International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 12 Issue 6, June-2023, Impact Factor: 7.957

Fabrication of Air Conditioning CUM Water Dispenser (4-1 System)

V. Siva Nagi Reddy[1], Rajana Siva[2], Boddeda Sai Ganesh[3], Neelapu Lok Sathish[4], Chitrothu J.S. Prasad[5], Dasari Mohan[6]

[1]Asst Professor, Aditya College of Engineering & Technology, Surampalem, A.P, India, 533437
[2,3,4,5,6] B.Tech Student, Aditya College of Engineering & Technology, Surampalem, A.P, India, 533437

ABSTRACT

This project "Combined Air Refrigeration, Air Conditioner and Water Dispenser (4-1 System) " deals with the study of air conditioner, air refrigeration and water dispenser system in a single unit. The main object behind this project is to develop the multifunctional system which can provide cold water, refrigeration effect and air conditioning effect with regular air/space conditioning system. The design mainly consists of compressor, condenser, expansion valve and other accessories (back pressure valve and diffuser). The refrigerant is used as a medium which absorbs the heat from the low temperature system and discards the heat so absorbed to a higher temperature system. This transfer of heat is used in a sensible manner to bring out the various heating and cooling effect. Common condenser and common compressor feds the system having separate evaporators. Various design and operations were modified with a view to save space, initial and maintenance costs.

INTRODUCTION

Introduction of air conditioner

The air conditioning is that branch of engineering sciences which deals with the study of air conditioning of air i.e supplying and maintaining desirable internal atmospheric conditions. This subject in its broad sense also deals with the conditioning of air for industrial purposes, food processing storage of food and other material

Air conditioning is the process of removing heat from a confined space. It can be used in both domestic and commercial environments.

Types of air conditioning systems

There are several types of air conditioning systems that may be installed in your home or space

Window air conditioner

This type is the most commonly used systems for single rooms. In this air conditioner, A single box houses all the components, namely the condenser, evaporator, compressor, cooling coil and expansion valve. A window air conditioner unit is fitted in a window still or in the rooms wall that is specially made for it.

This type is also referred to as a unitary air conditioning system. It blows out cooled air on one end and ejects the heat on the other end

Split or ductless air conditioner

This system is called a split system because it is made up of two units: one indoor and one out door. The former houses the evaporator and cooling fan. The latter, mean while, houses the compressor, expansion valve, and condenser. Split air conditioning systems provide the added convenience of not having to make a specialized a lot in the room wall. In addition to, modern split air conditioners do not take as much space as window units. this type is also referred to as a packaged terminal air conditioner. These are usually used in hotels, and apartments.

Portable air conditioner

This is a variation of the unitary air conditioning system. This type has a mobile air conditioning system placed on the floor inside a room .it discharges exhaust heat through the exterior wall by means of a hose vent. While this type is noiser than other systems, it can cool even the most stubborn hot rooms

Central air conditioning

This type is best for large buildings, hotels, movie theatres, factories and other bigger spaces. Fitting individual units like windoe air conditioners in each room of a big building can get super expensive. Having a central air conditioning system is the more practical choice when it comes to applications like this. This type of system makes use of a large compressor. Two separate packaged units are also used. The condensing unit is paced in the plenum of your furnance. This unifies the ductwork of your air conditioning and heating systems.

