In this Book, energy from the exhaust gas of an internal combustion engine is used to power an absorption refrigeration system to air-condition an ordinary passenger car. All the required parts for the absorption refrigeration system is designed and modeled in 3D modeling software CREO parametric software. Thermal analysis is done on the main parts of the refrigeration system to determine the thermal behavior of the system. Analysis is done in ANSYS.

Dr T Venkata Deepthi working as Associate Professor in MREC(A) have 14 years of Teaching Experience.
Dr S Udaya Bhaskar working as Associate Professor in MREC(A) have 14 years of Teaching Experience.
Mr Ch Ashok Kumar working as Assistant professor in MREC(A) have 8 years of Teaching Experience.

9 786206 182566

Dr. T. Venkata Deepthi
Dr. S. Udaya Bhaskar
Ch Ashok Kumar

Design of a Car AC absorption cycle using energy from IC exhaust gas

LAP LAMBERT Academic Publishing

Dr. T. Venkata Deepthi
Dr. S. Udaya Bhaskar
Ch Ashok Kumar

Design of a Car AC absorption cycle using energy from IC exhaust gas

Dr. T. Venkata Deepthi
Dr. S. Udaya Bhaskar
Ch Ashok Kumar

Design of a Car AC absorption cycle using energy from IC exhaust gas

LAP LAMBERT Academic Publishing

Imprint
Any brand names and product names mentioned in this book are subject to trademark, brand or patent protection and are trademarks or registered trademarks of their respective holders. The use of brand names, product names, common names, trade names, product descriptions etc. even without a particular marking in this work is in no way to be construed to mean that such names may be regarded as unrestricted in respect of trademark and brand protection legislation and could thus be used by anyone.

Cover image: www.ingimage.com

Publisher:
LAP LAMBERT Academic Publishing
is a trademark of
Dodo Books Indian Ocean Ltd. and OmniScriptum S.R.L publishing group

120 High Road, East Finchley, London, N2 9ED, United Kingdom
Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova, Europe
Printed at: see last page
ISBN: 978-620-6-18256-6

ABSTRACT

Air conditioning is the process of altering the properties of air (primarily temperature and humidity) to more favorable conditions. More generally, air conditioning can refer to any form of technological cooling, heating, ventilation, or disinfection that modifies the condition of air. It is a well-known fact that a large amount of heat energy associated withthe exhaust gases from an engine is wasted.

A rough energy balance of the available energy in the combustion of fuel in a motor car engine shows that one third is converted into shaft work, one third is lost at the radiator and one third is wasted as heat at the exhaust system. Even for a relative small car-engine, 15 kW of heat energy can be utilized from the exhaust gas. This heat is enough to power an absorption refrigeration system to produce a refrigeration capacity of 5 kW. Where thermal energy is available the absorption refrigerator can very well substitute than the vapour compression system. An absorption refrigerator is a refrigerator that uses a heat source (e.g., solar, kerosene-fueled flame, waste heat from factories or district heating systems) to provide the energy needed to drive the cooling system.

In this thesis, energy from the exhaust gas of an internal combustion engine is used to power an absorption refrigeration system to air-condition an ordinary passenger car. All the required parts for the absorption refrigeration system is designed and modeled in 3D modeling software CREO parametric software. Thermal analysis is done on the main parts of the refrigeration system to determine the thermal behavior of the system. Analysis is done in ANSYS.

KEYWORDS : Air Conditioner, Automobile, Compressor, Engine, Exhaust Gas.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Refrigeration is the process of casting off warmness from an enclosed or controlled space, or from a substance, and transferring it to an area in which it's miles unobjectionable. The number one cause of refrigeration is lowering the temperature of the enclosed area or substance after which keeping that decrease temperature as evaluate to surroundings. Cold is the absence of heat, therefore on the way to lower a temperature, one "removes warmness", rather than "including cold." The basic objective of growing a vapour absorption refrigerant system for vehicles is to cool the distance inside the automobile through making use of waste heat and exhaust gases from engine.

The air con gadget of motors in these days's world makes use of "Vapour Compression Refrigerant System" (VCRS) which absorbs and gets rid of heat from the interior of the car that's the space to be cooled and in addition rejects the heat to be somewhere else. Now to increase an performance of vehicle past a sure restriction vapour compression refrigerant device resists it because it can't employ the exhaust gases from the engine. In vapour compression refrigerant machine, the machine makes use of electricity from engine shaft as the input electricity to force the compressor of the refrigerant device, subsequently the engine has to provide greater work to run the compressor of the refrigeration gadget using more amount of gasoline.

Waste heat is heat, which is generated in a procedure through way of gas combustion or chemical response, and then "dumped" into the environment despite the fact that it can nevertheless be reused for a few beneficial and financial motive.

This warmth relies upon in part on the temperature of the waste warmth gases and mass go with the flow rate of exhaust gas. Waste heat losses get up both from system inefficiencies and from thermodynamic obstacles on device and procedures.

For instance, don't forget inner combustion engine about 30 to forty% is converted into beneficial mechanical work.

The last heat is expelled to the environment through exhaust gases and engine cooling structures .

It approach about 60 to 70% strength losses as a waste warmness via exhaust (30% as engine cooling system and 30 to forty% as environment through exhaust gasoline). Exhaust gases immediately leaving the engine will have temperatures as excessive as 842-1112°F [450-600°C]. Consequently, those gases have high warmth content material, wearing away as exhaust emission.

Efforts may be made to design more power green reverberatory engine with higher warmness transfer and decrease exhaust temperatures; but, the laws of thermodynamics location a lower limit at the temperature of exhaust gases

This loss of electricity of the car for refrigeration may be left out via using another refrigeration machine i.E. A “Vapour Absorption Refrigerant System” i.E low grade warmth operated structures. It is well known that an IC engine has an efficiency of about 35-forty%, which means that only one-0.33 of the energy within the gas is transformed into beneficial paintings and approximately 60-65% is wasted to environment.

In which 28-30% is lost with the aid of cooling water and lubrication losses, round 30-32% is lost in the form of exhaust gases and the rest by way of radiation, and many others.

In a Vapour Absorption Refrigerant System, a physicochemical manner replaces the mechanical process of the Vapour Compression Refrigerant System via the usage of electricity in the form of heat in place of mechanical work.

The warmness required for running the Vapour Absorption Refrigerant System can be acquired from that that is wasted into the ecosystem from IC engine. Hence to utilize the exhaust gases and waste warmness from an engine the vapour absorption refrigerant device may be placed into practice which will increase the overall performance of a car.

1.1 Possibility of warmth restoration and availability from I.C. Engine

Waste heat is heat, which is generated in a procedure through way of gas combustion or chemical response, and then “dumped” into the environment despite the fact that it can nevertheless be reused for a few beneficial and financial motive.

This warmth relies upon in part on the temperature of the waste warmth gases and mass go with the flow rate of exhaust gas. Waste heat losses get up both from system inefficiencies and from thermodynamic obstacles on device and procedures. For instance, don't forget inner combustion engine about 30 to forty% is converted into beneficial mechanical work.

The last heat is expelled to the environment through exhaust gases and enginecooling structures . It approach about 60 to 70% strength losses as a waste warmness via exhaust (30% as engine cooling system and 30 to forty% as environment through exhaust gasoline). Exhaust gases immediately leaving the engine will have temperatures as excessiveas 842-1112°F [450-600°C]. Consequently, those gases have high warmth content material, wearing away as exhaust emission. Efforts may be made to design more power green reverberatory engine with higher warmness transfer and decrease exhaust temperatures; but, the laws of thermodynamics location a lower limit at the temperature of exhaust gases.

1.2 Possible way of the usage of warmness recuperation system

Today’s present day existence is greatly relies upon on car engine, i.E. Internal Combustion engines. The majority of motors are nevertheless powered via either spark ignition (SI) or compression ignition (CI) engines. Small air-cooled diesel engines of up to 35 kW output are used for irrigation cause, small agricultural tractors and production machines whereas massive farms employ tractors of as much as 150 kW output. Water or air-cooled engines are used for various 35-one hundred fifty kW and except strictly air cooled engine is required, water-cooled engines are favored for better strength tiers. Earth shifting equipment makes use of engines with an output of up to 520 kW or even higher, up to 740 kW. Marine and locomotive applications commonly hire engines with an output rangeof a hundred and fifty kW or extra. Trucks and avenue engines commonly use high speed diesel engines with 220 kW output or greater. Diesel engines are used in small electrical energy generating gadgets or as standby units for medium ability strength stations.

Table 1.2 Types of engines and their power output

S.N	Engine Type	Power Output (kW)	Waste Heat
1.	Small air cooled diesel engine	35	30-40 % of energy waste loss from IC engines
2.	Water air cooled engine	35-150	
3.	Earth moving machineries	520-720	
4.	Marine applications	150-220	
5.	Trucks and road engines	220	

1.3 Working principle: Vapour absorption refrigeration device

Alternately condenses below excessive stress in the condenser by way of surrendering heat to the environment and vaporizes under low strain within the evaporator byusing soaking up heat from the medium being cooled. The most important distinction among the absorption and the vapour-compression cycles is the mechanism for circulating the refrigerant thru the gadget and supplying the essential stress distinction between the vaporizing and condensing tactics. The vapour compressor employed within the vapour- compression cycle is replaced inside the absorption cycle via an absorber and a generator or boiler, which compress the vapour as required. The energy input required by using the vapour-compression cycle is provided to the compressor inside the shape of mechanical work but In the absorption cycle, the strength enter is often in the form of warmth furnished to the generator. In the existing case the heat supply is the exhaust warmth of an internal combustion engine.

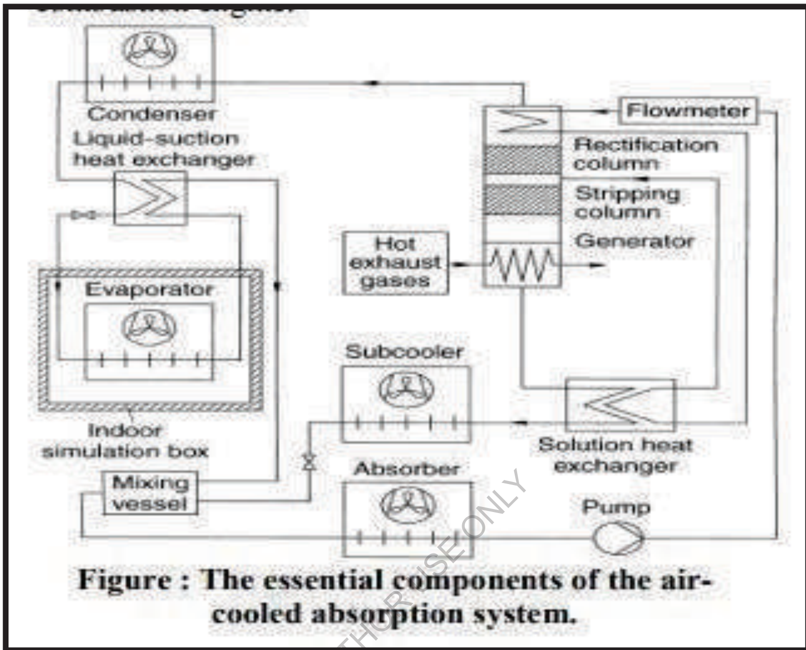

Figure : The essential components of the air-cooled absorption system.

Figure 1.3.1 The essential components of the air cooled absorption system

The boiling point of ammonia is decrease than that of water, so it vaporizes, isolating the refrigerant from the absorbent. Since the vapour is not a pure ammonia fuel, it ought to be purified as it flows via a stripping and rectification column.

The heat exchangers of the generator rectification system have been designed as compact plate-fin heat exchangers and the column became filled with chrome steel Pall earrings. In Vapour absorption refrigeration device, generator element is designed for using exhaust gasoline from internal combustion engine. Type of engine and also info of engine parameters are given below.

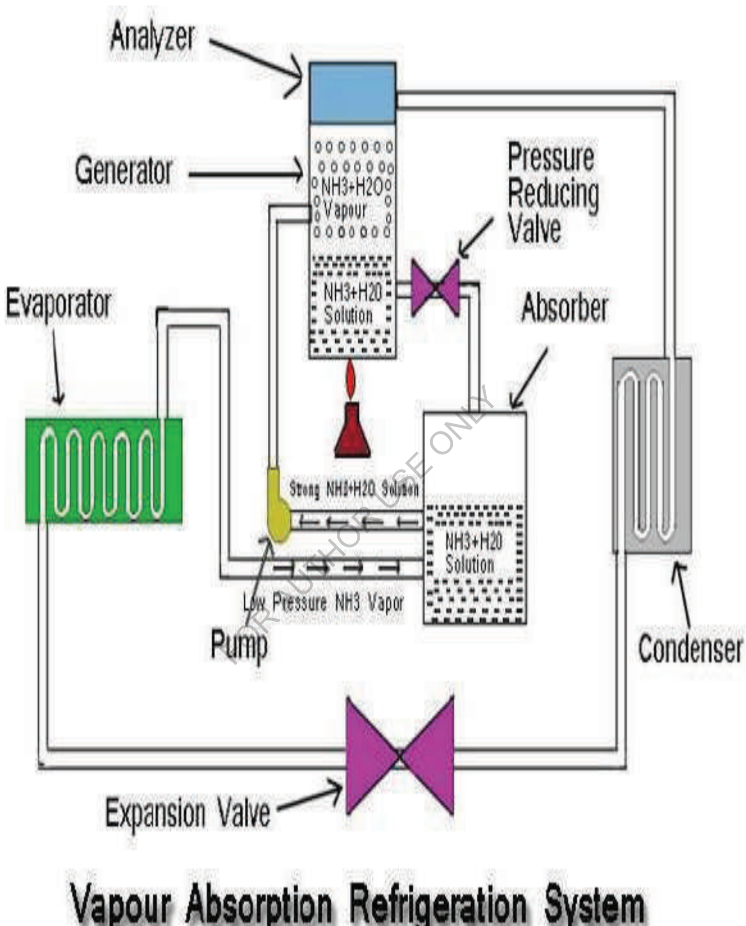

Figure 1.3.2 Working of VARS

Table 1.3.1 Engine specification

1.	Engine Make	Kirloskar
2.	Engine Type	Single Cylinder
3.	Power	3.7 kW
4.	Speed	1500 rpm
5.	Bore Diameter	80 mm
6.	Stroke Length	110 mm
7.	Room Temperature	29 °C
8.	Exhaust Gas Temperature Range	125°C to 260°C

Table : IC Engine specifications.

Temperature of an exhaust fuel in kirloskar engine by an warmness balance on engine by using using electrical loading. Fuel utilized in engine is excessive pace diesel. Exhaust gas temperature variety is numerous depends upon the type and additionally quantity load appearing at the engine.

. The most important distinction among the absorption and the vapour-compression cycles is the mechanism for circulating the refrigerant thru the gadget and supplying the essential stress distinction between the vaporizing and condensing tactics.

The vapour compressor employed within the vapour-compression cycle is replaced inside the absorption cycle via an absorber and a generator or boiler, which compress the vapour as required.

The energy input required by using the vapour-compression cycle is provided to the compressor inside the shape of mechanical work but In the absorption cycle, the strength enter is often in the form of warmth furnished to the generator. In the existing case the heat supply is the exhaust warmth of an internal combustion engine.

The heat exchangers of the generator rectification system have been designed as compact plate-fin heat exchangers and the column became filled with chrome steel Pall earrings. In Vapour absorption refrigeration device, generator element is designed for using exhaust gasoline from internal combustion engine. Type of engine and also info of engine parameters are given below.

CHAPTER 2

LITERATURE REVIEW

2.1 A Cooling System for an Automobile Based on Vapour Absorption Refrigeration Cycle Using Waste Heat of an Engine.

Now a days the air conditioning device of motors is specifically uses "Vapour Compression Refrigerant System" (VCRS) which absorbs and removes warmness from the indoors of the automobile this is the gap to be cooled and rejects the warmth to surroundings. In vapour compression refrigerant machine, the system makes use of strength from engine shaft as the input strength to force the compressor of the refrigeration system, consequently the engine has to produce extra work to run the compressor of the refrigerating machine utilising more quantity of gas. This lack of power of the automobile for refrigeration may be left out with the aid of using some other refrigeration device i.E. A "Vapour Absorption Refrigerant System". As widely known aspect approximately VAS that those machines required low grade power for operation. Hence in such varieties of machine, aphysicochemical manner replaces the mechanical manner of the Vapour Compression Refrigerant System via using power inside the shape of heat rather than mechanical work. This warmness received from the exhaust of excessive strength inner combustion engines. Keywords: Waste heat from I. C. Engine, Waste heat healing machine for I. C. Engine, car air-conditioning, absorption refrigeration, renewable energy.

2.2 Development Of Vapour Absorption Refrigerant System For Cars (the use of Engine Heat)

The fundamental goal of developing a vapour absorption refrigerant gadget for motors is to chill the gap within the car by using utilizing waste warmth and exhaust gases from engine. The air conditioning system of motors in today's global uses "vapour compression refrigerant machine" (vcrs) which absorbs and gets rid of warmth from the indoors of the auto that's the distance to be cooled and finally rejects the warmth to be elsewhere. Now to boom an efficiency of vehicle past a sure limit vapour compression refrigerant system resists it because it cannot employ the exhaust gases from the engine. In vapour compression refrigerant system, the machine utilizes strength from engine shaft because the input power to drive the compressor of the refrigerant machine, consequently the engine has to supply greater work to run the compressor of the refrigerating unit utlilzing greater quantity of fuel. This loss of electricity of the car for refrigeration may be left out via making use of another refrigeration machine i.E. A "vapour absorption refrigerant machine".

A automobile air-conditioning gadget based on an absorptionrefrigeration cycle the use of electricity from exhaust gas of an inner combustion engine Energy from the exhaust gasoline of an inner combustion engine is used to electricity an absorption refrigeration machine to air-situation an everyday passenger vehicle. The theoretical layout is verified through a unit that is tested underneath both laboratory and street-check situations. For the latter, the unit is installed in a Nissan 1400 truck and the consequences imply a a hit prototype and inspiring potentialities for destiny improvement. Keywords: vehicle air- conditioning, absorption refrigeration, renewable energy.

