IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

DESIGN AND ANALYSIS OF PORTABLE SOLAR THERMO-ELECTRIC AIR CONDITIONER

Telugu Shiva Krishna, Santrash Imran Basha, Shaik Mohammad Salman, Syed Mohammed Nadeemullah Hussainy, Shaik Mohammad Fareed, Mr S.Abzal Basha
Dept. of Mechanical Engineering, Brindavan Institute of Technology and Science, Kurnool, Andhra Pradesh, India

ABSTRACT:

Air Conditioner is the process of removing heat from a substance under controlled conditions. Air Conditioner is a reversed heat engine or a heat pump which pumps heat from a cold body and delivers it to a hot body. The substance which works in a heat pump to extract from a cold body and to deliver it to a hot body is called refrigerant. Refrigeration is an accomplished by various methods, such as the vapor compression system, absorption system, and steam jet refrigeration cycle the vapor compression system of refrigeration cycle. Thermoelectric couples are solid-state devices capable of generating electrical power from a temperature gradient, known as the *Seebeck effect*, or converting electrical energy into a temperature gradient, known as the *Peltier effect*. To assist the thermal designer in modeling thermoelectric coolers or Peltier modules, C&R Technologies' tool suite provides built in routines for modeling either standard Bismuth Telluride coolers or modules manufactured from alternative semiconductor materials. This module of solar air conditioner is being designed by the modeling software like CATIA V5; it is being done analysis by using ANSYS Workbench. The family of TEC routines provides the designer the ability to model single stage or multi-stage coolers, and calculate valuable sizing information regarding cooler performance. Solar electricity is the technology of converting sunlight directly in to electricity. It is based on photo-voltaic or solar modules, which are very reliable and do not require any fuel or servicing. Solar electric systems are suitable for plenty of sun and are ideal when there is no main electricity.

I.INTRODUCTION

"Faster, mightier & smaller" is still the keyword for every invention and development. In day-to-day world we concentrate on the compactness and efficiency of every product. Keeping this in our thought we have designed an economical and reliable unit known as "Solar Air Conditioner". "Human comfort is that condition of mind, which expresses itself with the thermal environment". In our project two rival properties of cool water and cool air are obtained. This system can be used continuously. By using our system there is no need of going for a Separate Air Conditioner.

1.1 Description of the Project

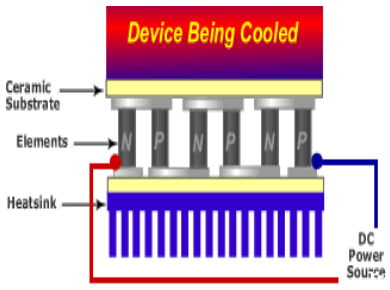

Fig: 1.1: Cooling process by ceramic substance

The field of mechanical engineering has a theme word called "CHANGE" as its backbone. The new technological advancements and the needs of people have made us think about this project. Our project is

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

maiden venture into the field of air temperature controlling and also deals with human comfort.

Thermoelectric couples are solid-state devices capable of generating electrical power from a temperature gradient, known as the Seebeck effect, or converting electrical energy into a temperature gradient, known as the Peltier effect.

A typical thermoelectric module is composed of two ceramic substrates that serve as a housing and electrical insulation for P-type and N-type (typically Bismuth Telluride) elements between the substrates. Heat is absorbed at the cold junction by electrons as they pass from a low energy level in the p-type element, to a higher energy level in the n-type element.

At the hot junction, energy is expelled to a thermal sink as electrons move from a high energy element to a lower energy element. A module contains several P-N couples that are connected electrically in series and thermally in parallel.