Working principle of air conditioning

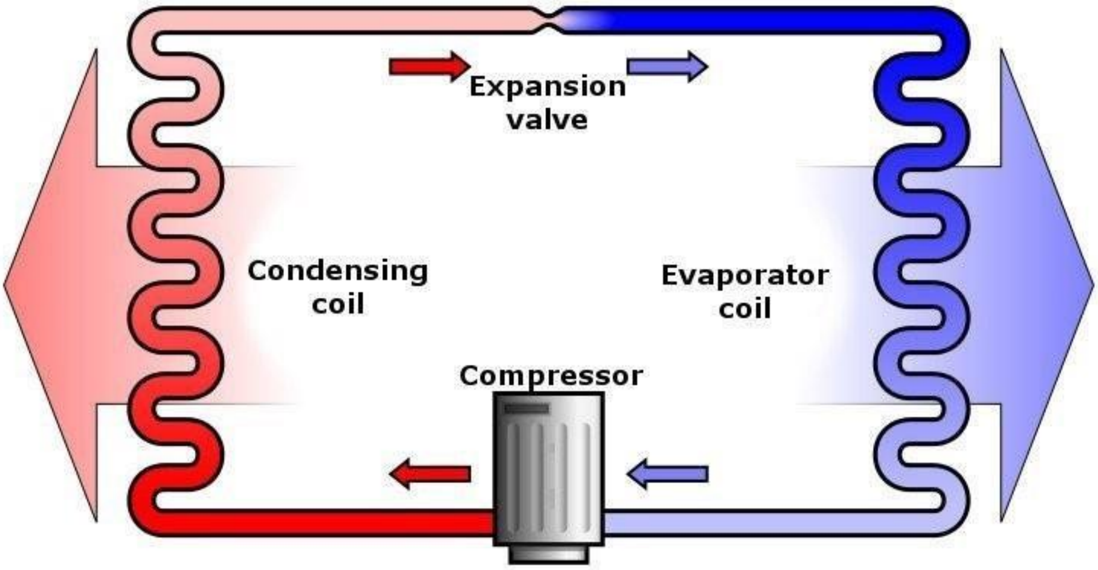


FIG 1: Working principle of air conditioning

Air conditioners work by removing the heat from the space they service. An air conditioner is simply a big refrigerator that uses the process of refrigerant to provide cooling for a building. Air conditioners work by using direct expansion coils or chilled water coils to remove the heat from the air as air is blown across the coils. Types of air conditioner systems that use direct expansion coils for cooling are window units, splitsystem air conditioners, package unit air conditioners, packaged terminal air conditioners like the ir conditioners used in hotels, and mini split ductless air conditioners. Air conditioners which utlise chilled water for air conditioning are typically commercial air conditioners for large commercial buildings. It does not matter what type of air conditioner is used the coils in the air conditioner system are brought to a temperature colder than the air these air conditioner coils are designed with materials like copper or aluminum to absorb ed heat easily and pass this heat to the refrigerant wheat her the refrigerant is water. Any type of refrigerant chemical or wheat her the refrigerant is water. Any type of refrigerant is designed to absorb heat. That is how air conditioning works.

Air conditioner components

Air conditioners use refrigerant that is pumped through coils where the refrigerant can either absorb heat or reject heat. For the process of how air conditioning works there needs to be some primary air conditioning components in the air conditioner system. The following is a description of the chief components in an air conditioning system that will show you how an air conditioner works.

Air Conditioner Compressor

There are different types of compressors used in air conditioning. There are scroll compressors, reciprocating compressors, rotary compressors, screw compressors, and centrifugal compressors. All the different types of compressors have different capacities and are used in various applications. The air conditioner compressor is like a pump. It pumps cool refrigerant vapour from the air conditioner evaporator and compresses the vapour. When the vapour is compressed, its pressure and temperature will raised. This high temperature vapour is pumped to the air conditioner condenser coils.

Air Conditioner Condenser

The air conditioner condenser coils receive the hot vapour from the compressor and immediately the air conditioner compressor begins to condense the refrigerant into a liquid by removing heat from the hot vapour. The heat is being removed from the hot vapour is the heat the refrigerant absorbed when the refrigerant was running through the air conditioner evaporator coils. The air conditioner condenser is responsible for rejecting the heat absorbed in the evaporator coil.

Metering Device

The most widely used metering devices are thermostatic expansion valves (TXV)followed by piton metering devices and capillary tubes. The refrigerant leaves the condenser as a liquid and is pumped to the air conditioner metering device. The metering device meters the refrigerant only allowing a certain quantity to get past it. Typically, the quantity of refrigerant is based on the size or capacity of the air conditioning system. TXV's will meter the refrigerant based on superheat or a calculated quantity of refrigerant needed to satisfy demand. Capillary tubes and pistons meter the same quantity of refrigerant no matter the demand. This is the reason why TXV metering devices are used in air conditioner systems rated for higher efficiency than the air conditioner systems that use capillary tubes or pistons to meter the refrigerant. The bottom for metering devices in an air conditioner system is that the metering creates a pressure drop of the liquid refrigerant. When the refrigerant drops in pressure, it drops in temperature. Some of the liquid will flash to a gas state depending on the temperature pressure relationship but the refrigerants now cold and ready to enter the air conditioner evaporator coil

Evaporator Coil

The evaporator coil in an air conditioner system is responsible for absorbing heat. As air (can also be water in a chiller) passes over the evaporator coils a heat exchange process takes place between the air and the refrigerant. The refrigerant absorbs the heat and as it absorbs the heat, it flashes to a vapour. The air condition evaporator conditions the air in two ways when it is typically operating below the dew latent heat removal is the process of drawing moisture out of the air and the sensible cooling is dropping the temperature of the air. Both types of heat removal make you more comfortable in the summer time. Most evaporator coils can be found in or near the air handling unit