2.3 Absorption AC in Vehicles Using Exhaust Gas.

Todays automobiles use the era of vapour compression system to run the air con gadget this is required to cool the passenger and maintain them in an premier temperature variety . But but the rising fuel cost and the burden supported at the combustion engines restriction show to be negative aspects .It as well as takes the using delight off the low potential engine automobiles. Contrary to this device, the try to have a vapour absorption gadget on lithium bromide might also prove to be an fine alternative. It will not require a strength input from the auto's engine as well .Instead the exhaust gas warmness can be used to run the device. The high degree of heat contained inside the exhaust is enough sufficient to run a decent potential absorption system and preserve foremost temperature situations within the automobile.

2.4 Development Of Air Conditioning System Based On Vapour Absorption Refrigeration Cycle For Automobiles Using Exhaust Gasses With R134a-Dmf

The air conditioning machine of automobiles in nowadays's global uses "Vapour Compression Refrigerant System" (VCRS) which absorbs and gets rid of heat from the indoors of the automobile. The system utilizes power from engine shaft as the enter energy to drive the compressor of the refrigerant machine.

The loss of energy of the engine to run the VCR system can be disregarded through using another refrigeration gadget i.E. A “Vapour Absorption Refrigerant System”.

In a Vapour Absorption Refrigerant System, a physicochemical procedure replaces the mechanical manner of the Vapour Compression Refrigerant System by using the use of energy inside the shape of heat in place of mechanical work.

The experimental work to make use of the waste warmness from exhaust gases from an engine for the vapour absorption refrigerant machine with R-134a as refrigerant and DMF as absorbent. The experimental consequences indicated that car performance enhances, noise reduces, renovation will become simpler, and tremendously dependable. The statistics received from experimentation is provided analyzed in this paper.

As we studied the refrigeration units currently used in road transport vehicles are predominantly of the vapour compression refrigeration type but this work represents study of air conditioning based on ammonia water vapour absorption system.

This is new technique to be used in air conditioning system of automobile and system especially in food preservation this design is couple the vapour absorption system cycle with automotive air conditioning system instead of vapour compression cycle. Considering the environmental changes and the atmospheric depravation including the factors such as excessive energy loss .

With the quickly environmental changes and atmospheric consequences the air conditioning of the moving vehicle has become a necessity in this paper an exploration has been done to research the possibility of the waste heat recovery and its subsequently utilization in air conditioning system of vehicle without increasing the expensive, weight, number of component and brings improvement in vehicle by making luxurious .

The attempt to have a vapour absorption system on lithium bromide may prove to be advantageous alternative.it will not require a power input from the cars engines well. Instead the exhaust gas heat may be used to run the system Colbourne summarized a study analyzing over 50 published technical documents comparing the performance of fluorinated refrigerants and HCs. A significantly higher number of tests showed an increase in performance when using HCs as compared to using fluorinated refrigerants. Colbourne and Suen .

Similarly, Colbourne and Ritter investigated the compatibility of non-metallic materials with HC refrigerant and lubricant mixtures.

They performed experiments in compliance with European standards for the testing of elastomeric materials and ASHRAE material compatibility test standards. Maclaine-Crossand Leonardi compared the refrigerant performance of HCs based on refrigerant properties and concluded that the COP improvements, commonly reported in literature, were consistent with better thermodynamic properties of HCs. R600a properties and their influences on system performance were discussed.

Now a days the air conditioning device of motors is specifically uses "Vapour Compression Refrigerant System" (VCRS) which absorbs and removes warmness from the indoors of the automobile this is the gap to be cooled and rejects the warmth to surroundings.

In vapour compression refrigerant machine, the system makes use of strength from engine shaft as the input strength to force the compressor of the refrigeration system, consequently the engine has to produce extra work to run the compressor of the refrigerating machine utilising more quantity of gas.

This lack of power of the automobile for refrigeration may be left out with the aid of using some other refrigeration device i.E. A "Vapour Absorption Refrigerant System".

As widely known aspect approximately VAS that those machines required low grade power for operation. Hence in such varieties of machine, a physicochemical manner replaces the mechanical manner of the Vapour Compression Refrigerant System via using power inside the shape of heat rather than mechanical work. This warmness received from the exhaust of excessive strength inner combustion engines. Keywords: Waste heat from I. C. Engine, Waste heat healing machine for I. C. Engine, car air-conditioning, absorption refrigeration, renewable energy.

The fundamental goal of developing a vapour absorption refrigerant gadget for motors is to chill the gap within the car by using utilizing waste warmth and exhaust gases from engine. The air conditioning system of motors in today's global uses "vapour compression refrigerant machine" (vcrs) which absorbs and gets rid of warmth from the indoors of the auto that's the distance to be cooled and finally rejects the warmth to be elsewhere. Now to boom an efficiency of vehicle past a sure limit vapour compression refrigerant system resists it because it cannot employ the exhaust gases from the engine. In vapour compression refrigerant system, the machine utilizes strength from engine shaft because the input power to drive the compressor of the refrigerant machine, consequently theengine has to supply greater work to run the compressor of the refrigerating unit utlilzing greater quantity of fuel. This loss of electricity of the car for refrigeration may be left out via making use of another refrigeration machine i.E. A "vapour absorption refrigerant machine".

A automobile air-conditioning gadget based on an absorptionrefrigeration cycle the use of electricity from exhaust gas of an inner combustion engine Energy from the exhaust gasoline of an inner combustion engine is used to electricity an absorption refrigeration machine to air-situation an everyday passenger vehicle. The theoretical layout is verified through a unit that is tested underneath both laboratory and street-check situations. For the latter, the unit is installed in a Nissan 1400 truck and the consequences imply a a hit prototype and inspiring potentialities for destiny improvement. Keywords: vehicle air- conditioning, absorption refrigeration, renewable energy

CHAPTER 3

COMPONENTS OF AIR COOLED ABSORPTION SYSTEM

3.1 CONDENSER

In systems concerning heat switch, a condenser is a tool or unit used to condense a substance from its gaseous to its liquid nation, by using cooling it. In so doing, the latent warmth is given up via the substance and transferred to the encircling environment. Condensers may be made in keeping with numerous designs, and are available in many sizes starting from instead small (hand held) to very large (business-scale devices utilized in plant processes). For example, a fridge uses a condenser to do away with heat extracted from the indoors of the unit to the out of doors air. Condensers are used in air con, commercial chemical tactics along with distillation, steam energy plants and different heat-change systems. Use of cooling water or surrounding air because the coolant is common in lots of condensers.

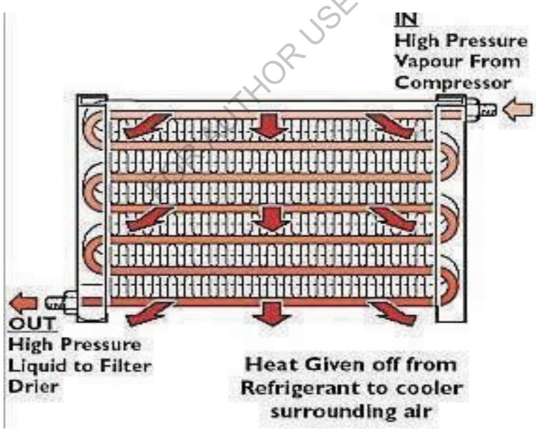

Figure 3.1.1 Working of condensor

3.1.1 Examples of condensers

A surface condenser is an example of the sort of warmth-change machine. It is a shell and tube heat exchanger mounted at the hole of each steam turbine in thermal power stations. Commonly, the cooling water flows thru the tube facet and the steam enters the shell facet in which the condensation happens on the outside of the heat switch tubes. The condensate drips down and collects at the bottom, often in a integrated pan called a hotwell. The shell aspect often operates at a vacuum or partial vacuum, produced by using the difference in particular volume among the steam and condensate. Conversely, the vapor may be fed thru the tubes with the coolant water or air flowing around the outdoor.

In chemistry, a condenser is the equipment which cools warm vapors, causing them to condense into a liquid. See "Condenser (laboratory)" for laboratory-scale condensers, rather than business-scale condensers. Examples include the Liebig condenser, Graham condenser, and Allihn condenser. This isn't always to be stressed with a condensation reaction which hyperlinks two fragments right into a single molecule through an addition response and an removal response.

In laboratory distillation, reflux, and rotary evaporators, several types of condensers are normally used. The Liebig condenser is genuinely a immediately tube inside a cooling water jacket, and is the only (and relatively least expensive) shape of condenser. The Graham condenser is a spiral tube within a water jacket, and the Allihn condenser has a chain of massive and small constrictions on the inner tube, every increasing the surface location upon which the vapor materials might also condense. Being extra complex shapes to fabricate, those latter sorts are also more steeply-priced to buy. These three kinds of condensers are laboratory glassware objects due to the fact that they may be usually made from glass. Commercially to be had condensers generally are fitted with ground glass joints and are available widespread lengths of 100, 2 hundred, and four hundred mm. Air-cooled condensers are unjacketed, while water-cooled condensers comprise a jacket for the water.

Larger condensers also are used in business-scale distillation techniques to cool distilled vapor into liquid distillate. Commonly, the coolant flows through the tube side and distilled vapor through the shell facet with distillate accumulating at or flowing out the bottom.

Figure 3.1.1.1 Condenser unit for crucial aircon for a regular residence

A condenser unit utilized in principal air con systems usually has a heat exchanger phase to cool down and condense incoming refrigerant vapor into liquid, a compressor to raise the pressure of the refrigerant and pass it alongside, and a fan for blowing outdoor air through the heat exchanger segment to cool the refrigerant internal. A typical configuration of this kind of condenser unit is as follows: The heat exchanger segment wraps across the aspects of the unit with the compressor interior. In this heat exchanger phase, the refrigerant goes through more than one tube passes, which might be surrounded by way of warmth switch fins through which cooling air can circulate from out of doors to in the unit. There is amotorized fan in the condenser unit near the top, which is covered with the aid of some grating to preserve any items from accidentally falling internal on the fan. The fan is used to blow the outside cooling air in via the warmth alternate section at the edges and out the top through the grating. These condenser gadgets are placed at the outdoor of the building they'relooking to cool, with tubing between the unit and constructing, one for vapor refrigerant getting into and every other for liquid refrigerant leaving the unit. Of direction, an electric power deliver is needed for the compressor and fan in the unit.

3.2 Direct contact condenser

In this sort of condenser, vapors are poured into the liquid without delay. The vapors lose their latent warmth of vaporization; subsequently, vapors switch their warmness into liquid and the liquid turns into warm. In this sort of condensation, the vapor and liquid are of

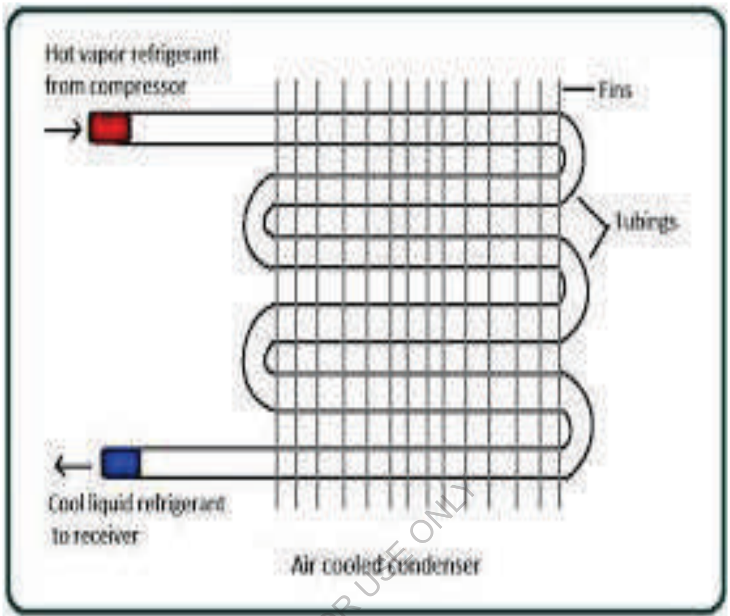

Figure 3.2.1 Air Cooled Condensor

identical sort of substance. In any other form of direct touch condenser, cold water is sprayed into the vapour to **be condensed.**

3.3 EVAPORATOR

An evaporator is a tool in a system used to turn the liquid form of a chemical substance inclusive of water into its gaseous-form/vapor. The liquid is evaporated, or vaporized, right into a gas form of the centered substance in that system.

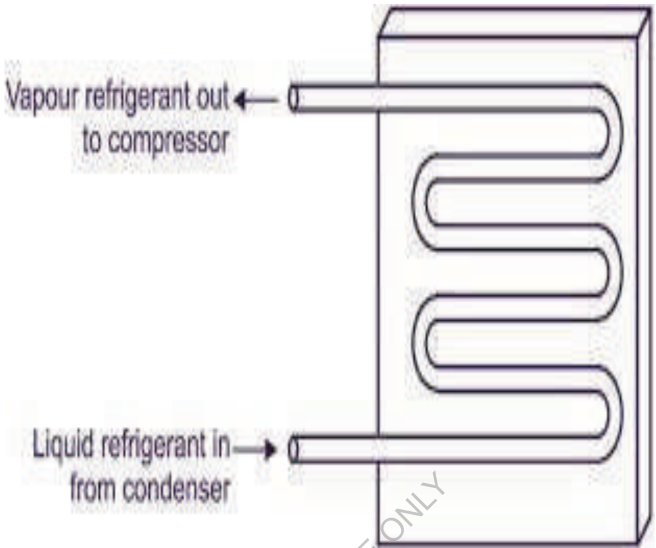

Figure 3.3.1 Evaporator

3.3.1 Uses

One kind of evaporator is a form of radiator coil used in a closed compressor driven move of a liquid coolant. That is known as an air-conditioning device (A/C) or refrigeration gadget to allow a compressed cooling chemical, inclusive of R-22 (Freon) or R-410A, to evaporate/vaporize from liquid to fuel within the machine whilst soaking up heat from the enclosed cooled region, as an instance a fridge or rooms interior, within the system. This works within the closed A/C or refrigeration device with a condenser radiator coil that exchanges the heat from the coolant, which include into the ambient environment.[1]

A one-of-a-kind type of evaporator can be used for heating and in all likelihood boiling a product containing a liquid to cause the liquid to evaporate from the product.

The suitable manner may be used to dispose of water or different liquids from liquid based combinations. The process of evaporation is broadly used to concentrate liquid foods, which includes soup or make concentrated milk known as "condensed milk" executed by using evaporating water from the milk. In the awareness manner, the purpose of evaporation is to vaporize maximum of the water from an answer which includes the preferred product.

An evaporator/evaporative-method may be used for setting apart liquid chemical compounds as well as to salvage solvents.

In the case of desalination of sea water or in Zero Liquid Discharge flora, the reverse reason applies; evaporation removes the perfect drinking water from the undesired solute/product, salt.

One of the maximum vital packages of evaporation is within the food and beverage industry. Foods or beverages that want to ultimate for a large amount of time or want to have sure consistency, like coffee, go through an evaporation step at some stage in processing.

In the pharmaceutical industry, the evaporation system is used to eliminate extra moisture, imparting an easily treated product and enhancing product stability. Preservation of lengthy-time period activity or stabilization of enzymes in laboratories are significantly assisted via the evaporation technique.

Another example of evaporation is within the recovery of sodium hydroxide in kraft pulping. Cutting down waste-coping with fee is some other predominant cause for huge companies to apply evaporation applications. Legally, all manufacturers of waste ought to get rid of waste using strategies like minded with environmental pointers; these methods are pricey. By putting off moisture through vaporization, industry can greatly lessen the quantity of waste product that have to be processed.

3.3.2 Energetic

Water may be removed from answers in approaches aside from evaporation, along with membrane processes, liquid-liquid extractions, crystallization, and precipitation. Evaporation can be distinguished from a few other drying techniques in that the very last made of evaporation is a concentrated liquid, now not a solid. It is also quite easy to apply and apprehend because it has been extensively used on a large scale, and many techniques are normally widely recognized. In order to concentrate a product by using water elimination, an auxiliary segment is used which lets in for clean transport of the solvent (water) in place of the solute. Water vapor is used as the auxiliary phase when concentrating non-volatile components, inclusive of proteins and sugars. Heat is added to the solution, and part of the solvent is transformed into vapor. Heat is the main device in evaporation, and the system occurs greater readily at excessive temperature and occasional pressures.

Heat is wanted to provide enough power for the molecules of the solvent to depart the solution and flow into the air surrounding the answer. The energy wanted may be expressed as an excess thermodynamic capacity of the water in the answer. Leading to one in all the most important troubles in industrial evaporation, the method requires sufficient electricity toput off the water from the answer and to deliver the warmth of evaporation. When eliminating the water, more than ninety nine% of the electricity needed is going towards presenting the warmth of evaporation. The need to overcome the floor anxiety of the answer additionally requires power. The power requirement of this procedure is very excessive because a segment transition must be induced; the water must move from a liquid to a vapor.

When designing evaporators, engineers must quantify the quantity of steam wished for every mass unit of water eliminated when a attention is given. An strength balance shouldbe used based totally on an assumption that a negligible quantity of warmth is lost to the gadget's surroundings. The warmness that desires to be furnished by means of the condensing steam will about same the heat needed to vaporize the water. Another consideration is the dimensions of the heat exchanger which affects the heat transfer fee.

Some commonplace phrases: A = heat transfer location, and q = usual warmness transfer charge.

3.4 How an Evaporator works

The answer containing the preferred product is fed into the evaporator and passes throughout a warmness source. The carried out warmness converts the water inside the answer into vapor. The vapor is eliminated from the rest of the answer and is condensed at the same time as the now-focused solution is both fed into a 2d evaporator or is eliminated.