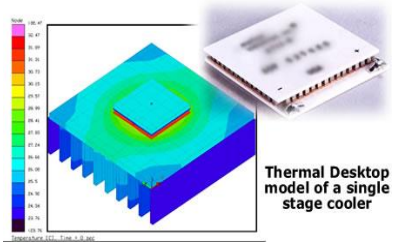

Fig: 1.2: Thermostatic Substance

To assist the thermal designer in modeling thermoelectric coolers or Peltier modules, C&R Technologies' tool suite provides built in routines for modeling either standard Bismuth Telluride coolers or modules manufactured from alternative semiconductor materials (in which case the user must provide the Seebeck coefficient, electrical resistivity, and thermal conductivity).

The routines allow applying the appropriate source terms and internally adjusting temperatures as needed in both steady state and transient simulations. The family of TEC routines provides the designer the ability to model single stage or multi-stage coolers, and calculate valuable sizing information regarding cooler performance.

1.2 Project Objective

Solar electricity is the technology of converting sunlight directly in to electricity. It is based on photo-voltaic or solar modules, which are very reliable and do not require any fuel or servicing. Solar electric systems are suitable for plenty of sun and are ideal when there is no main electricity.

Our objective is to design and analyze a system normally **"SOLAR AIR CONDITIONER".**

II - REVIEW OF LITERATURE

THERMAL EXCHANGE IN HUMAN BODY

The human body works best at certain temperatures like other machines, but it cannot tolerate with range of variations. The human body maintains its thermal equilibrium by three modes of heat transfer i.e. evaporation, radiation and convection.

A human body feels comfortable when the heat produced by metabolism of human body is equal to the sum of heat dissipated to the surroundings.

The normal temperature of the human body is 37 degree centigrade or 98.6 degree Fahrenheit. But, if this level goes below 36.5 degree centigrade or 98 degree Fahrenheit and exceeds 40.5 degree centigrade or 105 degree Fahrenheit, the conditions become dangerous for human existence.

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

BATTERY

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means.

Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern.

III - WORKING PRINCIPLE

Solar panel is used to charging the lead acid battery. Here we are using 12 volt 10 watts panel for demo purpose. The battery supply is given to the thermo-electric zip cooler. Before that the water is kept inside of the zip cooler. This water is cooled by the principle of see beck effect. In our zip cooler having two option

1. Cold Water
2. Hot Water

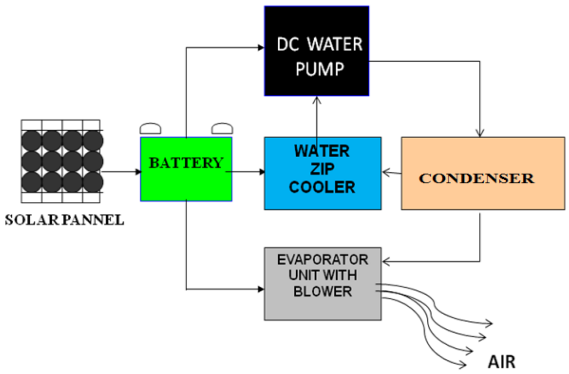

Fig: 3.1: Working principle

If electrical contacts are made with the two semiconductor materials and the contacts the connected through an external electrical conductor, the free electrons will flow from the n-type material through the conductor to the p-type material (figure). Here the free electrons will enter the holes and holes and become bound electrons thus both free electrons and hole will be removed. The flow of electrons through the external conductor constitutes an electric current, which will continue as long as move free electrons and holes are being formed by the solar radiation.

The photo-voltaic effect can be observed in almost any junction of material that have different electrical characteristics, but the best performance to date has been from cells using semiconductor materials especially all of the solar cells used for both space and terrestrial applications have been made of the semiconductor silicon. Future cells may use such materials as the Semiconductors like Gallium arsenate, copper sulfate cadsulphide etc. The device used to utilize the PHOTOVOLTAIC EFECT is SOLAR CELL.

4.1 Advantages of SOLAR-ELECTRIC AIR CONDITIONER

- Simple in design and analysis, and construction
- This system is noiseless in operation
- It is portable, so it can be transferred easily to any place
- Its operate in battery
- Maintenance cost is low
- Solar panel is used. so this project is non-conventional one
- Solar panel, battery is also used as a lighting system.