LITERATURE REVIEW

1. Prof. S.M. Sheikh, et al. Published journal(IOSR_JMCE)"Performance Investigation of Window Air Conditioner" .In this he is studied the proper definition of air conditioning system and the advantages and application of air conditioning system. Also by the calculation determines the all parameters related to the air conditioning system and based on that he consider the specification for this unit.
2. P. Dasthagiri, et al. Published paper (2015) "Fabrication and Analysis of Refrigerator Cum Chilled Water Dispenser" in this paper he is studied that why the combine system is required, we can cooled or freeze water with help of refrigerator.
3. Himanshu, et al. Published paper (2014), "Feasibility Study and Development of Refrigerator Cum Air Conditioner" in this paper he is studied that combine system of refrigerator with air-conditioner.
4. B. Naveen, et al. Published paper (2013), "Waste Heat Recovery in R & Ac Systems" This report deals with design and fabrications of a three in one air conditioner.
5. Dr. U. V. Kongre, A. R. Chiddarwar, et al. Published paper (2013) "Testing and
   Performance Analysis on Air Conditioner cum Water Dispenser" The paper introduced basic design principles and the test analysis performed in the laboratory. The paper also introduced comfort conditions and suitable coefficient of performance with respect to atmospheric condition, without sacrificing the air conditioning output.
6. P. Techarungpaisan, S. Theerakulpisut, S.Priprem (2006) developed a steady state simulation model to predict the performance of a small split type air conditioner with integrated water heater. The mathematical model consists of sub models of system components such as evaporator, condenser, compressor, capillary tube, receiver and water heater. The model was coded into a simulation program and used to predict system parameters of interest such as hot water temperature, condenser exit air temperature, evaporator exit air temperature, heat rejection in the condenser and cooling capacity of the system.

COMPRESSOR

Introduction to Compressor

Compressor is a part of A.C., which is used to compress the refrigerant up to higher than the atmospheric pressure. A compressor consists of two components: the power source and the compressing mechanism (piston, vane, etc.). In the case of an A.C. compressor, the compressing mechanism is in fact compressing the atmospheric refrigerant. A.C. compressor works as follow

Refrigerant enters the piston or vane, and it is compressed by increasing its pressure and at the same time decreasing its volume. As soon as the pressure reaches a maximum set by the operator or the manufacturer, a switch mechanism prevents any further refrigerant intake in the compressor. The compressed refrigerant is used and pressure levels decrease. As soon as the pressure reaches a minimum, also set by the operator or the manufacturer, the switch allows refrigerant to enter the compressor. This procedure is repeated as long as the compressor is being used.

Performance Factors for Compressors

Factors, which affect the performance of compressors, are:

a. speed of rotation

b. pressure at suction
c. pressure at discharge and
d. type of refrigerant being used

Similar compressors can operate at different capacities by varying their refrigerants and compressor horsepower input. When purchasing any type of compressor, the buyer should check certain characteristics that include the machine configuration, the operation type, the price, and the operating cost. In any case, he should check the performance of the compressor and consult with the manufacturer about the most suitable and safest compressor for his budget and requirements.

CONDENSER

Introduction of Condenser

A condenser is an apparatus or item of equipment used to condenser (change the physical state of a substance from its gaseous to its liquid state). In the laboratory, condensers are generally used in procedures involving organic liquids brought into the gaseous state through heating, with or without lowering the pressure (applying vacuum) though applications in inorganic and other chemistry areas exist. While condensers can be applied at various scales, in the research, training, or discovery laboratory, one most often uses glassware designed to pass a vapour flow over an adjacent cooled chamber. In simplest form, such a condenser consists of a single glass tube with outside air providing cooling. A further simple form, the Liebig-type of condenser, involves concentric glass tube, an inner one through which the hot gases pass, and an outer, "ported" chamber through which a cooling fluid passes, to reduce the gas temperature in the inner, to afford the condensation.

Depending on the application (chemical components being separated, and the required operating temperature) and the scale of the process (from very few microliters to process scales involving many liters), different types of condensers and means of cooling are used. Alongside the temperature differential and heat capacity of the cooling fluids (e.g., air, water, aqueous organic cosolvents),aqueous-organic co- solvents the size of the cooling surface and the way in which gas (vapour) and condensing liquid states come into contact are critical in the choice or design of a condenser system. Since at least the 19th century, scientists have sought creative designs to maximize the surface area of vapour-liquid contact and heat exchanger. Many types of laboratory condensers—simpler Liebig and Allihm, coiled Graham types, simple and Dimroth types of cold finger condensers, etc.—now common, have evolved to meet the practical need of larger cooling surfaces and controlled boiling and condensation in various procedures involving distillation, and a further very wide array of materials for "packing" simpler condensers to increase surface area (e.g., glass, ceramic, and metal beads, rings, wool, etc.) have been studied and applied. Likewise, the configurations of laboratory apparatus involving condensers are many and varied, to cover low and high boiling solvents, simple and complex separations, etc. Several common process types based on the change of physical state provided by condensers can easily be described, including simple evaporations or "solvent stripping" (the bulk removal of all volatiles to leave behind concentrated solutes present in the original solution being evaporated), reflux operations (where the aim is to contain all volatiles while providing a constant process temperature established by the boiling point of the solvent system being used), and separation/distillation operations (where high theoretical plates provide for selective delivery of one or more volatile components of a complex "mixture" in a controlled fashion). The direction of vapour and condensate flows in the laboratory condenser chosen for each of these may vary (e.g., being counter current in reflux procedures, and concurrent in many simple distillation procedures), as do the optimal flow direction for the cooling fluid, etc. In all processes, condenser selection/design requires that the heat of entering vapour never overwhelm the condenser and cooling mechanism; as well, the thermal gradients and material flows established during the gas-liquid transition are critical aspects, so that as processes increase in scale from laboratory to pilot plant and beyond, the design of condenser systems becomes a precise engineering science.

