FEM Analysis of Portable AC cooling Chamber

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Abstract: In day to day life because of the rising temperatures there is a high demand for cooling systems.The project is based on an abstract of creating a cooling system which is an air conditioner embedded with a cooling chamber. The current project is portable model which has the main functioning component as the air conditioner and the secondary component as the cooling chamber which acts as a refrigerator. The current project looks into creating a product which gives the user the comfort of two devices in one system. The basic advantage of the system is that two components run on a single compressor. The system is so formed that most of the refrigerant is moved to the air conditioning system and rest of the refrigerant is moved to cooling chamber thus producing maximum cooling through air conditioner and required cooling to the products through cooling chamber.

1. INTRODUCTION

1.1 General

The present dissertation is aimed at manufacture and assembly of vertical portable air conditioner. Nowadays people are facing problem of using restricted air conditioner which is confined to single room like split air conditioner so we have develop a solution in which the air conditioner can be move one place to another place conveniently without much effort. Also we have an advantage of just rotating and adjust back frame in order make it work as heat pump which can be changed accordingly to the season or place where climatic conditions are unpredictable.

Here we have prepared a manufacture line by which the product can be manufactured follow up the scheduled process at prescribed time. With the help of this manufacturing line there will be a systematic arrangement in the men and machinery in the manufacturing process. By this manufacturing line the idle time of men and machine is optimized. Men and machinery are utilized up to their maximum efficiency.

1.2 Need of Portable Air Conditioner

The use of air conditioners, popularly known as AC, has become almost compulsory in number of homes and houses. In fact there are number of people who just can't live without AC, they will need AC in their room, office, car, theatre and almost everywhere as there are a number a number of heat sources like electric equipments, also the heat generated by our body due to the metabolic activity and to maintain purity of air, humidity content in order to meet human comfort conditions.

Portable air conditioners work basically the same way as built-in air conditioner sucking in warm and humid air, cooling and dehumidifying it and blowing it back into the room. Single-duct models, with a duct connected to a window to vent heat from the room, can be very effective at cooling most of the room, but they draw the air from the room (in order to cool it) and vent some of it outside.

Venting the hot air outside through the duct results in a net air pressure reduction, so more warm air is drawn into the room from the rest of the house. The portable air conditioner thus faces a continual struggle to cool the room. Portable units are also noisier indoors than most split-systems (which have the advantage of having the noisiest component, the compressor, situated outside).

So while they are convenient and often comparatively cheaper than split-systems, single-duct portables are not as effective or efficient. The heat extracted from the air is vented through an air duct that you install in an open window. The unit also condenses water from the air while cooling, collecting this in a tank or draining it away via a tube. Dryer air feels more comfortable and enhances the cooling effect. A venting kit is included so you can seal the gap around the duct to stop the cool air escaping.

1.3 Air Conditioner

An air conditioner is a system or a machine that treats air in a defined, usually enclosed area via a refrigeration cycle in which warm air is removed and replaced with cooler and more humid air.

Air conditioning (often referred to as AC, A.C., or A/C) is the process of removing heat from a confined space, thus cooling the air, and removing humidity. Air conditioning can be used in both domestic and commercial environments. This process is used to achieve a more comfortable interior environment, typically for humans or animals; however, air conditioning is also used to cool/dehumidify rooms filled with heat-producing electronic devices, such as computer servers, power amplifiers, and even to display and store artwork.

Air conditioners often use a fan to distribute the conditioned air to an occupied space such as a building or a car to improve thermal comfort and indoor air quality. Electric refrigerant-based AC units range from small units that can cool a small bedroom, which can be carried by a single adult, to massive units installed on the roof of office towers that can cool an entire building. The cooling is typically achieved through a refrigeration cycle, but sometimes evaporation or free cooling is used. Air conditioning systems can also be made based on desiccants (chemicals which remove moisture from the air) and subterraneous pipes that can distribute the heated refrigerant to the ground for cooling

1.5 Vapor compression refrigeration cycle

Vaporr-compression refrigeration system (VCRS), in which the refrigerant undergoes different phase changes, is one of the many refrigeration cycles and is the most commonly, used method for air-conditioning of buildings and automobiles. It is also applicable in domestic and commercial refrigerators, large-scale warehouses for chilled or frozen storage of foods and meats, refrigerated trucks and railroad cars, and a host of other commercial and industrial services. Oil refineries, petrochemical and chemical processing plants, and natural gas processing plants are the many types of industrial plants that often utilize large vapour-compression refrigeration systems.
Refrigeration may be defined as lowering the temperature of an enclosed space by removing heat from that space, cools the space and transferring it elsewhere. the device that performs this function is called an air conditioner, refrigerator, air source heat pump, geothermal heat pump or chiller (heat pump)