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

4.2 Disadvantages of SOLAR-ELECTRIC AIR CONDITIONER

- It does not purify air.

4.3 Applications of SOLAR-ELECTRIC AIR CONDITIONER

- Domestic Application
- Office and Bank Application
- It is very much useful in College and Schools

V - DESIGN METHODLOGY OF SOLAR-ELECTRIC AIR CONDITIONER

5.1 Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. CATIA competes in the high-end CAD/CAM/CAE market with Cero Elements/Pro and NX (Unigraphics).

CATIA can be applied to a wide variety of industries, from aerospace and defense, automotive, and industrial equipment, to high tech, shipbuilding, consumer goods, plant design, consumer packaged goods, life sciences, architecture and construction, process power and petroleum, and services. CATIA V4, CATIA V5, Pro/ENGINEER, NX (formerly Unigraphics), and Solid Works are the dominant systems.

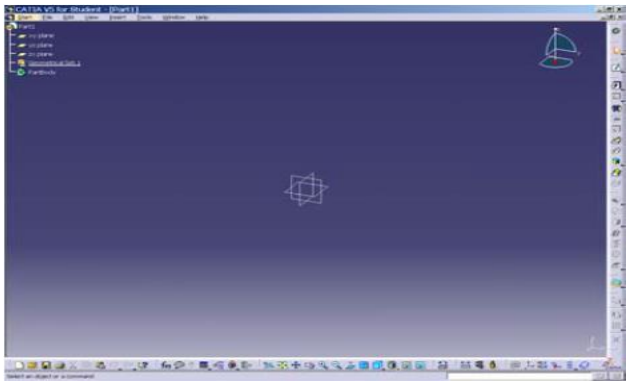

Fig: 5.1: Home Page of CatiaV5

Modeling of Portable Solar – Electric AIR CONDITIONER in CATIA V5

This Air Conditioner is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design.

The same CATIA V5 R20 3d model and 2d drawing model is shown below for reference. Dimensions are taken from. The design of 3d model is done in CATIA V5 software, and then to do test we are using below mentioned software's.

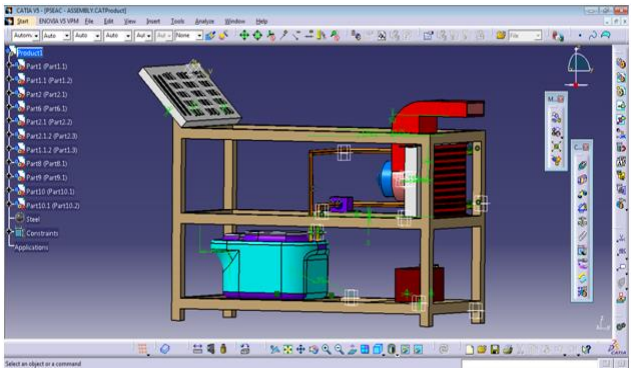

Fig: 5.2: Model design of PSEAC in CATIA-V5

VI - ANALYSIS OF PORTABLE SOLAR-ELECTRIC AIR CONDITIONER

6.1 Procedure for FE Analysis Using ANSYS:

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

The analyses of the blower, pump, pipes, sq. frame, condenser, air out port are done using ANSYS. For compete assembly is not required, motor and attached gear system is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs of assembly of machine.

6.2 Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

File Menu > Import> STEP > Click ok for the popped up dialog box > Click

Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

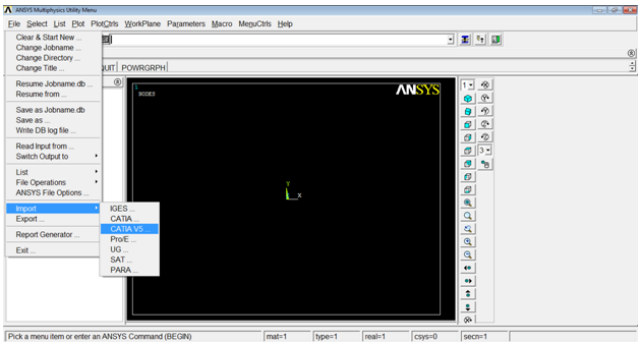

Fig.6.1: Import panel in Ansys.