Three important steps will happen to the refrigerant as it passes through the condensing unit.

First Step: The hot vapour coming from the compressor must be de-superheated to the vapour saturation point. De-superheated? De-superheated is removing a sensible heat from the refrigerant, lower the refrigerant temperature.

Second Step: In the middle of the condenser, there should is mixture of gas/liquid refrigerant. This is where the refrigerant vapour should change to 100 percent liquid refrigerant.
Third Step: The refrigerant temperature should be below the liquid saturation point, sub cooled.

The condenser can be free air cooled (domestic refrigerator), forced air cooled (windowair conditioner), water cooled (Central air conditioning plant in a library, cinema house and evaporative cooled (ice plant unit or a cold storage unit).

EXPANSION DEVICE

Introduction of Expansion Device

Metering devices regulate how much liquid refrigerant enters the evaporator as per heat load on evaporator. Common used metering devices are, small thin copper tubes referred to as "capillary tubes", thermally controller diaphragm valves"(thermostatic expansion valves, called "TXV's. This valve has the capability of controlling the refrigerant flow. If the load on the evaporator changes, the valve can respond to the change and increase or decrease the flow accordingly. The TXV has a sensing bulb attached to the outlet of the evaporator. This bulb senses the suction line temperature and sends a signal to the TXV allowing it to adjust the flow rate. This is important because, if not all, the refrigerant in the evaporator changes state into a gas, there could be liquid refrigerant content returning to the compressor. This can be fatal to the compressor. Liquid cannot be compressed and when a compressor tries to compress a liquid, mechanical failing can happen. The compressor can suffer mechanical damage in the valves and bearings. This is called" liquid slugging". Normally TXV's are set to maintain 10 degrees of superheat. That means that the gas returning to the compressor is at least 10 degrees away from the risk of having any liquid. The metering device tries to maintain a present degree of superheat at the outlet openings of the evaporator. As the metering devices regulates the amount of refrigerant going into the evaporator, the device lets small amounts of refrigerant out into the line and loses the high pressure to low pressure. Now we have a low pressure, cooler liquid refrigerant entering the evaporative coil.

These are of five type namely capillary tube (domestic fridge), Automatic expansion valve (ice plant unit), Thermostatic expansion valve (Library refrigeration plant, theatre air conditioning unit and many more), Low side float valve (industrial cooling units) and high pressure float valve (industrial cooling units). These causes the required pressure drop between the high and low pressure sides and also control the flow of refrigerant as per cooling requirements.

The expansion device is the fourth major component in air conditioner units. It's also known as meter devices. Air conditioner expansion valve is the divided point between the low side and the high side of the air conditioner units. Another dividing point is air conditioner compressors. The meter device is located indoor (air handler) units with the evaporator coils. It's small and hard to see, unless you open the evaporator compartment.

EVAPORATOR

Introduction of Evaporator

The evaporators are other important parts of the refrigeration and air conditioning systems. It through the evaporators that the cooling effect is produced in the refrigeration systems. It is in the evaporators where the actual cooling effect takes place in the refrigeration and the air conditioning systems. For many people the evaporator is the main part of the refrigeration system and they consider other parts as less useful. The evaporators are heat exchanger surfaces that transfer the heat from the substance to be cooled to the refrigerant, thus removing the heat from the substance. The evaporators are used for wide variety of diverse applications in refrigeration and air conditioning processes and hence they are available in wide variety of shapes, sizes and designs. They are also classified in different manner depending on the method of feeding the refrigerant, construction of the evaporator, direction of air circulation around the evaporator, application and also the refrigerant control.

In the domestic refrigerators the evaporators are commonly known as the freezers since the ice is made in these compartments. In case of the window and split air conditioners and other air conditioning systems where the evaporator is directly used for cooling the room air, it is called as the cooling coil. In case of large refrigeration plants and central air conditioning plants, the evaporator is also known as the chiller since these systems are first used to chill the water, which then produces the cooling effect.

In the evaporator, the refrigerant enters at very low pressure and temperature after passing through the expansion valve. This refrigerant absorbs the heat from the substance that is to be cooled so the refrigerant gets heated while the substance gets cooled. Even after cooling the substance the temperature of the refrigerant leaving the evaporator is less the than the substance. The refrigerant leaves the evaporator in vaporstate, mostly superheated and is absorbed by the compressor.