The vapour-compression uses a circulating liquid refrigerant as the medium which absorbs and removes heat from the space to be cooled and rejects that heat elsewhere. Depicts a typical, single-stage vapour-compression system. All the systems have four components: a compressor, a condenser, a thermal expansion valve (also called a throttle valve or metering device), and an evaporator. The r refrigerant enters the compressor in the thermodynamic state known as a saturated vapour and is compressed to a higher pressure, resultant is higher temperature. Then the hot refrigerant leaves, compressed vapour is then in the thermodynamic state known as a superheated vapour and it is at a temperature and pressure at which it can be condensed with either cooling water or cooling air flowing across the coil or tubes. This is where circulating refrigerant rejects heat from the system and the rejected heat is carried by either the water or the air (whichever may be the case).

The condensed liquid refrigerant, in the thermodynamic state called as a saturated liquid, is next routed through an expansion valve where it undergoes an absorption reduction in pressure. That pressure reduction results in the adiabatic flash evaporation of a component of the liquid refrigerant. The auto-refrigeration effect of the adiabatic flash evaporation lowers the temperature of the liquid and vapour refrigerant mixture to where it is cooler the space than the temperature of the enclosed space to be refrigerated.

The cold mixture is then routed through the fins or tubes in the evaporator. A fan circulates the warm air in the enclosed space across the fins or tubes carrying the cooled refrigerant liquid and vapour mixture. That warm air evaporates the liquid part of the cooled refrigerant mixture. At the same time, the circulating air is cooled and the air has less temperature of the enclosed space to the desired temperature. The evaporator is where the circulating refrigerant absorbs and removes heat which is subsequently rejected heat in the condenser and transferred elsewhere by the water or air used in the condenser.

To complete the refrigeration cycle, the refrigerant vapour from the evaporator is again a saturated vapour and then it enters into the compressor.

Stages of the Vapour-Compression Refrigeration Cycle

The Vapour-Compression Refrigeration Cycle is comprised of four steps. The conceptual figure of the process shows the PV changes during each part.

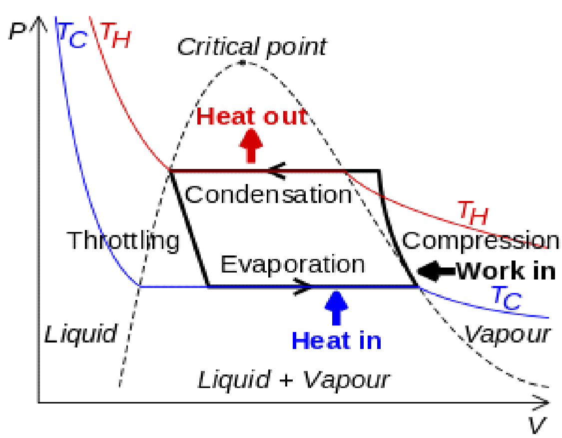


Figure 1: PV Diagram of VCRS

Part1: Compression

In this stage, the refrigerant enters the compressor as a gas under low pressure and having a low temperature. Then, the refrigerant is compressed adiabatically, so the fluid leaves the compressor under high pressure and with a high temperature.

Part 2: Condensation

The high pressure, high temperature gas releases heat energy and condenses inside the "condenser" portion of the system. The condenser is in contact with the hot reservoir of the refrigeration system. (The gas releases heat into the hot reservoir because of the external work added to the gas.) The refrigerant leaves as a high pressure liquid.

Part 3: Throttling

The liquid refrigerant is pushed through a throttling valve, which causes it to expand. As a result, the refrigerant now has low pressure and lower temperature, while still in the liquid phase. (The throttling valve can be either a thin slit or some sort of plug with holes in it. When the refrigerant is forced through the throttle, its pressure is reduced, causing the liquid to expand.)

Part 4: Evaporation

The low pressure, low temperature refrigerant enters the evaporator, which is in contact with the cold reservoir. Because a low pressure is maintained, the refrigerant is able to boil at a low temperature. So, the liquid absorbs heat from the cold reservoir and evaporates. The refrigerant leaves the evaporator as a low temperature, low pressure gas and is taken into the compressor again, back at the beginning of the cycle.