Meshing:

Mesh generation is the practice of generating a polygonal or polyhedral mesh that approximates a geometric domain. The term "grid generation" is often used interchangeably. Typical uses are for rendering to a computer screen as finite element analysis or computational fluid dynamics. The input model form can vary greatly but common sources are CAD, NURBS, B-rep and STL (file format). The field is highly interdisciplinary, with contributions found in mathematics, computer science, and engineering.

Three-dimensional meshes created for finite element analysis need to consist of tetrahedral, pyramids, prisms or hexahedra. Those used for the finite volume method can consist of arbitrary polyhedral. Those used for finite difference methods usually need to consist of piecewise structured arrays of hexahedra known as multi-block structured meshes.

Meshing is an integral part of the computer-aided engineering (CAE) simulation process. The mesh influences the accuracy, convergence and speed of the solution. Furthermore, the time it takes to create a mesh model is often a significant portion of the time it takes to get results from a CAE solution. Therefore, the better and more automated the meshing tools, the better the solution. From easy, automatic meshing to a highly crafted mesh, ANSYS provides the ultimate solution. Powerful automation capabilities ease the initial meshing of a new geometry by keying off physics preferences and using smart defaults so that a mesh can be obtained upon first try. Additionally, users are able to update immediately to a parameter change, making the handoff from CAD to CAE seamless and aiding in up-front design. Once the best design is found, meshing technologies from, ANSYS provide the flexibility to produce meshes that range in complexity from pure hex meshes to highly detailed Hybrid meshes.