PIPING MATERIAL

Introduction of Pipe Material

Pipe material should have high thermal conductivity, low cost, easy working and inertness with the refrigerant. Until date most commonly used pipe material is soft copper with all refrigerants except ammonia. The pipe material used with ammonia is mild steel as ammonia is highly corrosive to copper.

Condensation control

Where pipes operate at below-ambient temperatures, the potential exists for water vapour to condense on the pipe surface. Moisture is known to contribute towards many different types of corrosion, so preventing the formation of condensation on pipe work is usually considered important. Pipe insulation can prevent condensation forming, as the surface temperature of the insulation will vary from the surface temperature of the pipe. Condensation will not occur, provided that the insulation surface is above the dew point temperature of the air, and the insulation incorporates some form of water-vapours barrier or retarder that prevents water vapours from passing through the insulation to form on the pipe surface, to preventing the corrosion on pipe line, insulation are required with proper thickness and density.

Pipe freezing

Since some water pipes are located either outside or in unheated areas where the ambient temperature may occasionally drop below the freezing point of water, any water in the pipe work may potentially freeze. When water freezes, it expands due to negative thermal expansion, and this expansion can cause failure of a pipe system in any one of a number of ways. Pipe insulation cannot prevent the freezing of standing water in pipe work, but it can increase the time required for freezing to occur thereby reducing the risk of the water in the pipes freezing. For this reason, it is recommended to insulate pipe work at risk of freezing, and local water supply regulations may require pipe insulation be applied to pipe work to reduce the risk of pipe freezing, For a given length, a smaller-bore pipe holds a smaller volume of water than a larger-bore pipe, and therefore water in a smaller-bore pipe will freeze more easily (and more quickly) than water in a larger-bore pipe (presuming equivalent environments). Since smaller-bore pipes present a greater risk of freezing, insulation is typically used in combination with alternative methods of freeze prevention (e.g., modulating trace heating cable, or ensuring a consistent flow of water through the pipe).

Energy saving

Since pipe work can operate at temperatures far removed from the ambient temperature, and the rate of heat flow from a pipe is related to the temperature differential between the pipe and the surrounding ambient air, heat flow from pipe work can be considerable. In many situations, this heat flow is undesirable. The application of thermal pipe insulation introduces thermal resistance and reduces the heat flow.

Thicknesses of thermal pipe insulation used for saving energy vary, but generally, pipes operating at more-extreme temperatures exhibit a greater heat flow and larger thicknesses are applied due to the greater potential savings. The different size of pipe related with the energy saving. Depend on the flow rate, energy cost is determined by particular pipe size. Using PIPEOPT algorithm, if pipe diameter is lager, the energy is less than smaller pipe diameter because of the lower pressure.

The location of pipe work also influences the selection of insulation thickness. For instance, in some circumstances, heating pipe work within a well insulated building might not require insulation, as the heat that's "lost" (i.e., the heat that flows from the pipe to the surrounding air) may be considered "useful” for heating the building, as such "lost" heat would be effectively trapped by the structural insulation anyway. Conversely, such pipe work may be insulated to prevent overheating or unnecessary cooling in the rooms through which it passes.

Protection against extreme temperatures

Where pipe work is operating at extremely high or low temperatures, the potential exists for injury to occur should any person come into physical contact with the pipe surface. The threshold for human pain varies, but several international standards set recommended touch temperature limitsSince the surface temperature of insulation varies from the temperature of the pipe surface, typically such that the insulation surface has a "less extreme" temperature, pipe insulation can be used to bring surface touch temperatures into a safe range.

Control of noise

Pipe work can operate as a conduit for noise to travel from one part of a building to another (a typical example of this can be seen with wastewater pipe work routed within a building). Acoustic insulation can prevent this noise transfer by acting to damp the pipe wall and performing an acoustic decoupling function wherever the pipe passes through a fixed wall or floor and wherever the pipe is mechanically fixed.

Pipe work can also radiate mechanical noise. In such circumstances, the breakout of noise from the pipe wall can be achieved by acoustic insulation incorporating a high- density sound barrier.

Factors influencing performance:

The relative performance of different pipe insulation on any given application can be influenced by many factors. The principal factors are:

- Thermal conductivity ("k" or "2" value)
- Surface emissivity("s" value)
- Water vapour resistance ("u" value)
- Insulation thickness
- Density

Material
Pipe insulation materials come in a large variety of forms, but most materials fall into one of the following categories.

Mineral wool
Mineral wools, including rock and slag wools, are inorganic strands of mineralfiber bonded together using organic binders. Mineral wools are capable of operating at high temperatures and exhibit good fire performance ratings when tested. Mineral wools are used on all types of pipe work, particularly industrial pipe work operating at higher temperatures.

Glass wool
Glass wool is a high-temperature fibrous insulation material, similar to mineral wool, where inorganic strands of glass fiber are bound together using a binder. As with other forms of mineral wool, glass-wool insulation can be used for thermal and acoustic applications.