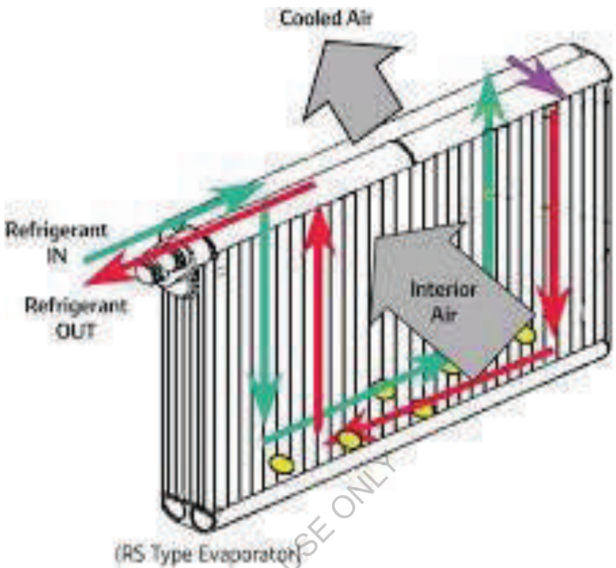

Figure 3.4.1 working of Evaporator

The evaporator, as a device, generally consists of four sections. The heating segment contains the heating medium, that can vary. Steam is fed into this phase. The most common medium includes parallel tubes however others have plates or coils typically made from copper or aluminium. The concentrating and isolating segment removes the vapor being created from the solution. The condenser condenses the separated vapor, then the vacuum or pump presents pressure to growth flow.

3.5 Refrigerant used for the Absorption Refrigeration Systems

A essential requirement of absorbent/refrigerant mixture is that, in liquid phase, they should have a margin of miscibility inside the operating temperature range of the cycle. The mixture should also be chemically strong, non-poisonous, and non-explosive. In addition to those requirements, the subsequent are appropriate:

A. Refrigerant ought to have excessive heat of vaporization and high awareness within the absorbent with the intention to keep low circulation charge among the generator and the absorber in keeping with unit of the cooling capacity.

B. Transport properties that have an effect on warmth and mass transfer, e.G., viscosity, thermal conductivity, and diffusion coefficient should be beneficial.

C. Both refrigerant and absorbent have to be noncorrosive, environmental friendly, and in your price range. There are a few 40 refrigerant compounds and two hundred absorbent compounds available. However, the maximum common operating fluids are water/ammonia and LiBr/water. Since the discovery of absorption refrigeration systems, water/ammonia has been broadly used for both cooling and heating functions. The primary homes are:

A. Ammonia (refrigerant) and water (absorbent) are pretty stable for a extensive variety of operating temperature and pressure.

B. Ammonia has a excessive latent heat of vaporization, which is necessary for efficient performance of the machine. Its latent warmness of vaporization at -15℃ is 1315kJ/Kg.

C. Its boiling point at atmospheric pressure is -33.Three ℃ & freezing factor is -77 ℃ .

D. It has maximum refrigerating effect in line with Kg of refrigerant. E The leakage of this refrigerant may be speedy & without difficulty detected through using burning sulphur candle which in the presence of ammonia will form white fumes of ammonium sulphite. F. It is environmental pleasant.

3.6 ABSORBER

An **absorption refrigerator** is a refrigerator that uses a heat source (e.g., solar energy, a fossil-fueled flame, waste heat from factories, or district heating systems) to provide the energy needed to drive the cooling process.

The system uses two coolants, the first of which performs evaporative cooling and is then absorbed into the second coolant; heat is needed to reset the two coolants to their initial states. The principle can also be used to air-condition buildings using the waste heat from a gas turbine or water heater. Using waste heat from a gas turbine makes the turbine very efficient because it first produces electricity, then hot water, and finally, air-conditioning—trigeneration.

Absorption refrigerators are commonly used in recreational vehicles (RVs), campers, and caravans because the heat required to power them can be provided by a propane fuel burner, by a low-voltage DC electric heater (from a battery or vehicle electrical system) or by a mains-powered electric heater. Unlike more common vapor-compression refrigeration systems, an absorption refrigerator has no moving parts.

3.7 GENERATOR

It is used **to generate the vapour refrigerant in generator outlet**. ammonium-water refrigerant is used in refrigerant and absorber. In the generator a mixture of ammonia and water is heated. The boiling point of ammonia is lower than that of water, so it vaporizes, separating the refrigerant from the absorbent.

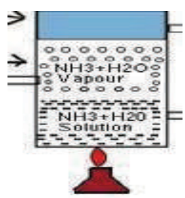

Figure 3.7.1 Working of Generator

3.8 Advantages

Uses Engine warmth as supply of energy for this reason enhances the efficiency of engine. Moving parts are handiest within the pump, that's a small detail in the machine therefore operation becomes smooth and also carrying and tearing is decreased. The system works at low evaporator pressures with out affecting the COP of the machine.Environmental friendly, no launch of CFC derivatives. Helps in shielding OZONE layer from depletion. Helps engine to cool, as it extracts warmth from engine. Low jogging value. Higher engine electricity performance

CHAPTER 4

INTRODUCTION TO CAD

Computer-aided layout (CAD) is using laptop structures (or workstations) to useful resource within the creation, change, evaluation, or optimization of a layout. CAD software is used to increase the productivity of the fashion designer, enhance the best of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often within the form of digital files for print, machining, or other production operations. The time period CADD (for Computer Aided Design and Drafting) is also used

Engineering drawings have been in use for more than 2000 years. However, the use of orthographic projections was formally introduced by the French mathematician Gaspard Monge in the eighteenth century.

Since visual objects transcend languages, engineering drawings have evolved and become popular over the years. While earlier engineering drawings were handmade, studies have shown that engineering designs are quite complicated. A solution to many engineering problems requires a combination of organization, analysis, problem solving principles and a graphical representation of the problem. Objects in engineering are represented by a technical drawing (also called as drafting) that represents designs and specifications of the physical object and data relationships. Since a technical drawing is precise and communicates all information of the object clearly, it has to be precise. This is where CAD comes to the fore. CAD stands for **C**omputer **A**ided **D**esign. CAD is used to design, develop and optimize products. While it is very versatile, CAD is extensively used in the design of tools and equipment required in the manufacturing process as well as in the construction domain. CAD enables design engineers to layout and to develop their work on a computer screen, print and save it for future editing.

When it was introduced first, CAD was not exactly an economic proposition because the machines at those times were very costly. The increasing computer power in the later part of the twentieth century, with the arrival of minicomputer and subsequently the microprocessor, has allowed engineers to use CAD files that are an accurate representation of the dimensions / properties of the object.

Use of CAD

CAD is used to accomplish preliminary design and layouts, design details and calculations, creating 3-D models, creating and releasing drawings, as well as interfacing with analysis, marketing, manufacturing, and end-user personnel.

CAD facilitates the manufacturing process by transferring detailed information about a product in an automated form that can be universally interpreted by trained personnel. It can be used to produce either two-dimensional or three-dimensional diagrams. The use of CAD software tools allow the object to be viewed from any angle, even from the inside looking out. One of the main advantages of a CAD drawing is that the editing is a fast process as compared to manual method. Apart from detailed engineering of 2D or 3D models, CAD is widely used from conceptual design and layout of products to definition of manufacturing of components. CAD reduces design time by allowing precise simulation rather than build and test physical prototypes. Integrating CAD with CAM (Computer Aided Manufacturing) streamlines the product development even more.

CAD is currently widely used for industrial products, animated movies and other applications. A special printer or plotter is usually required for printing professional design renderings. CAD programs use either vector-based graphics or raster graphics that show howan object will look.

Its use in designing digital systems is referred to as electronic design automation, or EDA. In mechanical layout it's far referred to as mechanical design automation (MDA) or computer-aided drafting (CAD), which incorporates the technique of creating a technical drawing with using pc software program.

CAD software for mechanical layout uses either vector-based totally photos to depict the objects of conventional drafting, or might also produce raster portraits showing the overall appearance of designed items. However, it includes greater than simply shapes. As inside the manual drafting of technical and engineering drawings, the output of CAD need tobring statistics, along with substances, approaches, dimensions, and tolerances, consistent with application-unique conventions.

CAD may be used to design curves and figures in two-dimensional (2D) area; or curves, surfaces, and solids in 3-dimensional (3D) space.

CAD is an critical commercial art substantially used in lots of applications, consisting of automobile, shipbuilding, and aerospace industries, commercial and architectural design, prosthetics, and lots of greater. CAD is likewise extensively used to provide computer animation for computer graphics in movies, marketing and technical manuals, often known as DCC digital content material introduction. The current ubiquity and strength of computers approach that even fragrance bottles and shampoo dispensers are designed the use of strategies remarkable via engineers of the Sixties. Because of its great financial significance, CAD has been a first-rate using pressure for research in computational geometry, computer pix (each hardware and software program), and discrete differential geometry.

There are several different types of CAD, each requiring the operator to think differently about how to use them and design their virtual components in a different manner for each.

2D CAD

There are many producers of the lower-end 2D systems, including a number of free and open-source programs. These provide an approach to the drawing process without all the fuss over scale and placement on the drawing sheet that accompanied hand drafting since these can be adjusted as required during the creation of the final draft.

3D CAD

3D wireframe is basically an extension of 2D drafting (not often used today) into a three-dimensional space. Each line has to be manually inserted into the drawing. The final product has no mass properties associated with it and cannot have features directly add to it, such as holes. The operator approaches these in a similar fashion to the 2D systems, although many 3D systems allow using the wireframe model to make the final engineering drawing views.

3D "dumb" solids are created in a way analogous to manipulations of real-world objects (not often used today). Basic three-dimensional geometric forms (prisms, cylinders, spheres, rectangles) have solid volumes added or subtracted from them as if assembling or cutting real-world objects. Two-dimensional projected views can easily be generated from the models. Basic 3D solids don't usually include tools to easily allow the motion of the components, set their limits to their motion, or identify interference between components.

There are two types of *3D* solid modeling

- Parametric modeling allows the operator to use what is referred to as "design intent". The objects and features are created modifiable. Any future modifications can be made by changing on how the original part was created. If a feature was intended to be located from the center of the part, the operator should locate it from the center of the model. The feature could be located using any geometric object already available in the part, but this random placement would defeat the design intent. If the operator designs the part as it functions the parametric modeler is able to make changes to the part while maintaining geometric and functional relationships.
- Direct or explicit modeling provide the ability to edit geometry without a history tree With direct modeling, once a sketch is used to create geometry the sketch is incorporated into the new geometry and the designer just modifies the geometry without needing the original sketch. As with parametric modeling, direct modeling has the ability to include the relationships between selected geometry (e.g., tangency, concentricity).

CAD is used to accomplish preliminary design and layouts, design details and calculations, creating 3-D models, creating and releasing drawings, as well as interfacing with analysis, marketing, manufacturing, and end-user personnel.

CAD facilitates the manufacturing process by transferring detailed information about a product in an automated form that can be universally interpreted by trained personnel. It can be used to produce either two-dimensional or three-dimensional diagrams. The use of CAD software tools allow the object to be viewed from any angle, even from the inside looking out.

One of the main advantages of a CAD drawing is that the editing is a fast process as compared to manual method. Apart from detailed engineering of 2D or 3D models, CAD is widely used from conceptual design and layout of products to definition of manufacturing of components. CAD reduces design time by allowing precise simulation rather than build and test physical prototypes. Integrating CAD with CAM (Computer Aided Manufacturing) streamlines the product development even more.

CAD is currently widely used for industrial products, animated movies and other applications. A special printer or plotter is usually required for printing professional design renderings. CAD programs use either vector-based graphics or raster graphics that show how an object will look.

Its use in designing digital systems is referred to as electronic design automation, or EDA. In mechanical layout it's far referred to as mechanical design automation (MDA) or computer-aided drafting (CAD), which incorporates the technique of creating a technical drawing with using pc software program.

CAD software for mechanical layout uses either vector-based totally photos to depict the objects of conventional drafting, or might also produce raster portraits showing the overall appearance of designed items. However, it includes greater than simply shapes. As inside the manual drafting of technical and engineering drawings, the output of CAD need to bring statistics, along with substances, approaches, dimensions, and tolerances, consistent with application-unique conventions.

CHAPTER 5

INTRODUCTION TO CREO

PTC CREO, previously known as Pro/ENGINEER, is 3-d modeling software utilized in mechanical engineering, design, production, and in CAD drafting carrier firms. It changed into one of the first 3D CAD modeling applications that used a rule-primarily based parametric gadget. Using parameters, dimensions and features to capture the behavior of the product, it could optimize the improvement product as well as the layout itself.

CreoTM Parametric is one of the most powerful Computer-Aided Design (CAD), Computer-Aided Analysis and Computer-Aided Manufacture (CAM) software packages available in the world today. It is the flagship of a family of other software products, developed by PTC Corporation, for engineering design and product development, also including CreoTM Direct, CreoTM Simulate, CreoTM Layout and others.

The main applications are in mechanical, product design, aerospace, construction, shipbuilding and other industries. CreoTM Parametric (or Creo) was previously known as Pro/EngineerTM and WildfireTM. The core of the software contains a variety of tools for the creation, validation and communication of complex three-dimensional (3D) objects as parts and assemblies.

In addition, there are integrated applications that associate directly with the 3D model geometry and support the development of engineering drawings, mould design, NC machine simulation, sheet metal design, piping and wiring, harness design, structural strength, thermal and CFD analyses, kinematic and dynamic analyses, feasibility and optimisation studies, and others.

This long list of applications is not meant to scare the user but only to illustrate the vast scope and complexity of a modern CAD/CAM package. The main purpose of this textbook is to explain the main CAD/CAM methodology and principles embedded in the software. The book is organised as a set of core lessons that provide a quick start and guide the reader in the process of mastering the basics of 3D CAD modelling

The name become changed in 2010 from Pro/ENGINEER Wildfire to CREO. It become introduced by using the company who evolved it, Parametric Technology Company (PTC), all through the launch of its suite of design products that consists of programs inclusive of assembly modeling, 2D orthographic perspectives for technical drawing, finite detail analysis and more.

PTC CREO says it can provide a more efficient layout experience than different modeling software program due to its unique functions such as the mixing of parametric and direct modeling in one platform. The entire suite of applications spans the spectrum of product development, giving designers alternatives to apply in every step of the manner. Thesoftware also has a greater user friendly interface that provides a better revel in for designers.It also has collaborative capacities that make it clean to proportion designs and make changes.

There are limitless advantages to using PTC CREO. We'll check them in this -component series.

First up, the largest advantage is improved productiveness due to its green and flexible design competencies. It changed into designed to be less difficult to use and have functions that allow for design procedures to transport more quickly, making a designer's productivity degree increase.

Part of the cause productivity can be extended is because the package deal offers tools for all phases of development, from the beginning levels to the hands-on advent and manufacturing. Late stage modifications are not unusual inside the design method, however PTC CREO can manage it. Changes may be made that are meditated in other elements of the process.

The main applications are in mechanical, product design, aerospace, construction, shipbuilding and other industries. CreoTM Parametric (or Creo) was previously known as Pro/EngineerTM and WildfireTM. The core of the software contains a variety of tools for the creation, validation and communication of complex three-dimensional (3D) objects as parts and assemblies.

The collaborative functionality of the software also makes it easier and faster to use. One of the motives it may method statistics extra quick is due to the interface between MCAD and ECAD designs. Designs may be altered and highlighted between the electric and mechanical designers operating on the venture.

The time stored by means of using PTC CREO isn't the best benefit. It has many ways of saving costs. For instance, the cost of creating a new product may be lowered because the development technique is shortened due to the automation of the technology of associative manufacturing and provider deliverables.

PTC also gives comprehensive education on a way to use the software program. This can store corporations by using doing away with the need to rent new employees. Their training program is to be had on line and in-character, however materials are available to get admission to every time.

A particular feature is that the software program is available in 10 languages. PTC is aware of they have people from all around the world the usage of their software program, so they offer it in multiple languages so almost all people who wants to use it is able to achieve this

Part of the cause productivity can be extended is because the package deal offers tools for all phases of development, from the beginning levels to the hands-on advent and manufacturing. Late stage modifications are not unusual inside the design method, however PTC CREO can manage it. Changes may be made that are meditated in other elements of the process.

The collaborative functionality of the software also makes it easier and faster to use. One of the motives it may method statistics extra quick is due to the interface between MCAD and ECAD designs. Designs may be altered and highlighted between the electric and mechanical designers operating on the venture.

.

5.1 ADVANTAGES OF CREO PARAMETRIC SOFTWARE

1. Optimized for model-based totally organizations
2. Increased engineer productivity
3. Better enabled concept layout
4. Increased engineering competencies
5. Increased manufacturing talents
6. Better simulation
7. Design abilties for additive manufacturing

5.2 CREO parametric modules:

- Sketcher
- Part modeling
- Assembly
- Drafting

5.3 FINAL DIMENSIONS

Dimensions of the designed pre-heater

Outside Diameter of the tube, D0 = 0.012 m

Inside Diameter of the tube, Dj = 0.01 m

Length of the tube, L =2m

By using comparable calculations additionally findout the

Dimensions of the following Generator

It is the place wherein the exhaust gas tube is surpassed via the field and the tube emperature is

assumed to be a regular.

Dimensions of the designed generator

Outside Diameter of the exhaust gas tube,

D0 = zero.04 m

Taking interior diameter of the exhaust gasoline tube, Di =

zero.038m

Length of the tube required for the desired warmth

switch, L= 1 m

5.4 Condenser Dimensions:

Assume circular cross segment of the condenser coil of

thickness, a = 5 mm &Diameter d = 18 mm.

Dimensions of the designed condenser

Diameter of the tube, d = 0.018 m Thickness of the

tube, a= 0.1/2 m Length of the tube, L = 7.Forty five m

5.5 Evaporator Dimensions

The evaporator is of circular go segment and should be manufactured from copper tubes to have maximum heat switch from the environment to the refrigerant. The tube is coiled to accommodate it inside the car.

Dimensions of the designed evaporator

Outside Diameter of the tube, D0 = zero.01 m Inside

Diameterof the tube,

Dj - 0.008 m Length of the tube, L = 6.26 m

5.6 Absorber Dimension

It is a container inside the device which absorbs the refrigerant coming from the evaporator using the answer coming from the generator. Proper cooling bought to be provided as warmness is liberated throughout the absorption method which need to be completed using air.