FEM Analysis

ANSYS is a finite element analysis software package • Capable of analyzing a range of engineering applications: - Structural - Thermal - Electromagnetic - Fluid Dynamics • Unitless analysis, but must be consistent throughout.

1. Preprocessing
   Define element type, real constants, and material properties.
   Define geometry Processors.
2. Solution
   Define type of analysis.
   Set boundary conditions.
   Apply loads.
   Initiate finite element solution.
3. Post processing
   Review results using graphical displays and tabular listings.Verify against analytical solutions.

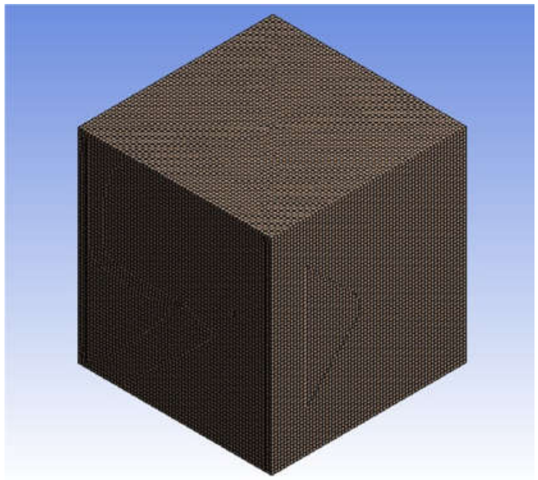


Fig.2 Meshed model of Cooling Chamber

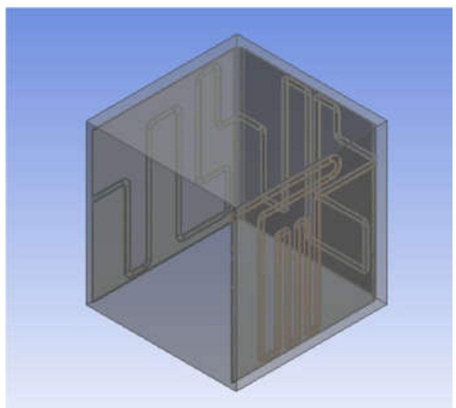


Fig.3 Transparent view of Cooling Chamber

Method of Simulation

The simulation is followed is shown as step by step with aid of fig respectively. Fig4 to