Flexible elastomeric foams
These are flexible, closed-cell, rubber foams based on NBR or EPDM rubber. Flexible elastomeric foams exhibit such a high resistance to the passage of water vapour that they do not generally require additional water-vapour barriers. Such high vapour resistance, combined with the high surface emissivity of rubber, allows flexible elastomeric foams to prevent surface condensation formation with comparatively small thicknesses.

Rigid foam
Pipe insulation made from rigid Phenolic, PIR, or PUR foam insulation is common insome countries. Rigid-foam insulation has minimal acoustic performance but can
Exhibit low thermal-conductivity values of 0.021 W/(m·K) or lower, allowing energy- saving legislation to be met whilst using reduced insulation thicknesses.

Polyethylene
Polyethylene is a flexible plastic foamed insulation that is widely used to prevent freezing of domestic water supply pipes and to reduce heat loss from domestic heating pipes. The fire performance of Polyethylene is typically 25/50 E84 compliant up to 1" thickness.

Cellular Glass
100 % Glass manufactured primarily from sand, limestone & soda ash.

Aerogel
Silica Aerogel insulation has the lowest thermal conductivity of any commercially produced insulation. Although no manufacturer currently manufactures Aerogel pipe sections, it is possible to wrap Aerogel blanket around pipework, allowing it to function as pipe insulation. The usage of Aerogel for pipe insulation is currently limited,

REFRIGERANTS

Introduction of Refrigerants
It is working substance in a refrigeration unit like blood in the human body. It selection depends on many considerations like temperature to be produced, latent heat, ozone depletion potential, global warming potential, toxicity, in flammability, inertness, corrosion, erosion, action with water and lubricating oil, cost, availability, leak detection and power requirements for a certain amount of cooling needed. Various commonly used refrigerants are halogenated saturated hydrocarbons like R-134, R-22 and inorganic compounds like ammonia and air. Most common previously used refrigerants like R-12 and R-11 has been banned because of their high ozone depletion and global warming potentials. Mixed refrigerants and zoetrope's are also in use. Refrigerants can be primary, secondary and tertiary type depending where and how these are being used. The same substance, for example, air can be primary in aircraft in a central air conditioning plant.

Classification of refrigerants:
Primary refrigerants:
Primary refrigerants directly take part in the refrigerating system and actually produce the low temperatures by absorption of latent heat. Examples: ammonia, carbon dioxide, sulphur dioxide, Freon etc. Primary refrigerants are further classified into the following groups:

Halocarbon compounds
This group includes refrigerants, which contain one, or more of three halogens (chlorine, fluorine and bromine).they are available in the market under trade names of Freon, Genetron, Isotron and Areton

Freon-22

It is a low temperature refrigerant and extensively used in air-conditioning applications with reciprocating compressors. It is also used in low temperature applications such as cold storages. It is nontoxic, non-flammable and non-corrosive refrigerant. The refrigerating capacity of feron-22 is 60% more than feron-12. Leakage of the refrigerant maybe detected with halide torch. Its cylinder colour code is green.

Azeotropes:

An azeotrope is a compound of two or more different substances and the substance forming azeotrope cannot be separated by distillation. An azeotrope evaporates and condenses as a single substance with the properties that are different from of either constituent. Example: R-500, R-501, R-502.

Hydrocarbons

Hydrocarbon refrigerants are used in low temperature applications. All Hydrocarbon refrigerants are made from carbon and hydrogen .they are highly flammable and explosive but possess satisfactory thermodynamic properties. Examples: Methane, Ethane, Propane, Butane and Isobutene.

Inorganic Compounds

Inorganic compounds are oldest refrigerant and most widely used of all refrigerants. They possess excellent properties but are highly toxic and flammable. These compounds are listed below. Two digit represent the molecular weight.

Table 1 Most commonly used Inorganic compounds

Numerical designation	Chemical name	Chemical formula
717	Ammonia	NH3
718	Water	H_20
729	Air	-
744	Carbon dioxide	CO2
764	Sulphur dioxide	SO2

Unsaturated Organic compound

These refrigerants are mainly hydrocarbon compounds with ethylene and propylene base. Numerical designations of these refrigerants are given below.

Table 2 Most commonly used unsaturated organic compounds

Numerical designation	Chemical name	Chemical formula
1120	Trichloro ethylene	C2H4CL3
1130	Dichloro ethylene	C2H4CL2
1150	Ethylene	C2H4
1270	propylene	C2H6

Oxygen Compounds

These refrigerants are mainly hydrocarbons, which contains oxygen elements.
Commonly used refrigerants of this group are given below.