VII - DISCUSSION ON ANALYSYS RESULT

7.1 Results of Displacement analysis:

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

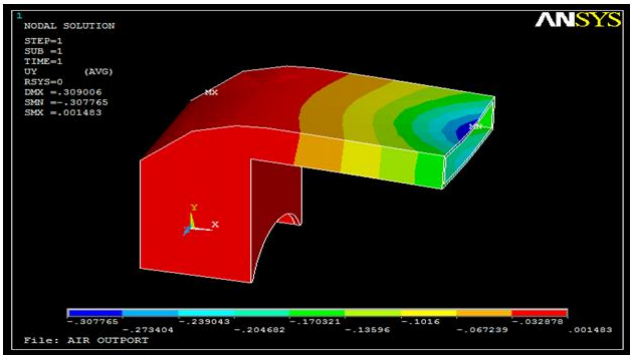

Fig: 7.1: Displacement of AIR OUTPORT

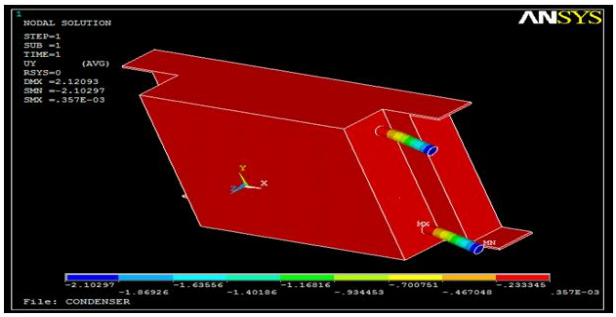

Fig: 7.2: Displacement of CONDENSER

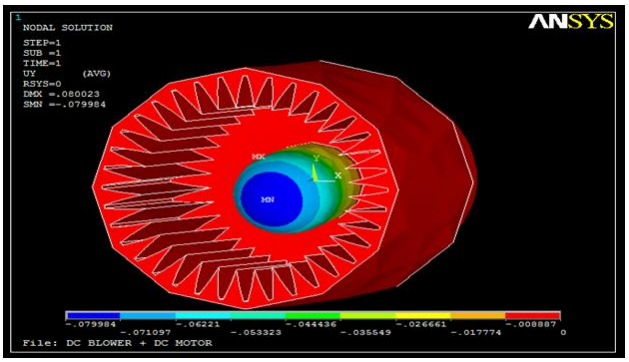

Fig: 7.3: Displacement of DC BLOWER + DC MOTOR

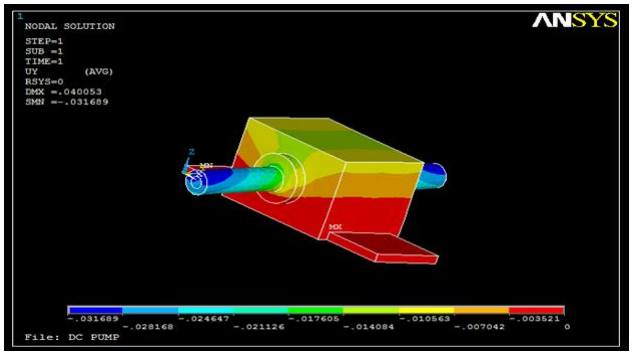

Fig: 7.4: Displacement of DC PUMP

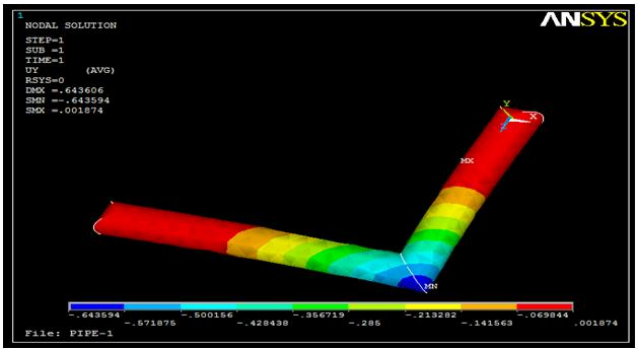

Fig: 7.5: Displacement of PIPE-1

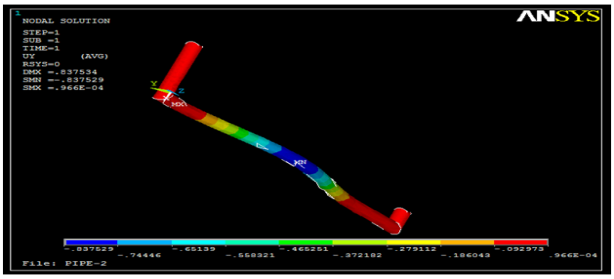

Fig: 7.6: Displacement of PIPE-2

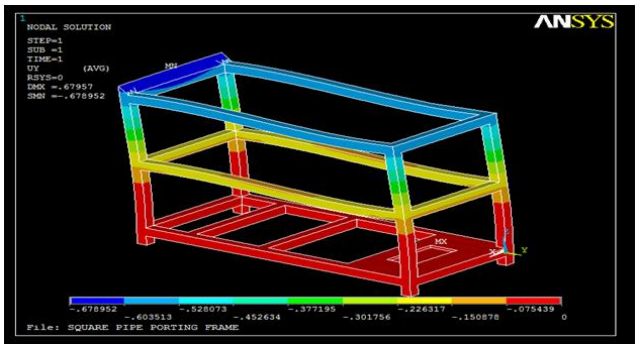

Fig: 7.7: Displacement of SQUARE PIPE PORTING FRAME

7.2 Results of Stress analysis:

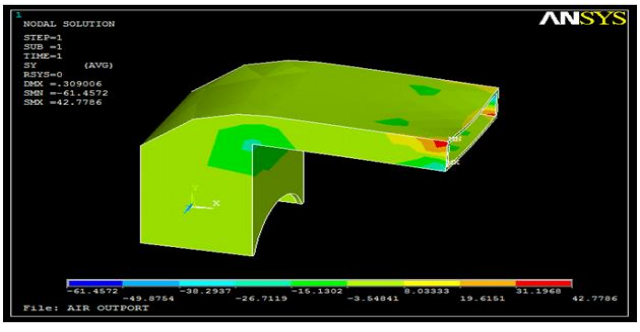

Fig: 7.8: Stress Analysis of AIR OUTPORT

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

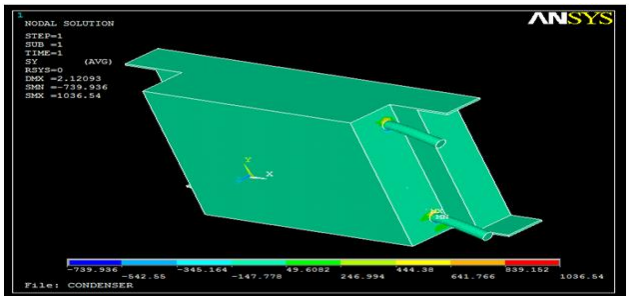

Fig: 7.9: Stress Analysis of CONDENSER