Dimensions of the designed absorber

Outside diameter of the absorber, D0 = 76 mm Total

length of the absorber,

L = 205 mm Outer diameter of the fins,

Df= 109 mm ,No. Of fins, n=7

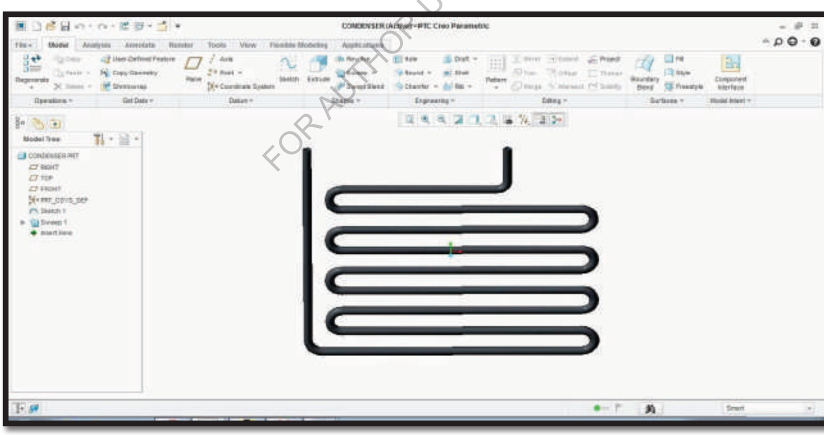

Figure 5.6.1 Condenser model

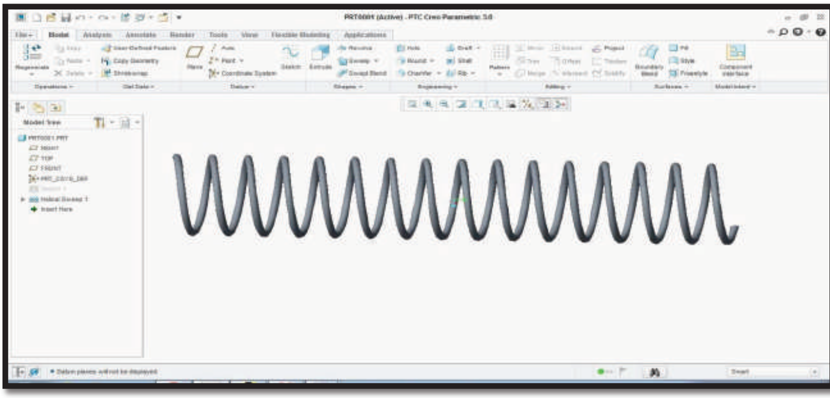

Figure 5.6.2 Evaporator version

CHAPTER 6

INTRODUCTION TO FEA

Finite element analysis is a way of solving, usually about, sure issues in engineering and science. It is used mainly for troubles for which no genuine answer, expressible in a few mathematical shape, is to be had. As such, it's far a numerical in place of an analytical approach. Methods of this kind are wanted due to the fact analytical techniques can't cope with the actual, complicated problems which are met with in engineering. For instance, engineering strength of substances or the mathematical concept of elasticity may be used to calculate analytically the stresses and lines in a dishonest beam, however neither could be very successful in finding out what is occurring in a part of a car suspension gadget at some stage in cornering.

One of the first applications of FEA changed into, indeed, to locate the stresses and traces in engineering components below load. FEA, while applied to any practical version of an engineering aspect, requires an giant quantity of computation and the development of the technique has depended on the availability of appropriate virtual computers for it to run on. The approach is now applied to problems regarding a huge variety of phenomena, including vibrations, warmth conduction, fluid mechanics and electrostatics, and a huge range of cloth residences, which include linear-elastic (Hookean) behavior and conduct regarding deviation from Hooke's law (as an example, plasticity or rubber-elasticity).

Many complete trendy-reason pc applications are now to be had that can cope with a wide range of phenomena, together with greater specialised programs for specific applications, for example, for the take a look at of dynamic phenomena or large-scale plastic waft. Depending on the type and complexity of the analysis, such applications may also run on a microcomputer or, at the other severe, on a supercomputer. FEA is largely a chunk-wise system. It can be carried out to 1-dimensional issues, but greater usually there's a place or quantity within which the answer is required. This is split up into a number of smaller regions or volumes, that are referred to as finite elements. Figure 1 indicates a -dimensional model of a spanner that has been so divided: the manner is referred to as discretisation, and the assembly of factors is called a mesh.

CHAPTER 7

INTRODUCTION TO ANSYS

7.1 Structural Analysis

ANSYS Autodyn is laptop simulation tool for simulating the response of materials to short length extreme loadings from effect, high pressure or explosions.

7.2 ANSYS Mechanical

ANSYS Mechanical is a finite element analysis tool for structural analysis, such as linear, nonlinear and dynamic research. This laptop simulation product provides finite elements to model behavior, and supports cloth fashions and equation solvers for a wide variety of mechanical design issues. ANSYS Mechanical additionally consists of thermal evaluation and paired-physics abilities involving acoustics, piezoelectric, thermal–structural and thermo-electric powered evaluation.

7.3 Fluid Dynamics

ANSYS Fluent, CFD, CFX, FENSAP-ICE and related software are Computational Fluid Dynamics software program equipment used by engineers for design and evaluation. These gear can simulate fluid flows in a digital surroundings — for instance, the fluid dynamics of deliver hulls; gasoline turbine engines (including the compressors, combustion chamber, mills and afterburners); aircraft aerodynamics; pumps, lovers, HVAC systems, mixing vessels, hydro cyclones, vacuum cleaners, etc.

CHAPTER 8

THERMAL ANALYSIS OF CONDENSER

Table 8.1 Steel Thermal Properties

Thermal Properties	Metric
CTE, linear	7.02 - 21.1 µm/m-°C
Specific Heat Capacity	0.200 - 0.620 J/g-°C
Thermal Conductivity	2.02 - 34.3 W/m-K
Melting Point	1230 - 1530 °C
Solidus	1230 - 1480 °C
Liquidus	1360 - 1530 °C
Maximum Service Temperature, Air	120 - 1400 °C
Minimum Service Temperature, Air	-200 - -34.0 °C

Table 8.2 Aluminum alloy Thermal Properties

Thermal Properties	Metric
Heat of Fusion	386.9 J/g
Heat of Vaporization	9462 J/g
CTE, linear	24.0 µm/m-°C @Temperature 20.0 - 100 °C
	25.5 µm/m-°C @Temperature 20.0 - 300 °C
	27.4 µm/m-°C @Temperature 20.0 - 500 °C
Specific Heat Capacity	0.900 J/g-°C
Thermal Conductivity	210 W/m-K
Melting Point	660.37 °C
Boiling Point	2519 °C

Table 8.3 Copper Thermal Properties

Thermal Properties	Metric
Heat of Fusion	204.8 J/g
Heat of Vaporization	5234 J/g
CTE, linear	16.4 µm/m-°C @Temperature 20.0 - 100 °C
	18.5 µm/m-°C @Temperature 250 °C
	20.2 µm/m-°C @Temperature 500 °C
	24.8 µm/m-°C @Temperature 925 °C
Specific Heat Capacity	0.385 J/g-°C
Thermal Conductivity	385 W/m-K
	357 W/m-K @Temperature 727 °C
	398 W/m-K @Temperature 27.0 °C
	401 W/m-K @Temperature 0.000 °C
	483 W/m-K @Temperature -173 °C
	10500 W/m-K @Temperature -253 °C
	19600 W/m-K @Temperature -263 °C
Melting Point	1083.2 - 1083.6 °C
Boiling Point	2562 °C

Table 8.4 Titanium alloy Thermal Properties

Thermal Properties	Metric
CTE, linear	8.70 µm/m-°C @Temperature 20.0 - 100 °C
	9.20 µm/m-°C @Temperature 20.0 - 250 °C
	10.0 µm/m-°C @Temperature 20.0 - 500 °C
Specific Heat Capacity	0.525 J/g-°C
Thermal Conductivity	7.00 W/m-K
Melting Point	1550 - 1600 °C
Solidus	1550 °C
Liquidus	1600 °C

CHAPTER 9

CONDENSER

Open work bench 14.5>select **steady state thermal** in analysissystems>selectgeometry>right click on the geometry>import geometry>select **IGES** file>open

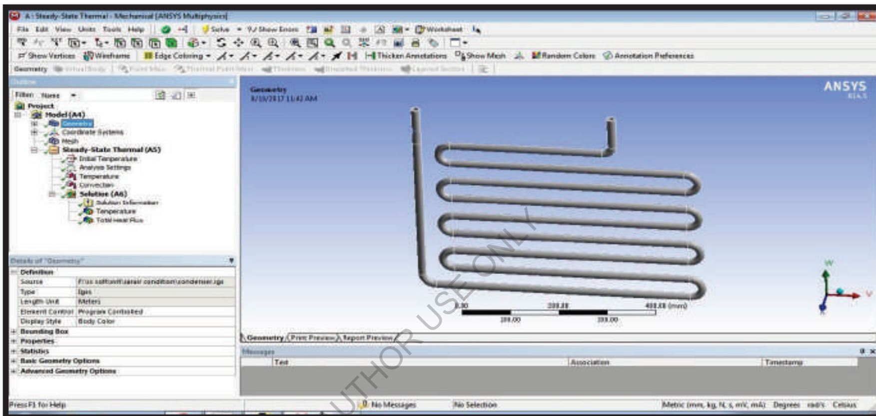

Figure 9.1 Geometry Model

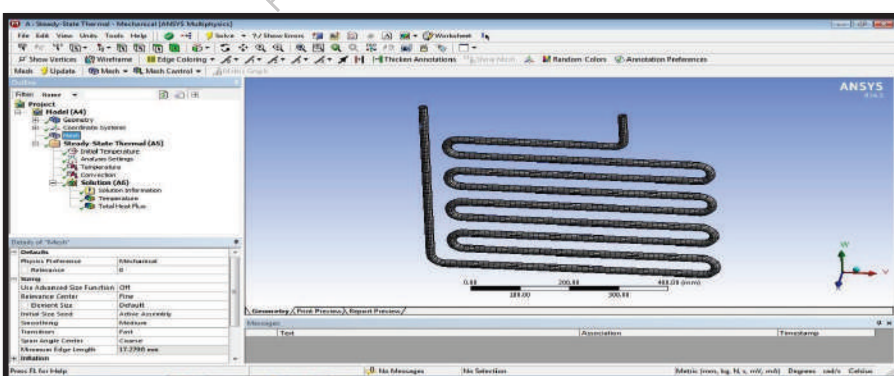

Figure 9.2 Meshed Model

Finite element analysis or FEA representing a real project as a “mesh” a series of small, regularly shaped tetrahedron connected elements, as shown in the above fig.And then setting up and solving huge arrays of simultaneous equations. The finer the mesh, the more accurate the results but more computing power is required.

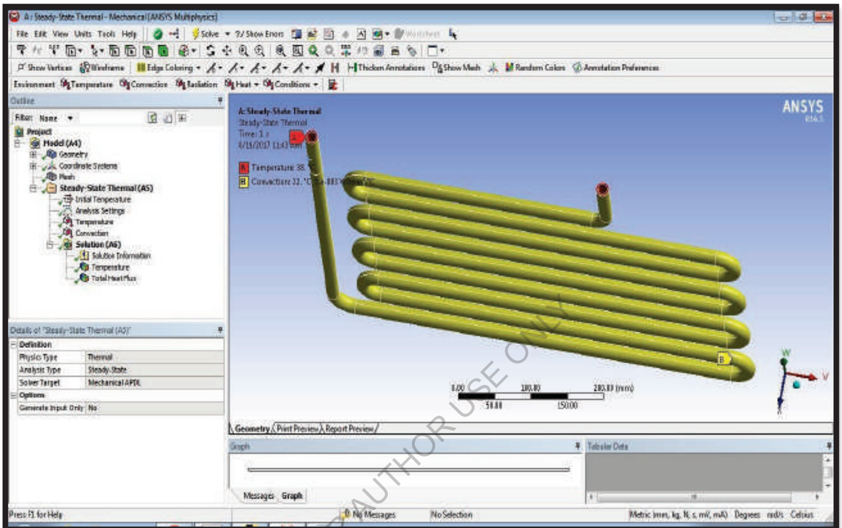

Figure 9.3 Boundary Conditions

Select steady state thermal >right click>insert>select convection> enter film coefficient value Select steady state thermal >right click>insert>select heat flux