Table 3 Most Commonly Used Oxygen Compounds

Numerical designation	Chemical name	Chemical formula
610	Ethyl ether	C2H5- O -C2H6
611	Methyl formate	C2H4O2

Nitrogen Compounds

These refrigerants are hydrocarbons with methane or ethane base and having nitrogen elements. Numerical designations of these refrigerants are given below.

Table 4 Most Commonly Used Nitrogen Compounds

Numerical designation	Chemical name	Chemical formula
630	Methylamine	CH3NH2
631	Ethyalamine	C2H5NH2

Properties comparison of R-410a and R-32

S.NO	PROPERTY	r-410a	r-32
1	Molecular Weight (Da)	72.6	52.02
2	Melting point (°C)	−155	-52
3	Boiling point (°C)	−4.5	-136
4	Liquid density (30°C), kg/m3	1040	4.25
5	Vapour density (30°C), air=1.0	3.0	0.33
6	Vapour pressure at 21.1°C (MPa)	1.383	0.237
7	Critical temperature (°C)	72.8	78.11
8	Critical pressure,(bar)	45.95	57.82
9	Gas heat capacity (kJ/(kg·°C))	0.84	0.75
10	Liquid heat capacity @ 1 atm, 30°C, (kJ/(kg·°C))	1.8	1.6