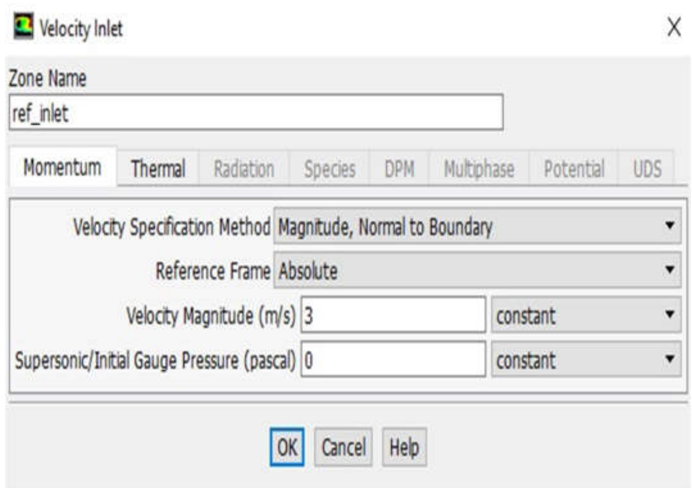


Fig.4 Step1

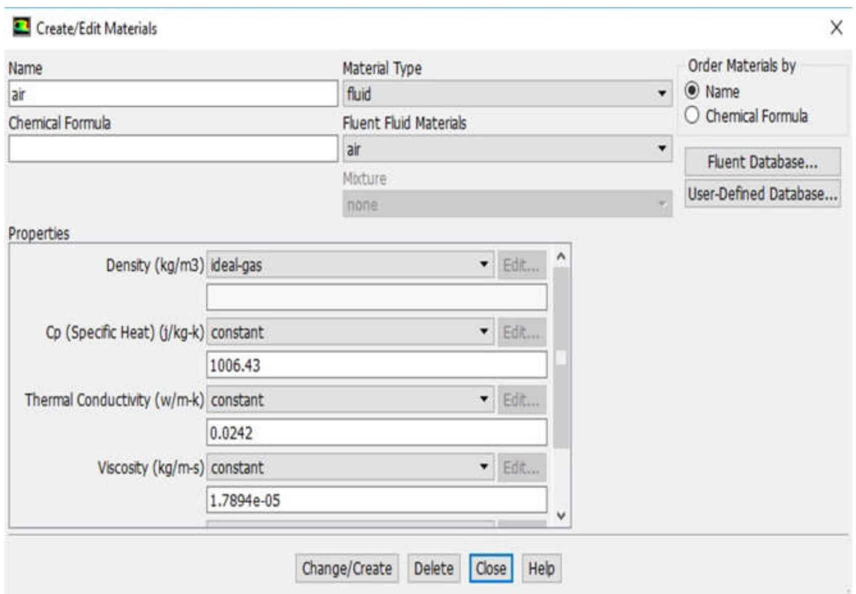


Fig.5 Step2

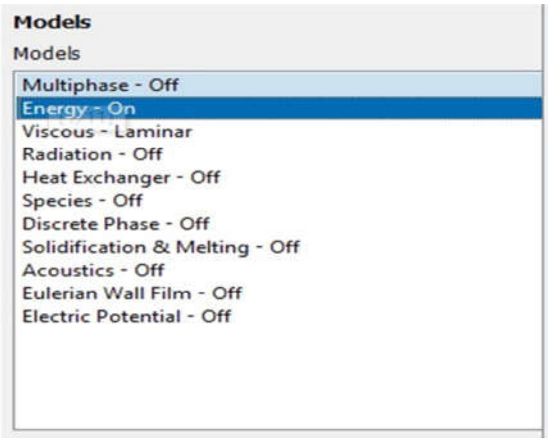


Fig.7 Step3

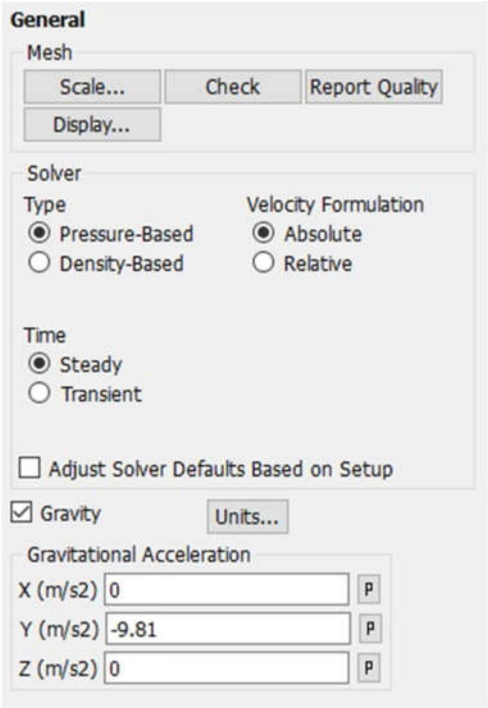


Fig.8 Step4

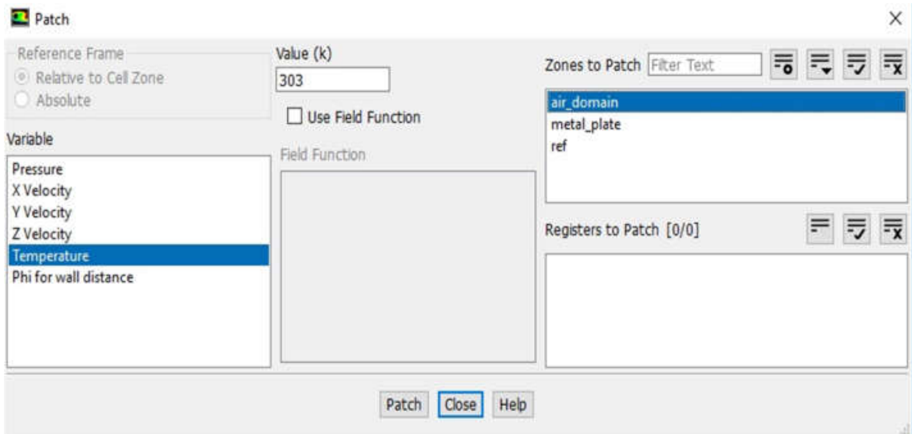
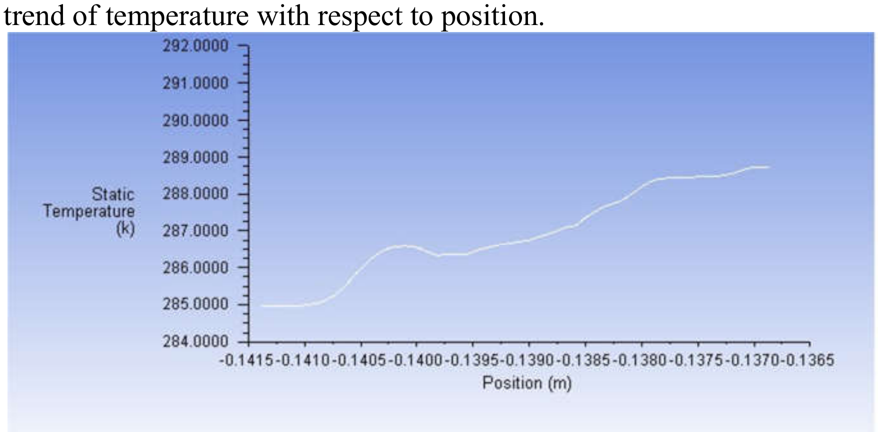


Fig.9 Step5

Results:

The obtained results are shown in graphs static temp vs position and it shows an incremental trend of temperature with respect to position.



Graph.1 Static temp vs Position

Temperature Contours from Simulation:

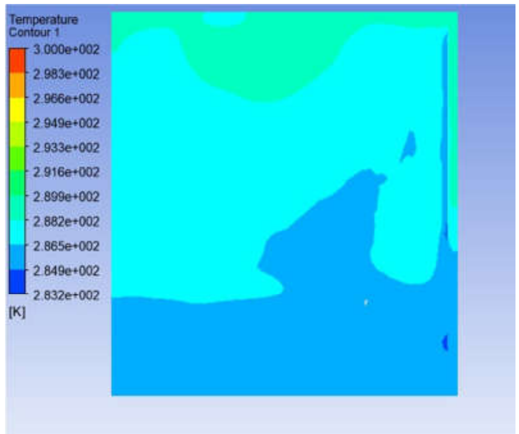


Fig.10 Contour 1

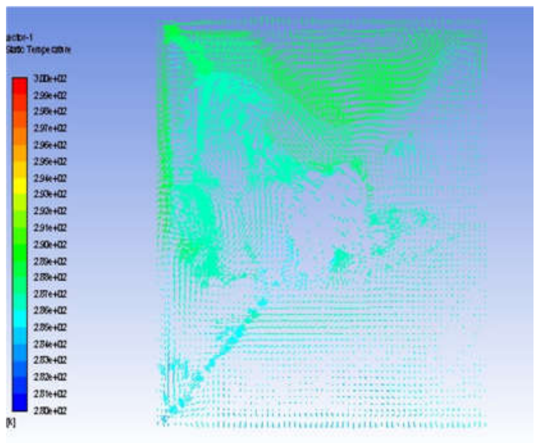


Fig.11 Contour 2

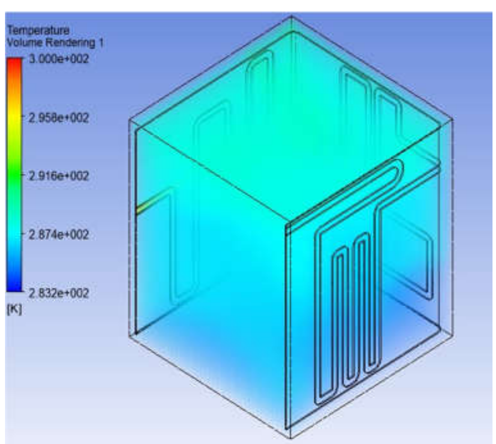


Fig.12 Contour 3

Conclusion

The current project looks into creating a product which gives the user the comfort of two devices in one system with aid of FEM analysis. The basic advantage of the system is that two components run on a single compressor. The system is so formed that most of the refrigerant is moved to the air conditioning system and rest of the refrigerant is moved to cooling chamber thus producing maximum cooling through air conditioner and required cooling to the products through cooling chamber. The FEM analysis showed that the system can be optimized.

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