Select steady state thermal >right click>solve

Solution>right click on solution>insert>select temperature

9.1 FLUID- WATER

9.1.1 MATERIAL- STEEL

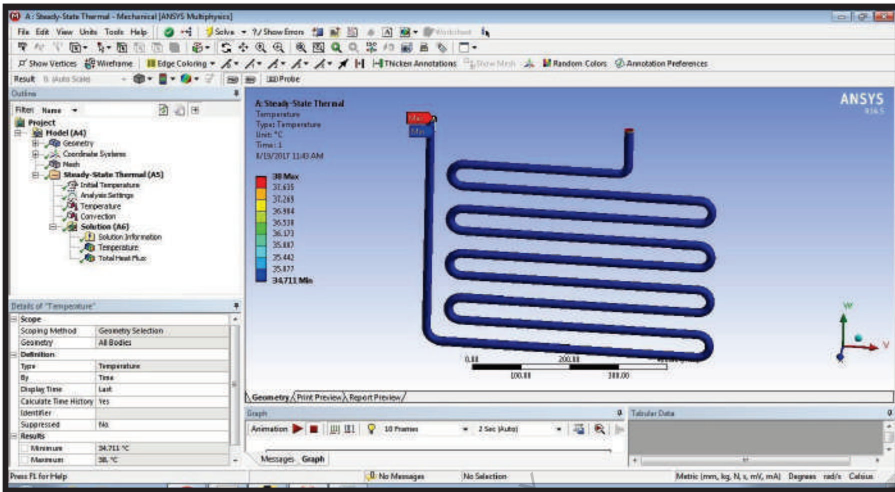

Figure 9.1.1.1 Temperature distribution

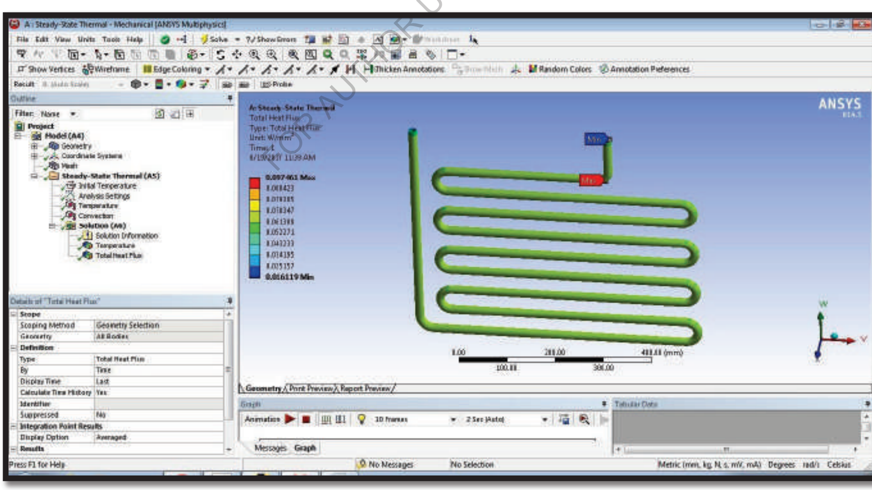

Figure 9.1.1.2 Heat Flux

9.1.2 MATERIAL- ALUMINUM

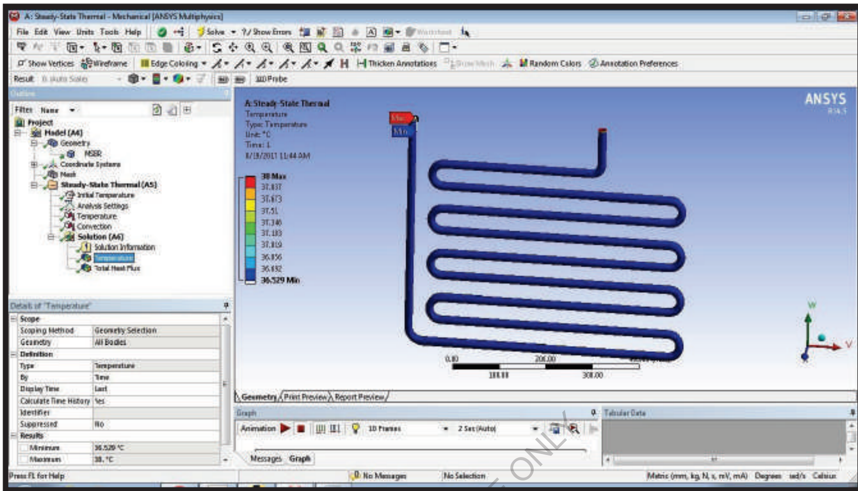

Figure 9.1.2.1 Temperature Distribution

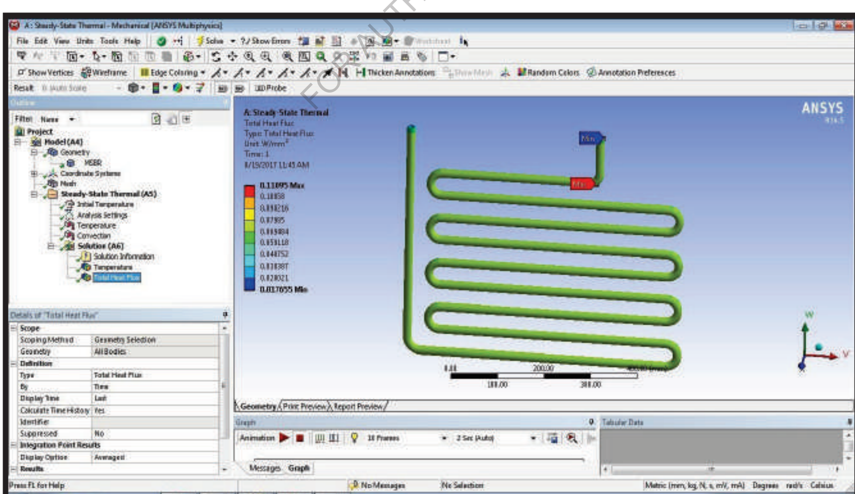

Figure 9.1.2.2 Heat Flux

9.1.3 MATERIAL- COPPER

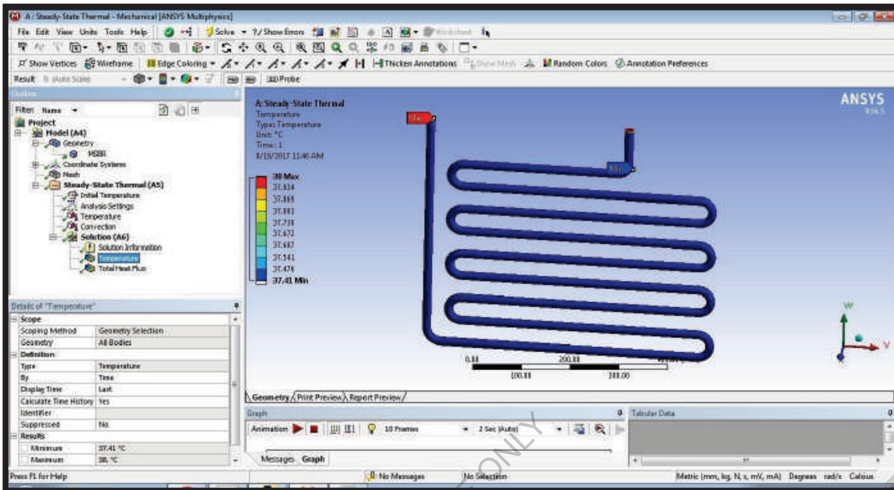

Figure 9.1.3.1 Temperature Distribution

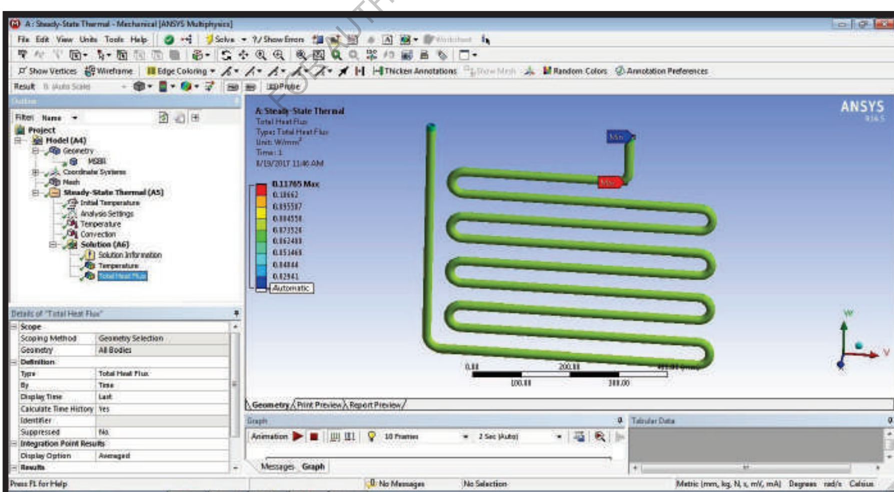

Figure 9.1.3.2 Heat Flux

9.1.4 MATERIAL- TITANIUM ALLOY

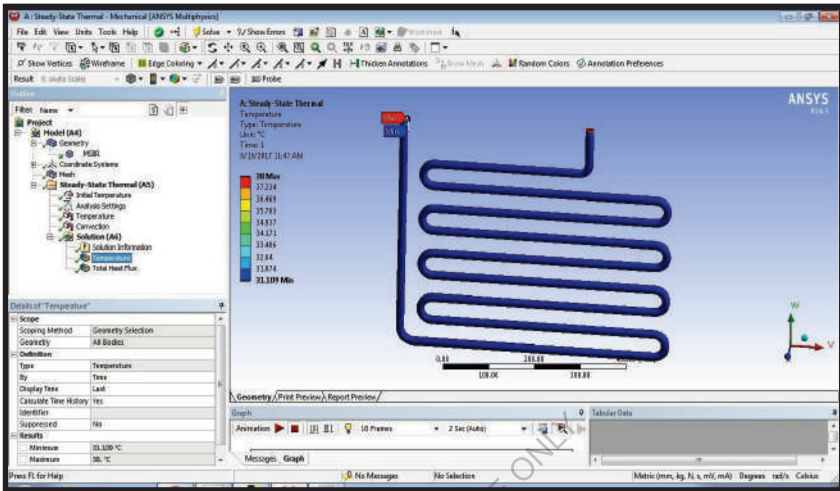

Figure 9.1.4.1 Temperature Distribution

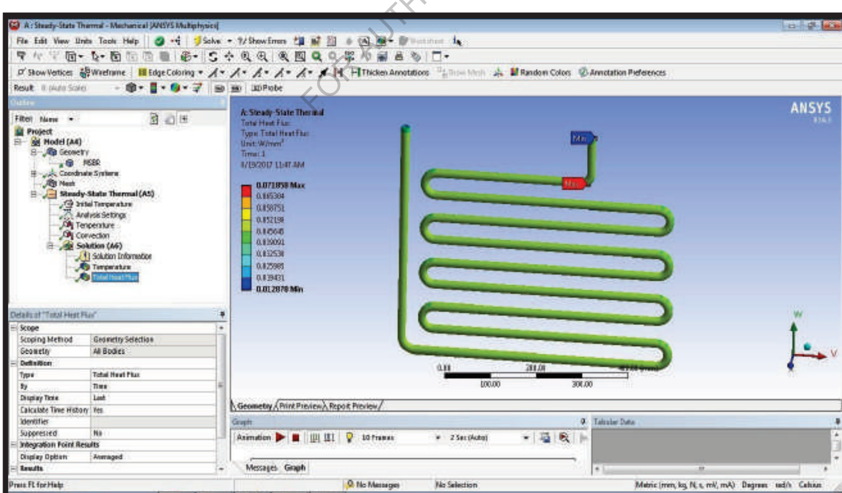

Figure 9.1.4.2 Heat Flux

9.2 FLUID- R134A

9.2.1 MATERIAL- STEEL

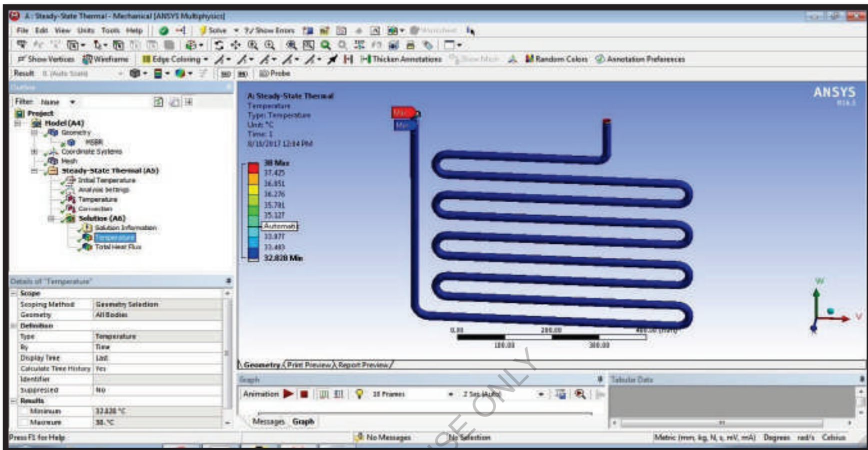

Figure 9.2.1.1 Temperature Distribution

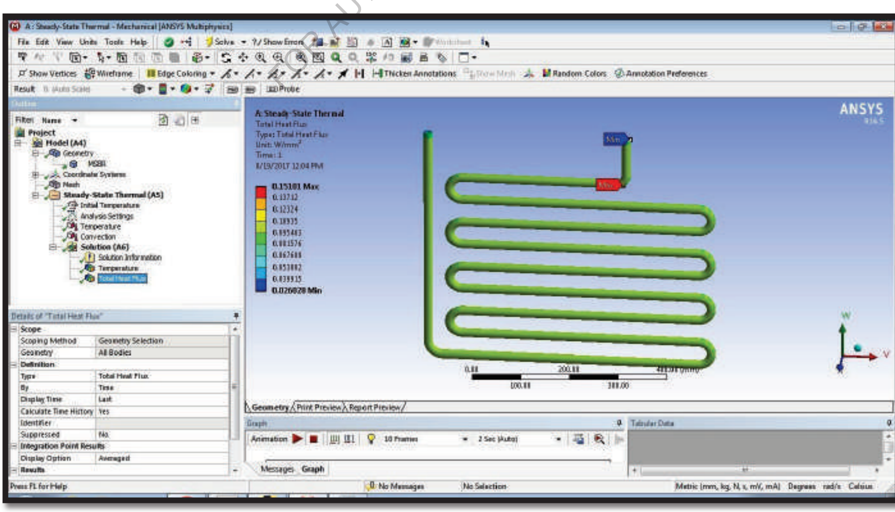

Figure 9.2.1.2 Heat Flux

9.2.2 MATERIAL- ALUMINUM

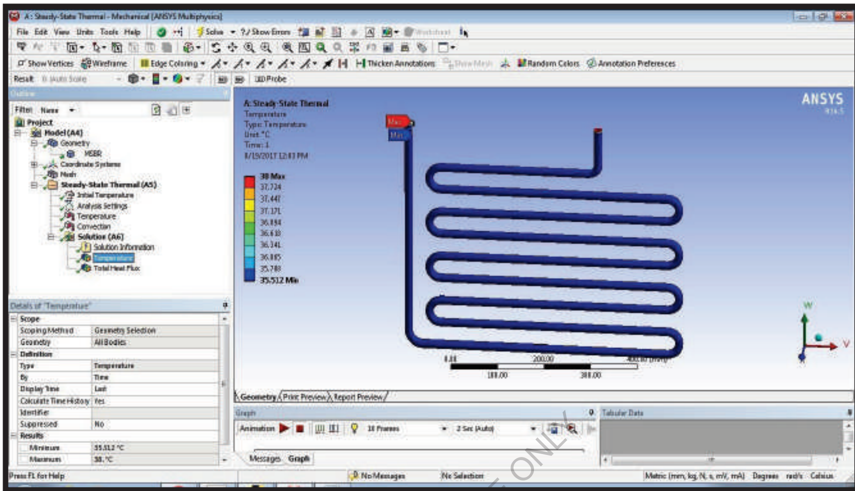

Figure 9.2.2.1 Temperature Distribution

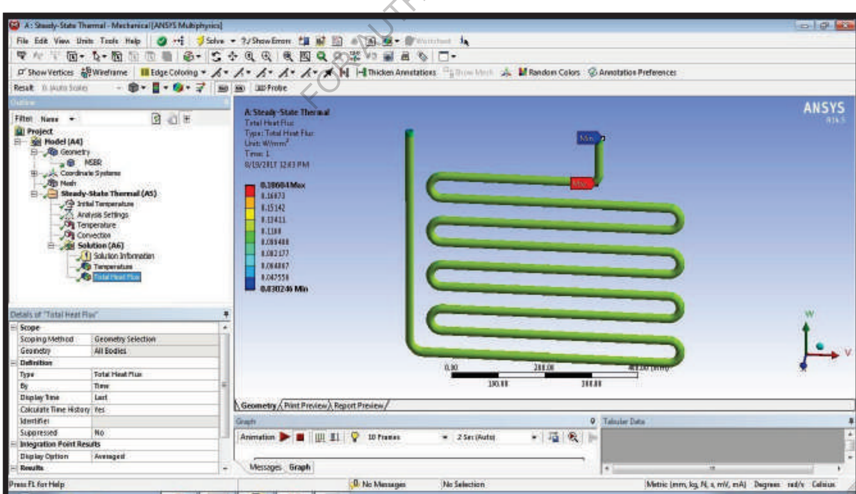

Figure 9.2.2.2 Heat Flux

9.2.3 MATERIAL- COPPER

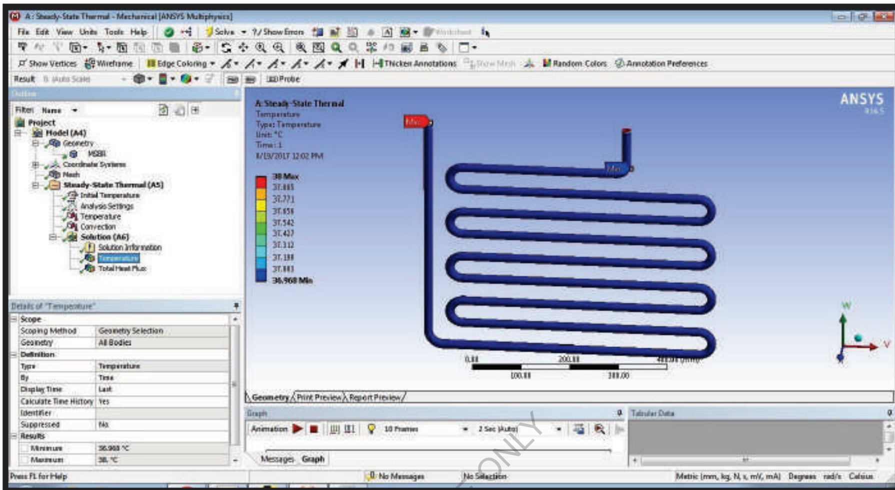

Figure 9.2.3.1 Temperature Distribution

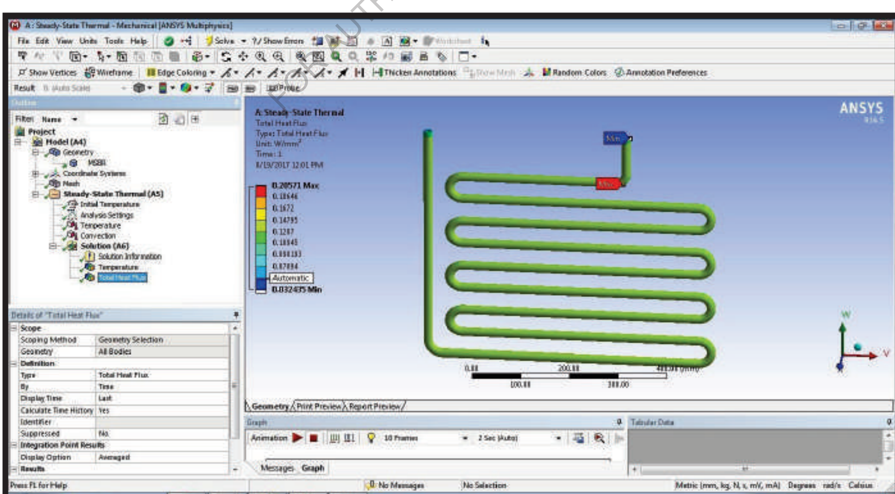

Figure 9.2.3.2 Heat Flux

9.2.4 MATERIAL- TITANIUM ALLOY

