditioners too).

Purpose

The purpose of refrigeration is to bring (or maintain) a system to temperatures below that of the environment. Human basic resources are: Clean air, potable water, and edible food (basic peace, health and appreciation by other and by oneself). Nowadays we want also air conditioning, cold drinks, and refrigerated-store food, so refrigeration is used to better meet all basic human needs.

Various Methods of Refrigeration

Vapour Compression System

The refrigerant vapor is compressed and pumped into the condenser (heat exchanger) by a compressor. Compressing the gas causes the temperature of the gas to increase. The gas is not at a temperature higher than that of the surrounding air, the heat flows the condenser allows the gas to turn into a liquid.

The liquid refrigerant is still under pressure as it flows to the expansion valve (or capillary tube). The expansion valve meters the liquid refrigerant into the evaporator (heat exchanger) to maintain a low-pressure condition in the evaporator. The low pressure in the evaporator causes the liquid to boil into a gas. As the liquid changes into a gas (boils) it absorbs heat (refrigerating affects.

The heat absorbed by the refrigerant gas is carried to compressor to start the whole cycle again. This is the manner by which heat is pumped from the cold area (i.e. your refrigerator) to the warm area (outside the refrigerator).

Vapor absorption system

With the application of heat at the generator, ammonia vapor is driven from the solution. This hot vapor rises into the separator a portion of the water condenses and flow by gravity into the condenses into a liquid. The liquid ammonia enters by gravity into the evaporator, where it is mixed with hydrogen gas. Circulation of hydrogen gas causes a reduction in pressure within the evaporator. The low pressure causes the ammonia liquid to boil into a gas (evaporating) and absorbing heat in the process (refrigerating effect). The mixture of hydrogen/ammonia vapor that's carrying the absorbed heat is now drawn by gravity for ammonia, it separates from generation to starts the cycle again.

Need for Alternate Materials

Introduction to Thermoelectric

Air Conditioning

A thermoelectric cooler (TEC), some times called a thermoelectric module or peltier, is a semiconductor-based electronic components that function as a small heat pump. By applying a low voltage DC power source to a TEC, heat will be moved through the cooled while the opposite face simultaneously is heated. Consequently, a thermoelectric cooler may be used for both heating and cooling by reversing the polarity (changing the direction of the applies current). This as ability makes TECs highly suitable for precise temperature control applications as will as where space limitations and reliability are paramount and CFCs are not desired.

A typical single stage cooler consists of two ceramic plates with p-and n- type semiconductor material (bismuth telluride) between the plates. The elements of semiconductor material are connected electrically in series and thermally in parallel. When a positive DC voltage is applied to the n-type semiconductor electrons pass from the p-to the n-type semiconductor and the cold side temperature will decrease as heat is absorbed. The heat absorption (cooling) is proportional to the current and the number of thermoelectric couples. This heat is transferred to hot side of the cooler, where it is dissipated into the heat and surrounding environment. The theries behind the operation of thermoelectric cooling can be traced back to the early 1800s. Jean peltier discovered there is a heating or cooling effect when electric current passes discovered there is a heating or cooling effect when electric current passes through two conductors. Thomas Seebeck found two dissimilar conductors at different temperature would create an electromotive force or voltage. William Thomson (lord kelvin) showed that over a temperature gradient, a single conductor with current flow will have reversible heating and cooling. With thise principles in mind and the introduction of semiconductor materials in the late 1950s, thermoelectric cooling has become a viable technology for small cooling application.

GIST of Thermoelectric Refrigerator

Peltier Effect

"When an electric current is passed in a circuit consisting of two different metals, heat is evolved at one junction and absorbed at the other end" it is complementary to seebeck effect.

Components used in Thermoelectric Air Conditioner

- Thermoelectric module
- Heat sink
- Fan
- Aluminium plate (cold plate)
- Spacer blocks
- Insulation form
- Thermal grease

Thermoelectric Modules

Thermoelectric modules are solid-state heat pumps that operate on the peltier effect. A thermoelectric module consists of an array of p- and n- type semiconductor elements heavily doped with electrical carriers. The array of elements is soldered so that it is electrically connected in series and thermally connected in parallel. This array is then affixed to two ceramic substrates, one on each side of the elements.

Design Calculations

Device Performance Formulae

Heat Pumped at Cold Surface

$_{C}$ =2N[a I T_C -(($I^2{}_r$) / (2G)) -k DTG]

Voltage:

V =2N [(I_r)/ G) + ($_a$ DT)]

Maximum Current

Imax =(KG/a) [(1 + (2Z Th)) - 1]

Optimum Current:

I_{opt}=[KDTG(1 +(1+Z Tave)½] / (a Tave)

COP Cofficient of performance

(Q_c /I V)

Optimum COP (calculated at Iopt):

COP_{opt}= (Tave/DT)[((1 =ZTave)½ -1) /((1=Z Tave)½+1)]-½

Maximum DT with Q =0

DT_{MAX} =Th – [(1 + 2Z Th)½ -1)/z]

Heat Transfer Formulae

Heat gained or lost through the walls of an insulated container:

Q =(A ×DT × K) / (DX)

Where:

Q = Heat (Watts)

A = External surface area of container (m^2)

DT = Temp. difference (inside vs. outside of insulation (Watt/ meter Kelvin)

K = thermal conductivity of insulation (Watt/meter Kalvin)

DX = insulation thickness (m)

Time required to change the temperature of an object:

t = (m× Cp × DT)/Q

WHERE:

t = Time interval (seconds)

m = Weight of the object (kg)

Cp=Specific heat of material (j /(kg K))
DT= Temperature change of object (Kelvin)
Q= Heat added or removed (Watts)

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