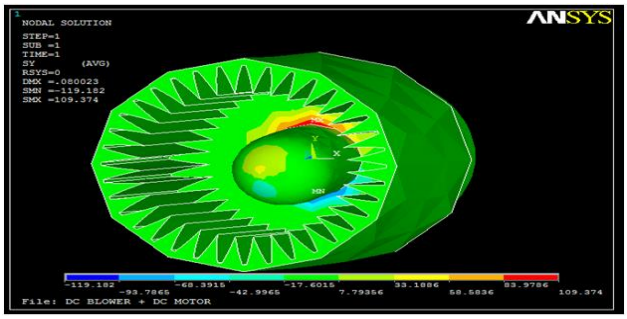

Fig: 7.10: Stress Analysis of DC BLOWER + DC MOTOR

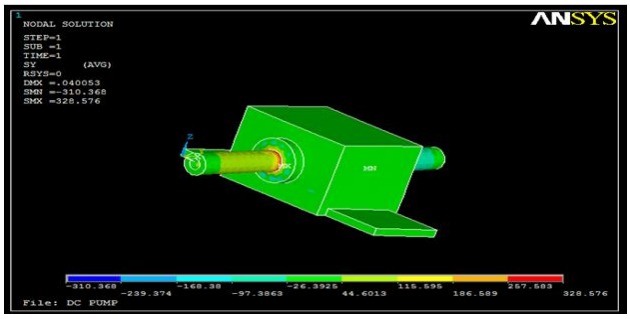

Fig: 7.11: Stress Analysis of DC PUMP

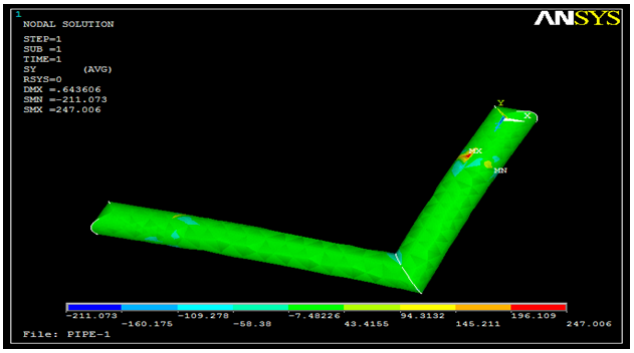

Fig: 7.12: Stress Analysis of PIPE-1

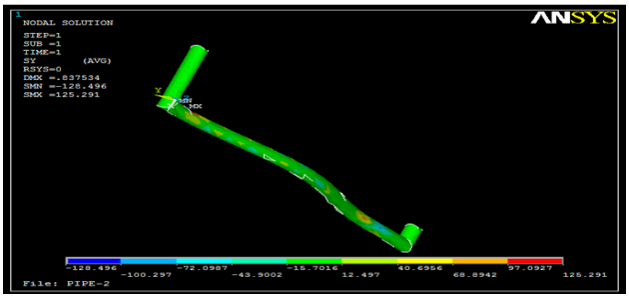

Fig: 7.13: Stress Analysis of PIPE-2

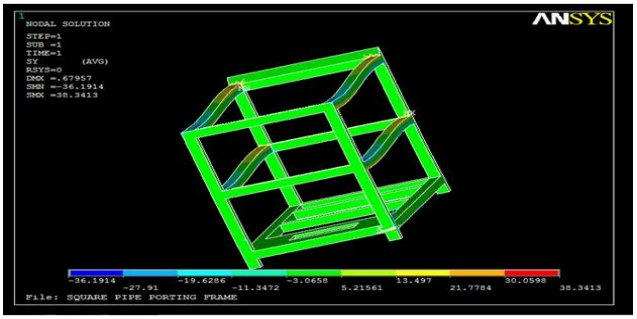

Fig: 7.14: Stress Analysis of SQUARE PIPE PORTING FRAME

7.3 Results of Strain analysis:

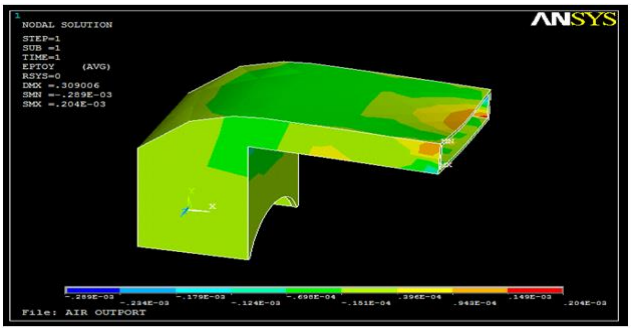

Fig: 7.15: Strain Analysis of AIR OUTPORT

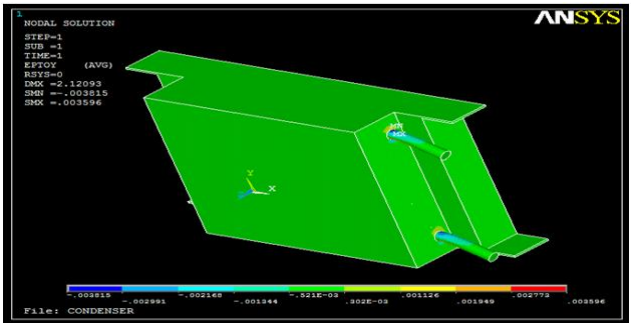

Fig: 7.16: Strain Analysis of CONDENSER

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

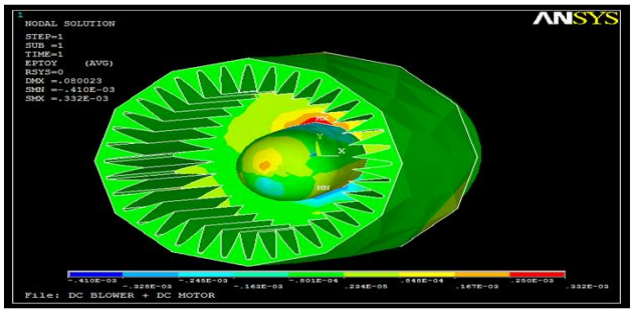

Fig: 7.17: Strain Analysis of DC BLOWER + DC MOTOR

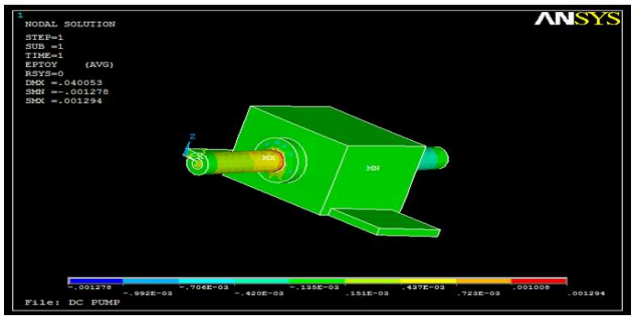

Fig: 7.18: Strain Analysis of DC PUMP

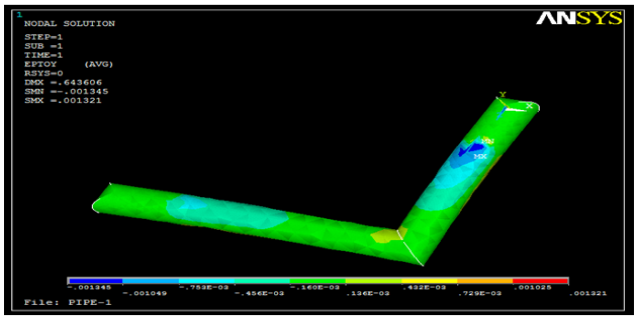

Fig: 7.19: Strain Analysis of PIPE-1