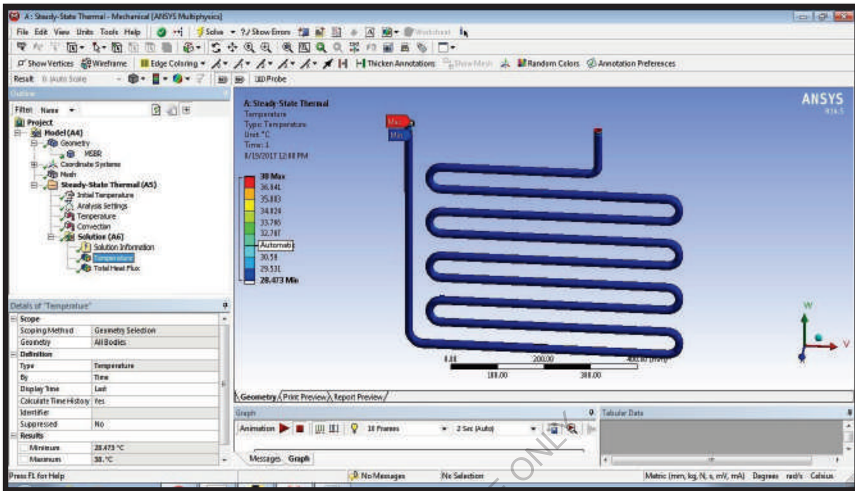

Figure 9.2.4.1 Temperature Distribution

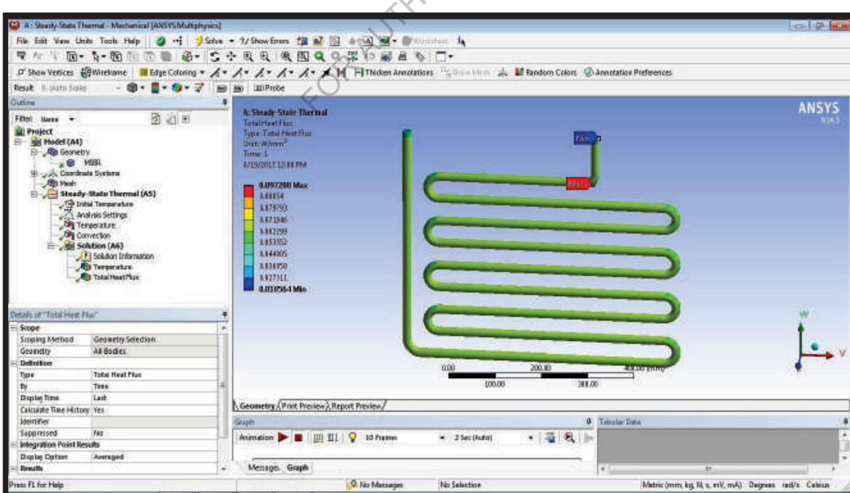

figure 9.2.4.2 Heat Flux

CHAPTER 10

EVAPORATOR

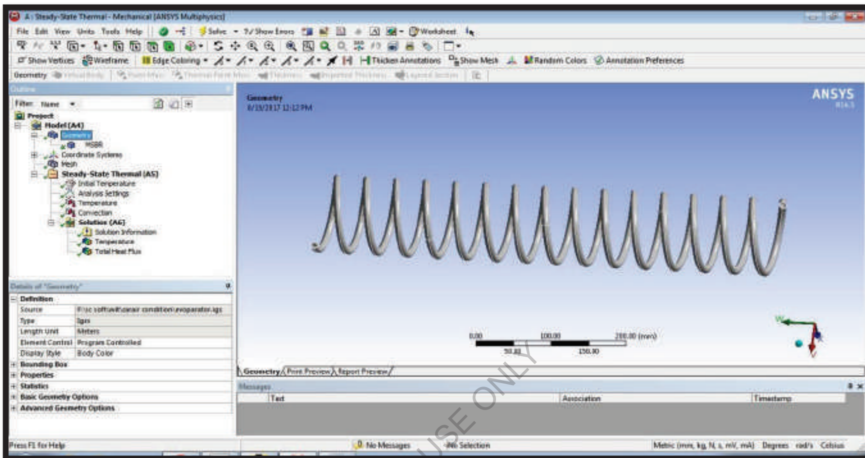

Figure 10.1 Geometry Model

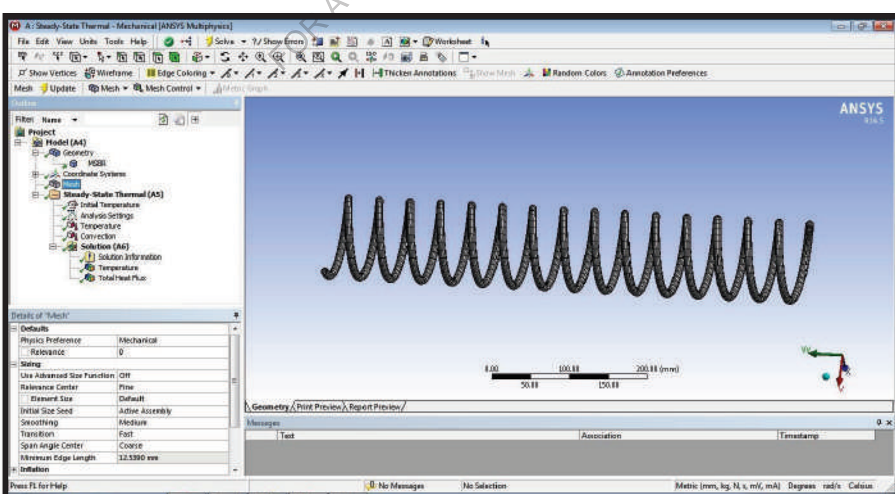

Figure 10.2 Meshed Model

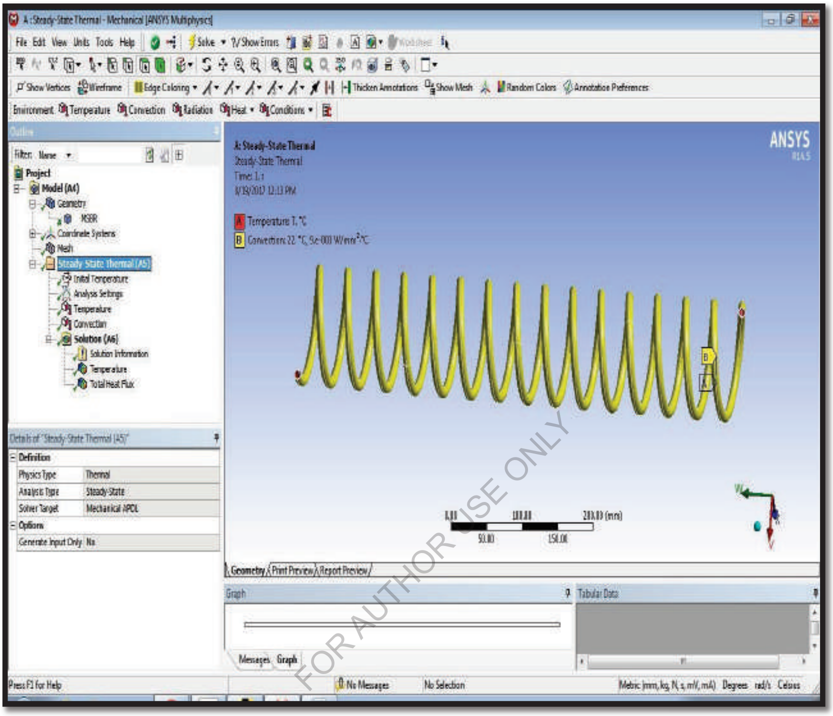

Figure 10.3 Boundary Conditions

10.1 FLUID- R134A

10.1.1 MATERIAL- STEEL

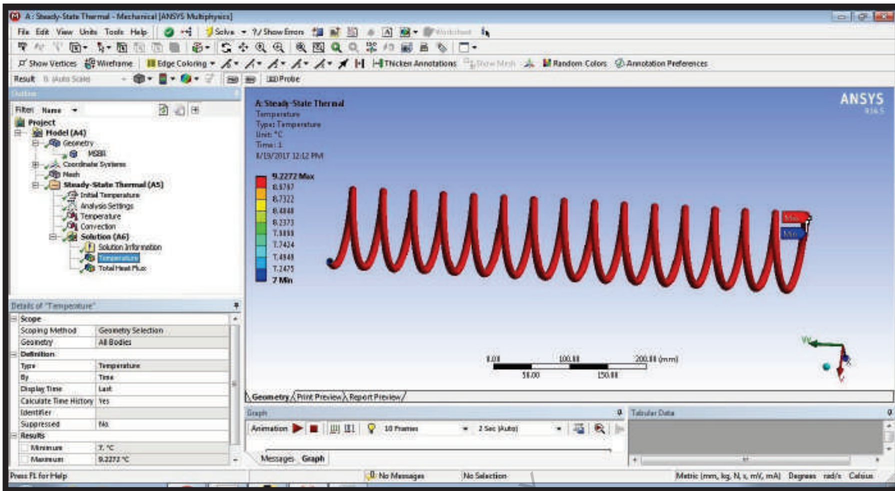

Figure 10.1.1.1 Temperature Distribution

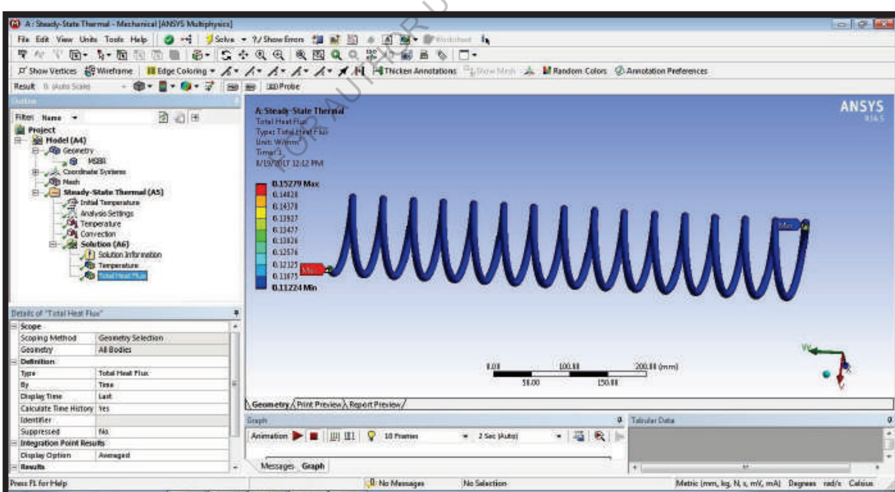

Figure 10.1.1.2 Heat Flux

10.1.2 MATERIAL- ALUMINUM

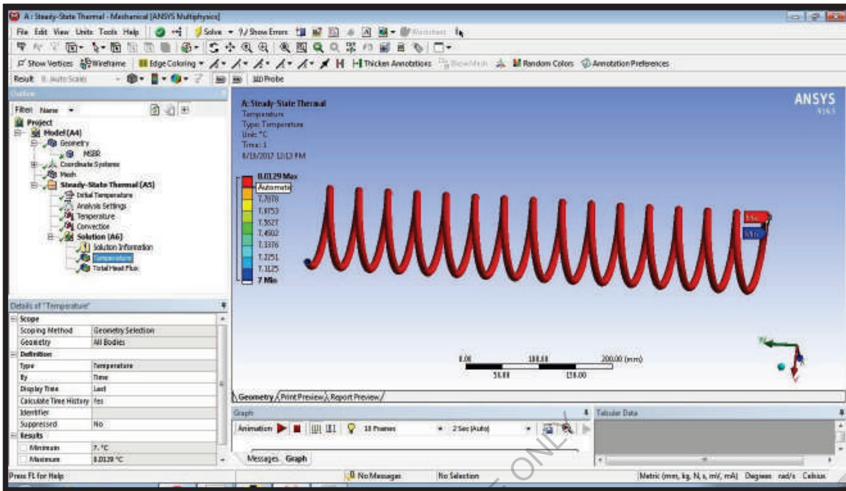

Figure 10.1.2.1 Temperature Distribution

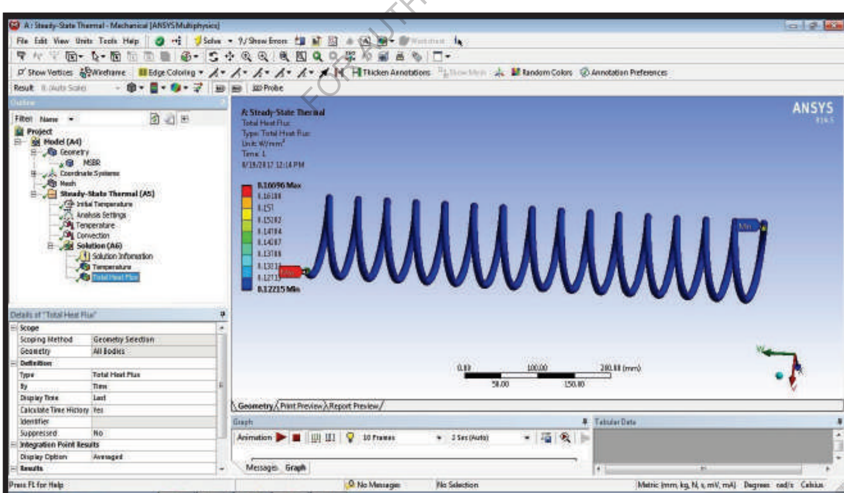

Figure 10.1.2.2 Heat Flux

10.1.3 MATERIAL- COPPER

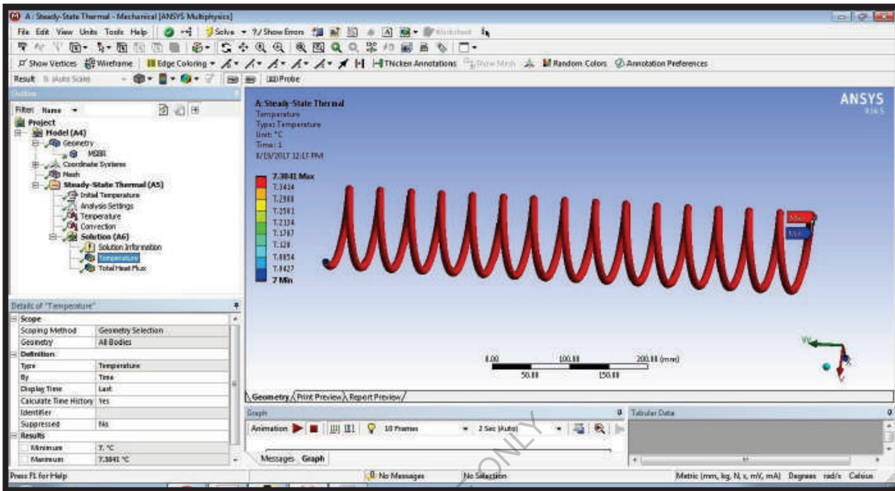

Figure 10.1.3.1 Temperature Distribution

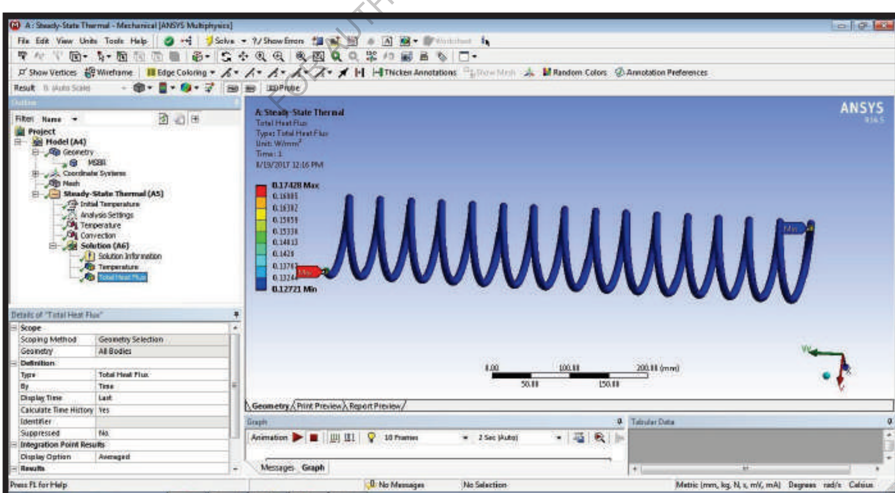

Figure 10.1.3.2 Heat Flux

10.1.4 MATERIAL- TITANIUM ALLOY

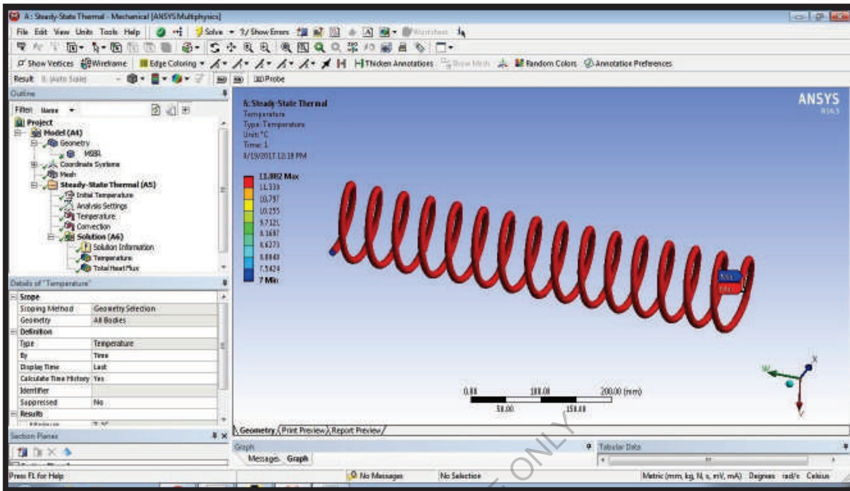

Figure 10.1.4.1 Temperature Distribution

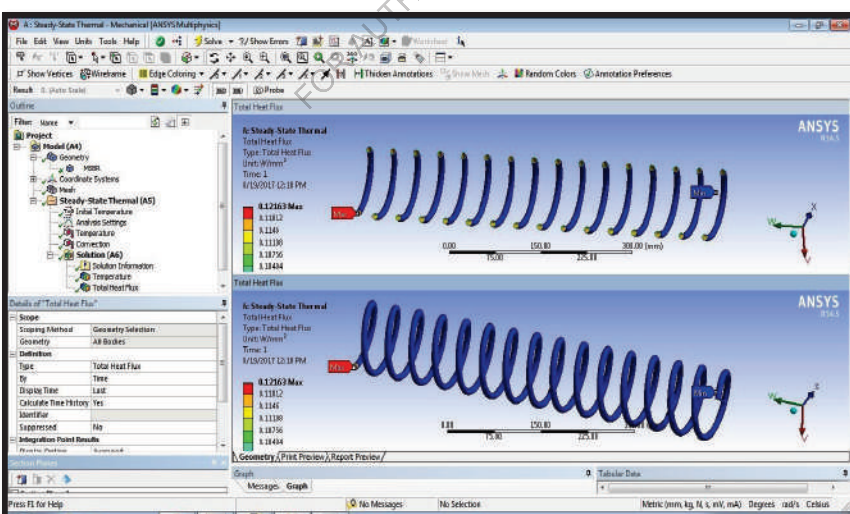

Figure 10.1.4.2 Heat Flux

10.2 FLUID- WATER

10.2.1 MATERIAL- STEEL

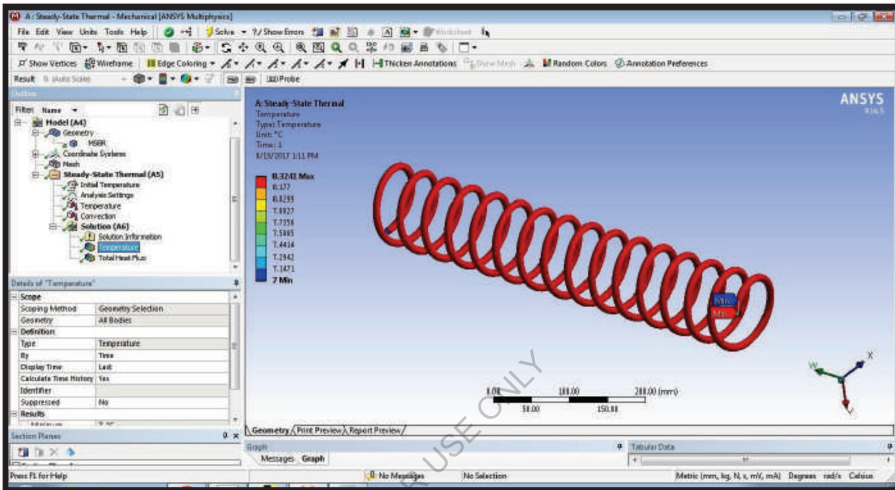

Figure 10.2.1.1 Temperature Distribution

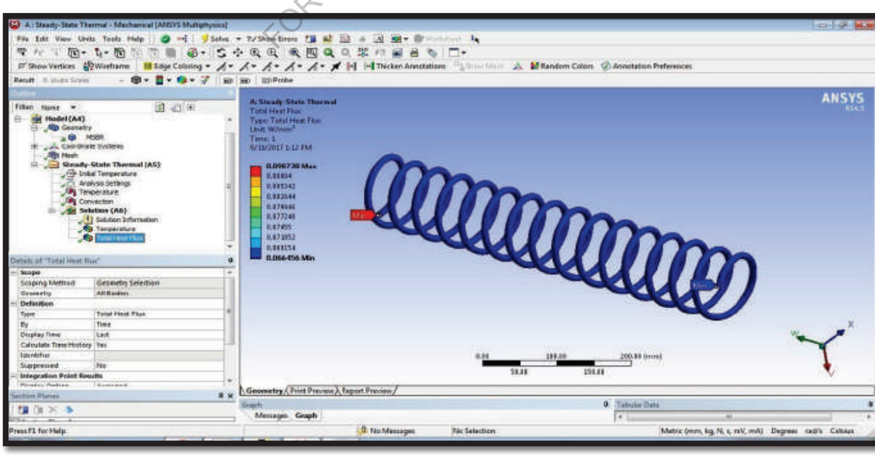

Figure 10.2.1.2 Heat Flux

10.2.2 MATERIAL- ALUMINUM

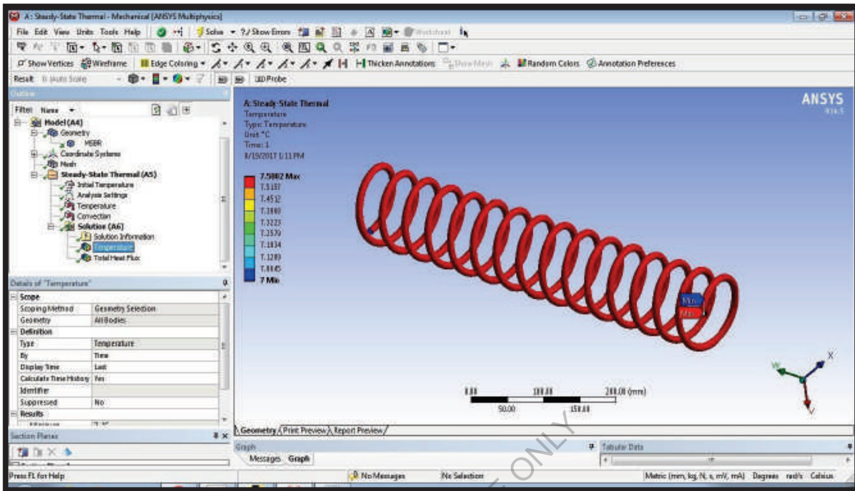

Figure 10.2.2.1 Temperature Distribution

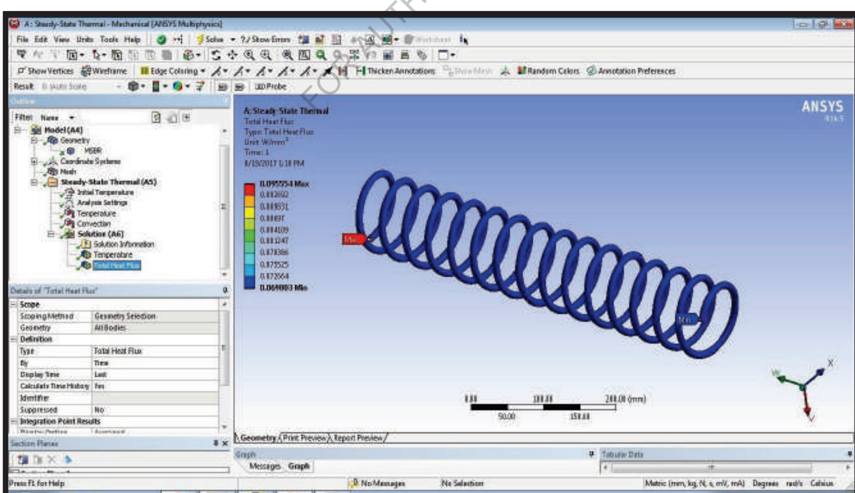

Figure 10.2.2.2 Heat Flux

10.2.3 MATERIAL- COPPER

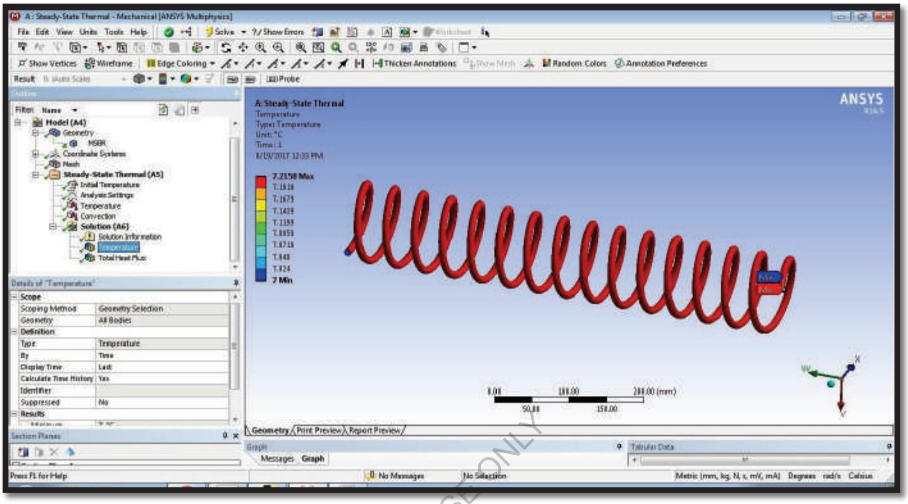

Figure 10.2.3.1 Temperature Distribution

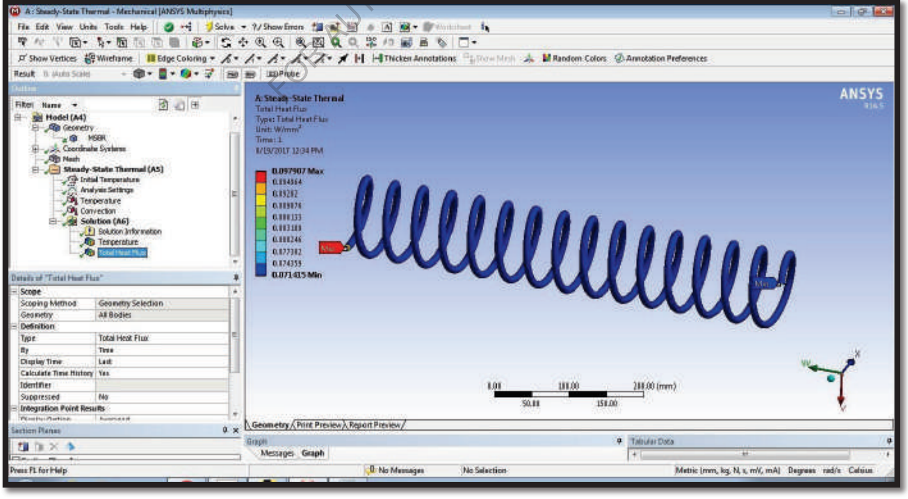

Figure 10.2.3.2 Heat Flux

10.2.4 MATERIAL- TITANIUM ALLOY

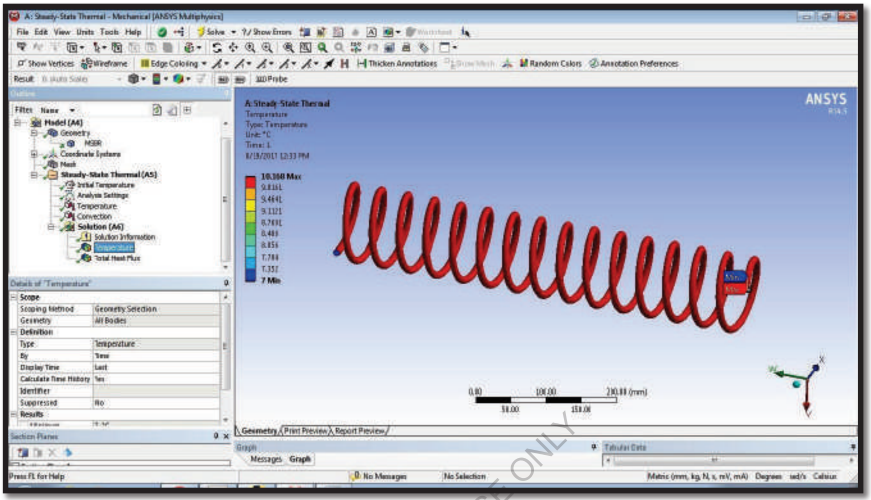

Figure 10.2.4.1 Temperature Distribution

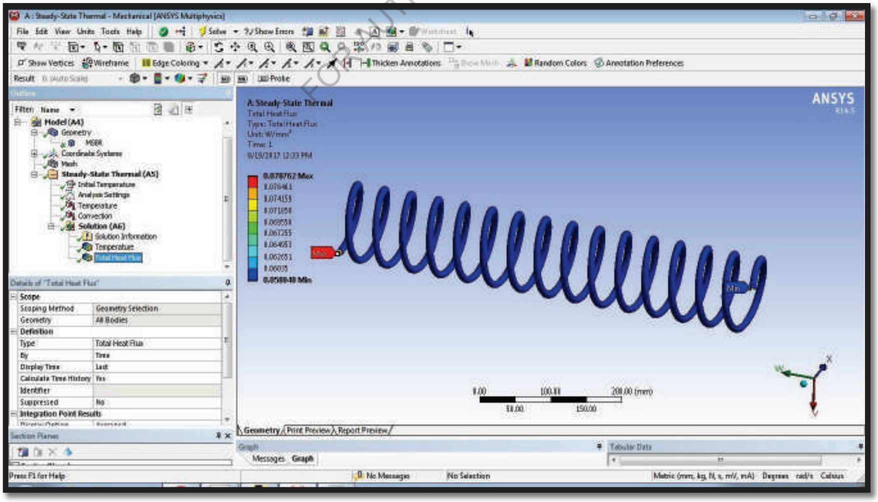

Figure 10.2.4.2 Heat Flux

CHAPTER 11

CFD ANALYSIS OF CONDENSER

11.1 FLUID- WATER

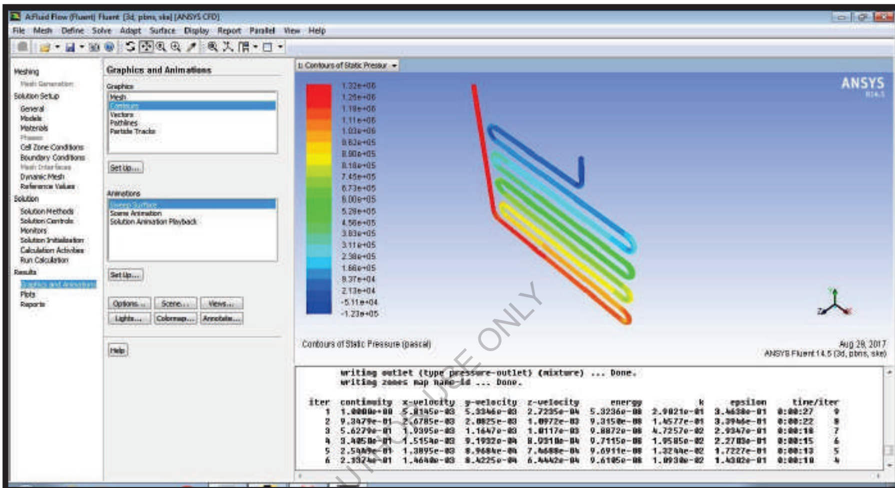

Figure 11.1.1 Pressure Drop

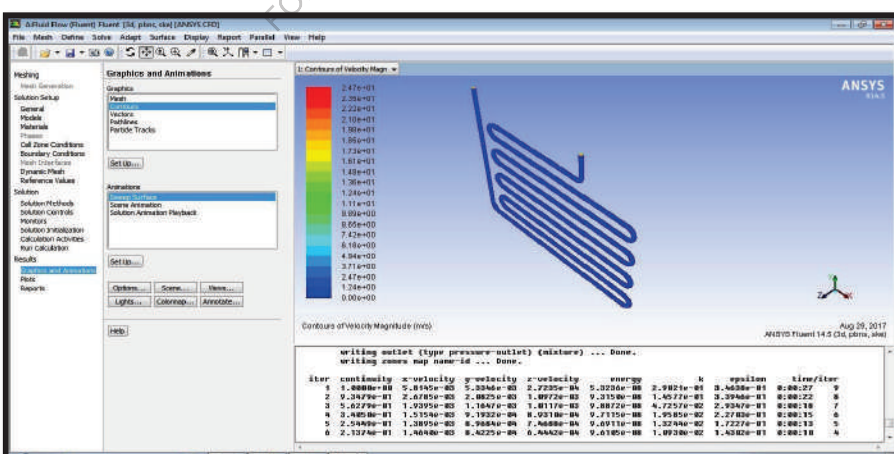

Figure 11.1.2 Velocity

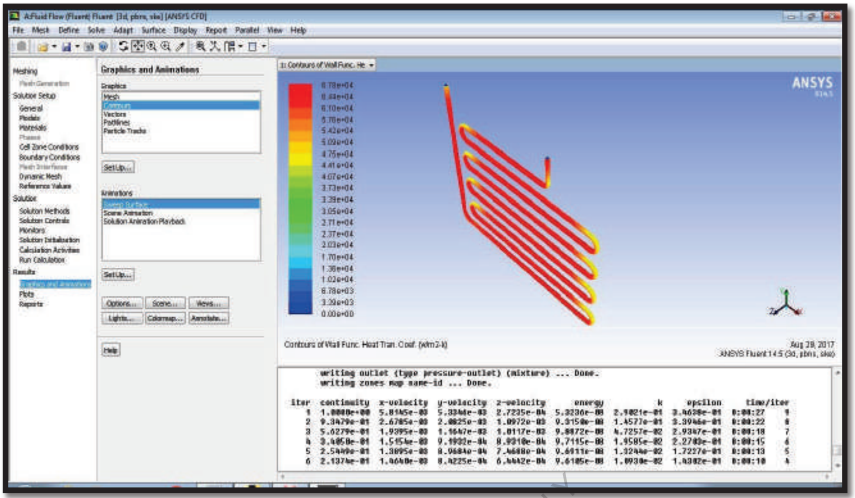

Figure 11.1.3 Heat Transfer Coefficient

Table 11.1.1 Mass Flow Rate & Heat Transfer Rate

Mass Flow Rate	(kg/s)
inlet	2.6064684
interior-____msbr	-6807.0132
outlet	-2.6390946
wall-____msbr	0
Net	-0.032626152
Total Heat Transfer Rate	**(w)**
inlet	815883.56
outlet	-826097.63
wall-____msbr	0
Net	-10214.063

11.2 FLUID- R134A

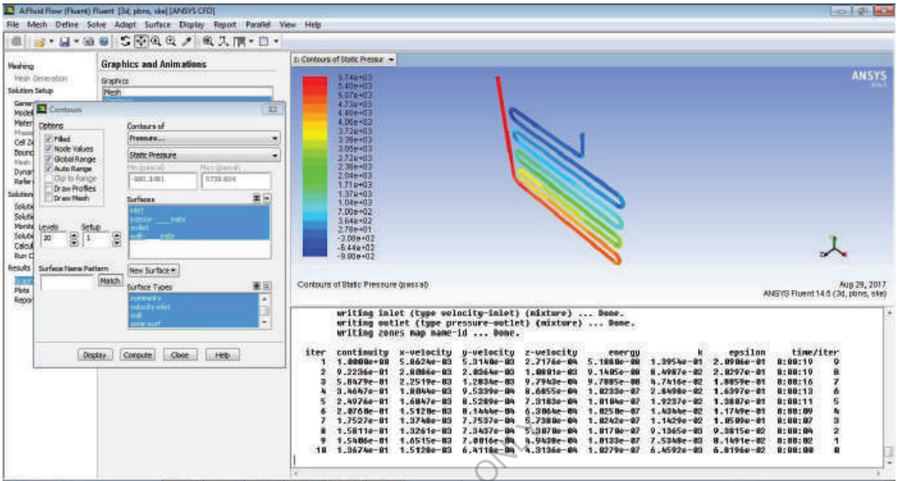

Figure 11.2.1 Pressure Drop

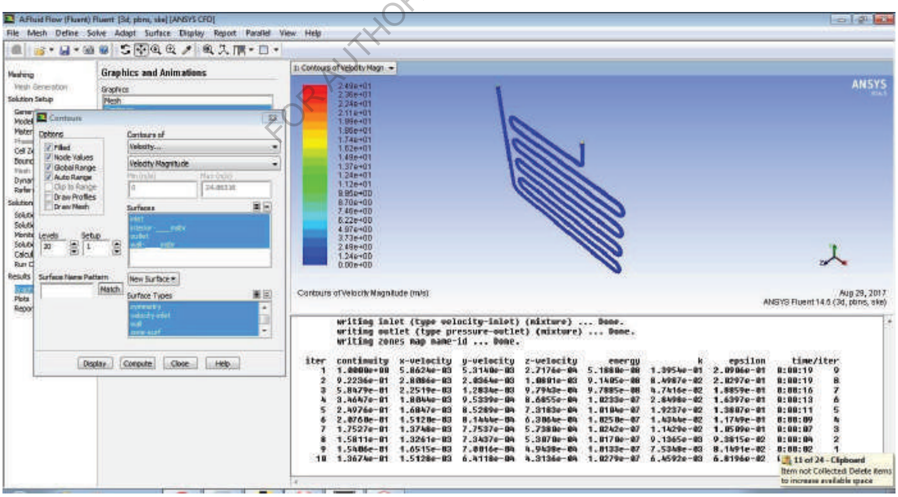

Figure 11.2.2 Velocity

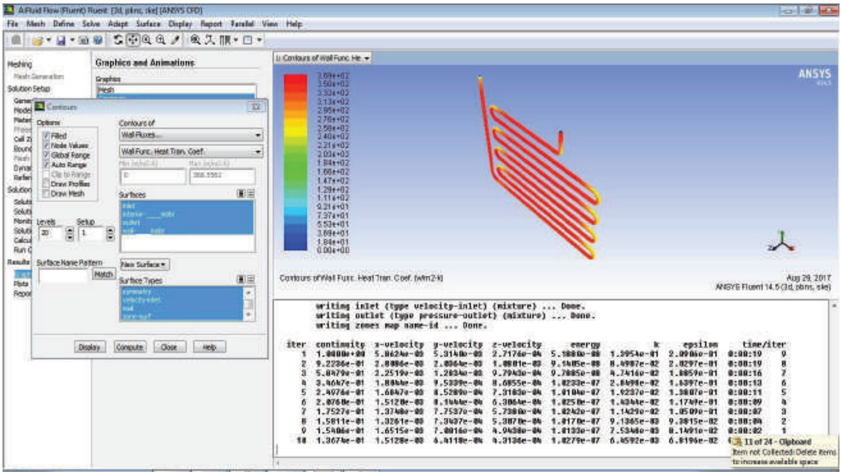

Figure 11.2.3 Heat Transfer Coefficient

Table 11.2.1 Mass Flow Rate& Heat Transfer Rate

Mass Flow Rate	(kg/s)
inlet	0.011097466
interior-____msbr	-28.889351
outlet	-0.011226054
wall-____msbr	0
Net	-0.00012858864