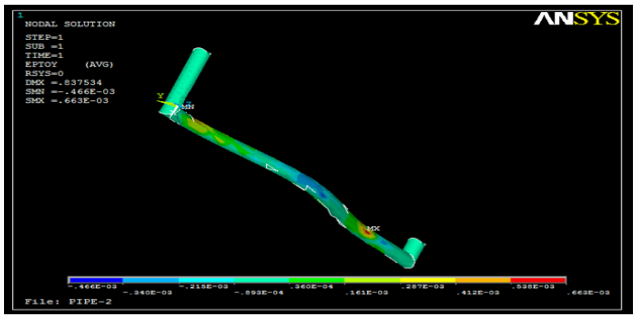

Fig: 7.20: Strain Analysis of PIPE-2

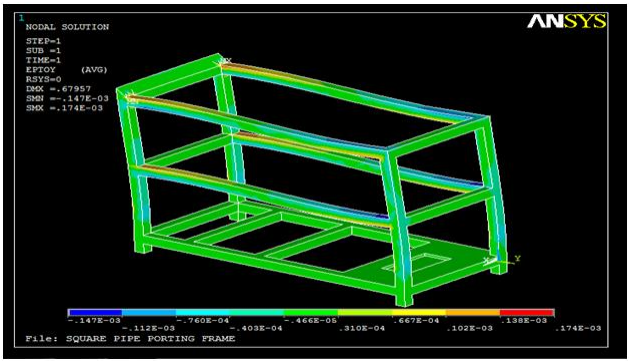

Fig: 7.21: Strain Analysis of SQUARE PIPE PORTING FRAME

VIII - CONCLUSION

As shown above figures of the displacement of the meshed and solved using Ansys and displacement is very less. This is showing us that clearly each component in assembly is having minor displacement. Stress is at the fixing location (Minimum Stress which is acceptable), stress value is 0.679 MPa. The value which is very less compared to yield value of Mild steel; this is below the yield point. The maximum stress is coming, this solution solving with the help of Ansys software so that the maximum stress is less .so we can conclude our design parameters are approximately correct. The final result positive manner .There is no problem with the design assembly of the machine. To assist the thermal designer in modeling thermoelectric coolers modules, C&R Technologies' tool suite provides built in routines for modeling either standard Bismuth Telluride coolers or modules manufactured from alternative semiconductor materials. The family of TEC routines provides the designer the ability to model single stage or multi-stage coolers, and calculate valuable sizing information regarding cooler performance.

IJMTARC – VOLUME – IX – ISSUE – 38, JUL - SEP, 2022 ISSN: 2320-1363

In this changing modern world every day there is a new discovery in all fields of science and technology, benefiting the mankind. In this work the design of Solar Air Conditioner is slightly modified with an addition air cooler. If one utilizes energy which goes as waste even more useful things can be made.

IX.REFERENCES

1. Air conditioning engineering, w.p. Jones, Elbs (1994)

2. Refrigeration & air conditioning system, R.S.Khurmi

3. Refrigeration & air conditioning, A.S.Sarao, P.S.Gaabi

4. Turbo machines, K.Pandian

5. Thermal engineering, K.R.Govindan