Total Heat Transfer Rate	(w)
inlet	837.29041
outlet	-846.9939
wall-____msbr	0
Net	-9.7034912

CHAPTER 12

CFD ANALYSIS OF EVAPORATOR

12.1 FLUID- WATER

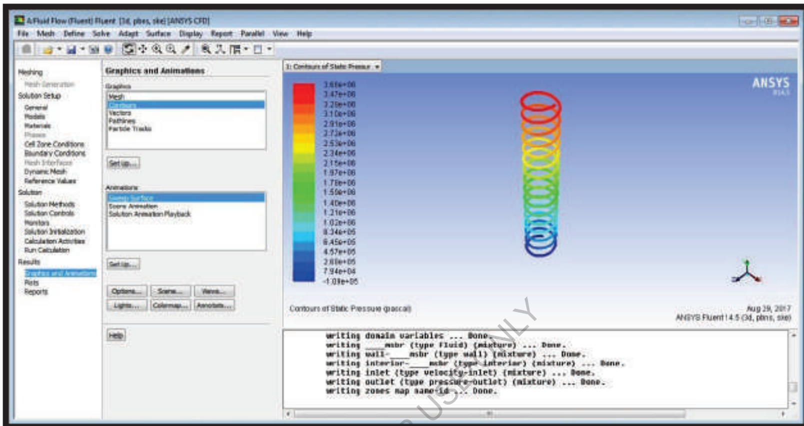

Figure 12.1.1 Pressure drop

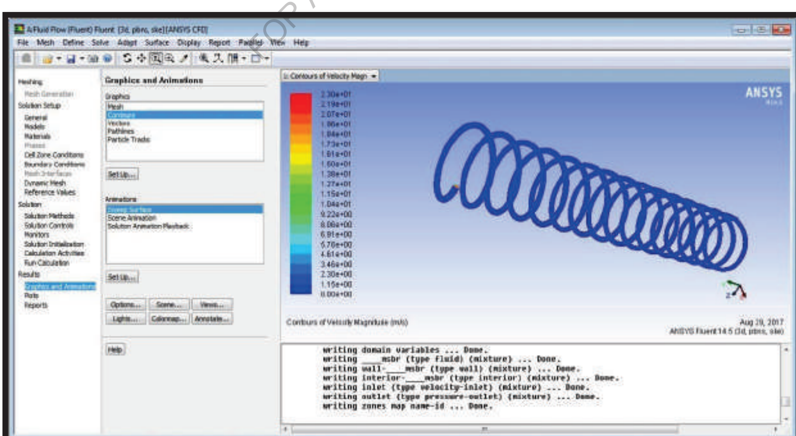

Figure 12.1.2 Velocity

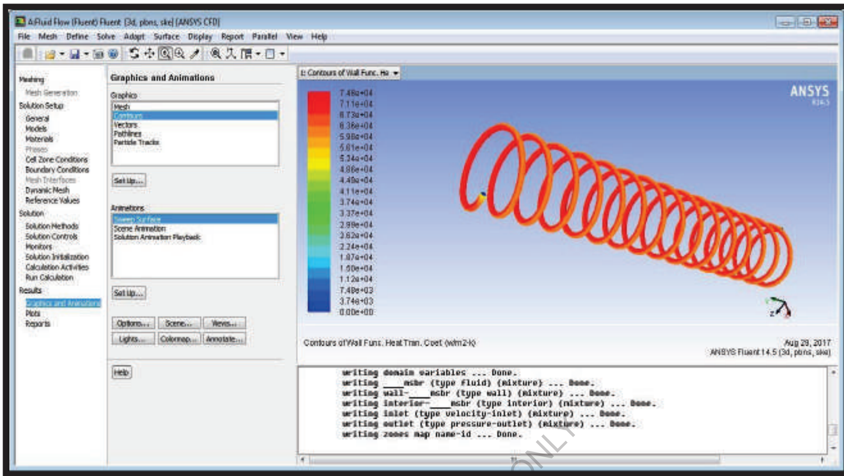

Figure 12.1.3 Heat Transfer Coefficient

Table 12.1.1 Mass Flow Rate & Heat Transfer Rate

Mass Flow Rate	(kg/s)
inlet	0.98557758
interior-____msbr	-4346.1807
outlet	-0.9655804
wall-____msbr	0
Net	0.01999718
Total Heat Transfer Rate	**(w)**
inlet	308508.19
outlet	-302245.72
wall-____msbr	0
Net	6262.4688

12.2 FLUID- R134A

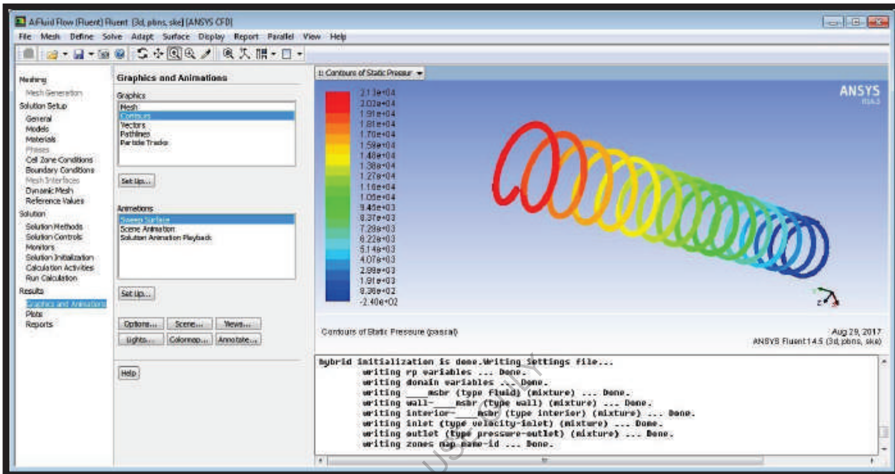

Figure 12.2.1 Pressure Drop

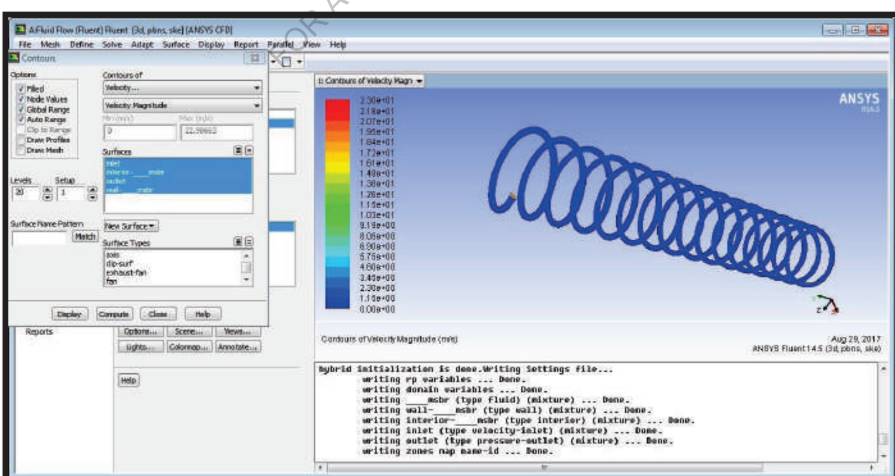

Figure 12.2.2 Velocity

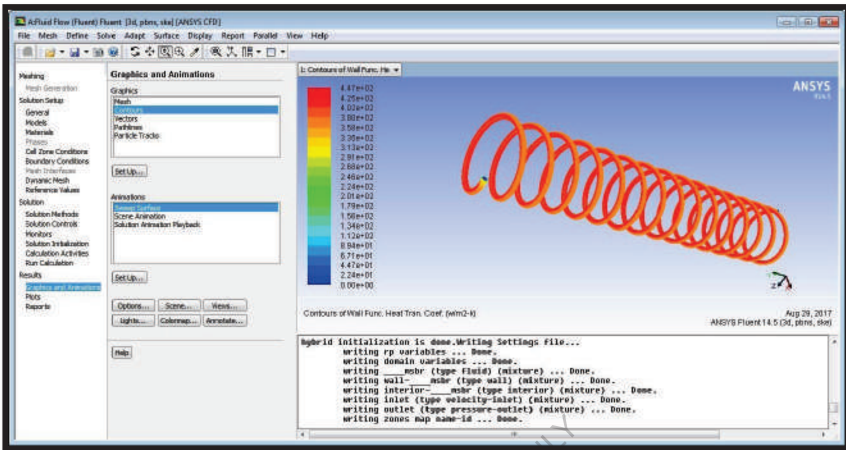

Figure 12.2.3 Heat Transfer Coefficient

Table 12.2.1 Mass Flow Rate & Heat Transfer Rate

Mass Flow Rate	(kg/s)
inlet	0.0041962578
interior-____msbr	-18.614588
outlet	-0.0040464965
wall-____msbr	0
Net	0.00014976133
Total Heat Transfer Rate	**(w)**
inlet	316.6026
outlet	-305.30411
wall-____msbr	0
Net	11.298492

CHAPTER 13

RESULTS

Table 13.1 Result Table condenser

Fluids	Materials	Temperature (^0C)		Heat flux (w/mm^2)
		Max.	Min.	
Water	steel	38	34.714	0.097461
	Aluminum alloy	38	36.529	0.11095
	copper	38	37.41	0.11765
	Titanium alloy	38	31.109	0.071858
R134A	steel	38	32.828	0.15101
	Aluminum alloy	38	35.312	0.186044
	copper	38	36.969	0.20571
	Titanium alloy	38	28.473	0.097288

Table 13.2 Result Table Evaporator

Fluids	Materials	Temperature (^0C)		Heat flux (w/mm^2)
		Max.	Min.	
Water	steel	8.3241	7	0.090738
	Aluminum alloy	7.5802	7	0.095554
	copper	7.2158	7	0.097907
	Titanium alloy	10.168	7	0.078762
R134A	steel	9.2272	7	0.15279
	Aluminum alloy	8.0129	7	0.16696
	copper	7.3841	7	0.17428
	Titanium alloy	11.882	7	0.12163

Table 13.3 CFD Analysis Results

Models	Fluids	Pressure drop(Pa)	Velocity (m/s)	Heat transfer coefficient (w/m2-k)	Mass flow rate(kg/s)	Heat transfer rate (W)
Condenser	**Water**	**1.32e+06**	**2.47e+01**	**6.78e+04**	**0.032626152**	**10214.063**
	R134A	**5.74e+03**	**2.49e+01**	**3.69e+02**	**0.00012858864**	**9.7034912**
Evaporator	**Water**	**3.68e+06**	**2.30e+01**	**7.48e+04**	**0.01999718**	**6262.4688**
	R134A	**2.13e+04**	**2.20e+01**	**4.47e+02**	**0.00014976**	**11.298492**

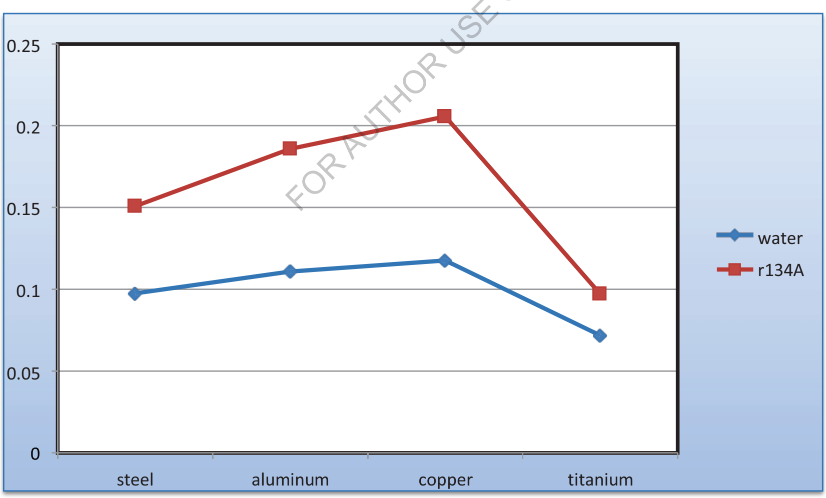

Fig 13.1 Condenser graph

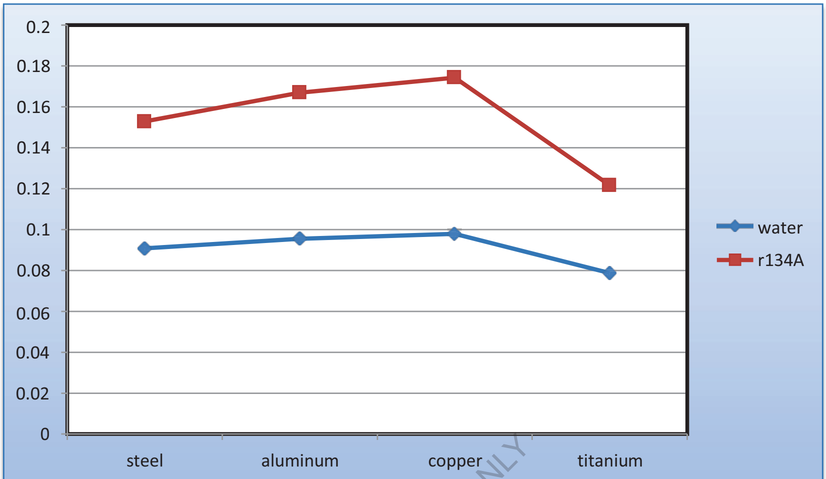

Fig 13.2 Evaporator graph

CHAPTER 14

CONCLUSION

Thermal analysis was done in two main components i.e condenser & evaporator though the results obtained. This result will have to be improved for further development. It can be concluded that:

I. for the working of vapor absorption refrigeration system generally achieved by burning the fuel in a separate combustion chamber and then supplying the Generator of a Vapor Absorption Refrigeration System with the products of its combustion to produce the required refrigerating effect. However this prospect is eliminated since it requires a separate fuel and a separate combustion chamber which makes it uneconomical and the system becomes inefficient.

ii. The above draws back will elimina ted by utilizing the heat of combustion which is wasted into the atmosphere. By designing a generator capable of extracting the waste heat of an IC engine without any decrease in engine efficiency, a Vapor Absorption Refrigeration System can be brought to work. Since this arrangement does not require any extra work expect a small amount of work required for the pump, which can be derived from the battery,this system can be used in automobiles where engine efficiency is the primary consideration.

iii. In this project CREO parametric software is used for the design of components & used ANSYS for the analysis

iv. By observing the analysis results, total heat flux is more for copper than remaining three materials for both condenser and evaporator. So using copper is better.

The theoretical analysis is verified by experiments. This work results from a prototype which will have to be improved for further development. The claim that is made from this work is that it has shown the feasibility of such a system in a positive frame. It can be concluded that

Vapour compression refrigeration requires a significant supply of work from an electric motor or other source of mechanical power. Absorption refrigeration is an alternate approach to cooling that is largely thermally driven and requires little external work.

This form of refrigeration is growing in importance as energy conservation considerations demand closer scrutiny of the disposition of heat rejection from thermal processes. Absorption refrigeration provides a constructive means of utilizing waste heat or heat from inexpensive

Sources at a temperature of a few hundred degrees, as well as directly from fossil fuels. It is possible to produce cooling effect by recovery of exhaust heat through vehicle.

In the exhaust gases of motor vehicles, there is enough heat energy that can be utilised to power an air-conditioning system. Therefore, if airconditioning is achieved without using the engine's mechanical output, there will be a net reduction in fuel consumption and emissions.

Once a secondary fluid such as water is used, the aqua-ammonia combination appears to be a good candidate as a working fluid for an absorption car air-conditioning system. This minimises any potential hazard to the passengers. The low COP value is an indication that improvements to the cycle are necessary

CHAPTER 15

FUTURE SCOPE

The use of VAR in road transport vehicles has the advantage of reducing the dedicated IC engine, refrigerant compressor, unit weight, capital cost, fuel costs, maintenance, atmospheric pollution and noise pollution.

Experimental results proved that it is possible to drive a vapour absorption refrigeration system using the exhaust gases from a diesel engine. This suggests that such a system could be used in road transport vehicles. However, further consideration is required with respect to the following:

The design of a heat exchanger to extract waste heat without excessive pressure drops in the exhaust systems, the effect of increased back pressure on the engine performance, the corrosion effect of the exhaust gases on the heat exchanger material, the fluctuations in the cooling capacity due to variations in vehicle speed, and alternative energy input while vehicle is stationary, the effect of varying ambient conditions on the system performance, and accommodating the system on the vehicle.

This area of study is worth pursuing in terms of energy and cost savings, and suggests that a prototype design study be undertaken.

One more difficulty on which further study and research required is that when a vehicle be at rest or in very slow moving traffic conditions.

In either of these conditions the resulting reduction in heat input to the generator would cause a corresponding drop in the cooling effect of the system.

REFERENCES

1. Anantha narayanan P N (2005) 'Refrigeration & Air Conditioning', Tata McGraw-Hill..3rdedition, pp.398 - 424.

2. Arora;Domkundwar. (2004) 'A course in Refrigeration & Air Conditioning', Dhanpat Rai & Co., 7thedition, pp.6.1- 6.23.

Three. Lorentzen G. And Pettersen J. (1993) A New, Efficientand Environmentally Benign System for Car air-conditioning, International Journal Refrigeration, 161.

Four. Arora C P (2002) 'Refrigeration & Air Conditioning', Tata McGraw Hill., 2d edition, pp.301-314, 339 - 356,427 - 456.

Five. Ballaney PL (2003),* Refrigeration & Air Conditioning' Khanna Publishers., 13th edition, pp. 483 - 542. Page forty nine

6. Domkundwar & Domkundwrar. (2005) 'Heat & Mass Transfer- Data Book', Dhanpat Rai & Co., 2nd edition,

7. Horuz I (August 1999), 'Vapor Absorption Refrigeration in Road Transport Vehicles', Journal of Energy Engrg., Volume one hundred twenty five, Issue 2, pp. Forty eight-fifty eight.

Eight. Manohar Prasad. (2000) 'Refrigeration & Air Conditioning', New Age International Publishers., 3rd version, pp. 188 - 225.

Nine. Manohar Prasad. (2000) 'Refrigeration & Air Conditioning - Data Book'. New Age International Publishers., 2d edition. 10. Vicatos G. (1995) Heat and mass switch traits: Design and optimisation of absorption refrigeration machines, PhD thesis, University of Cape Town South Africa.