8

Fig 2: Properties comparison of R-410a and R-32

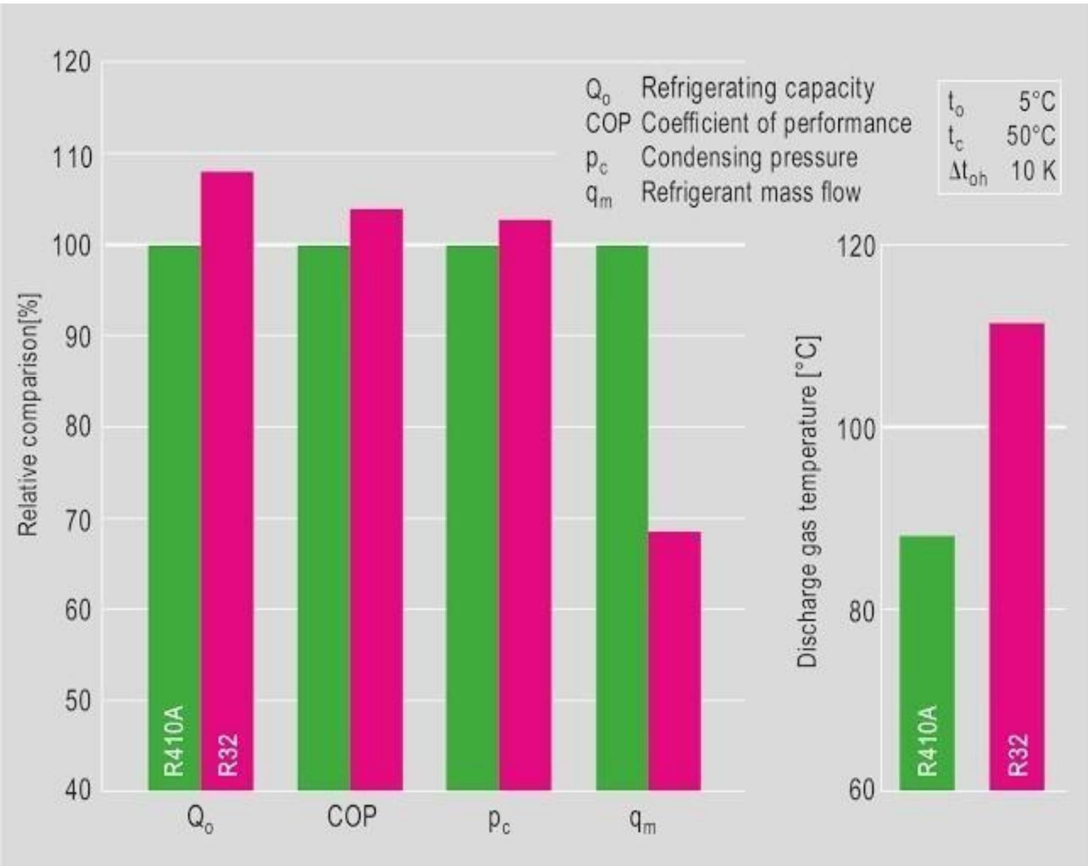


Fig 3; various properties graphical comparison of r-410a and r-32

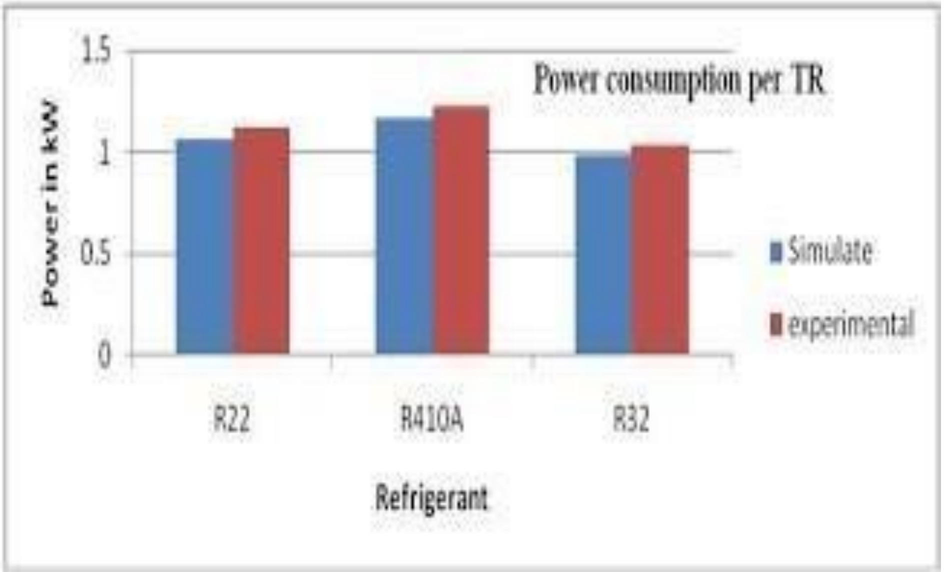


Fig 4; power consumption comparasion of R-22, R-410a & R-32

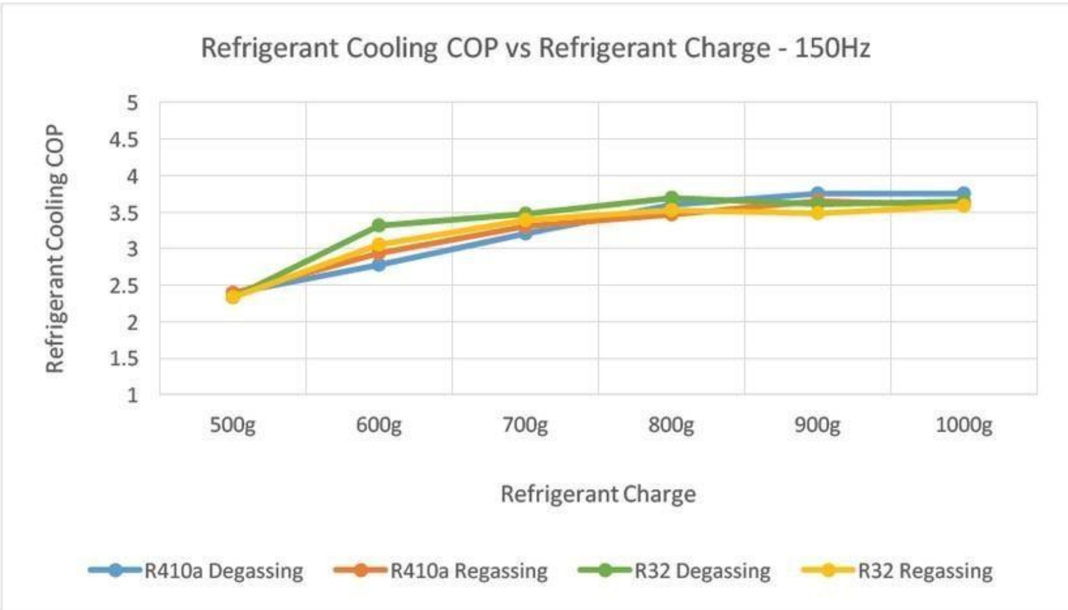
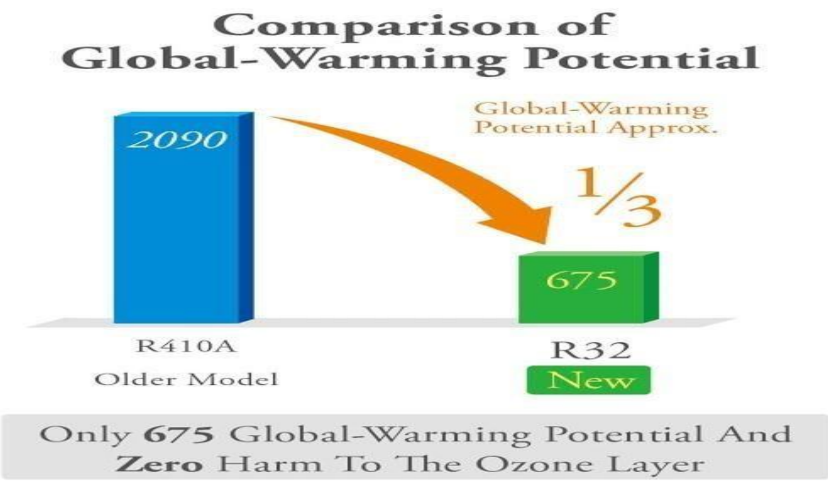


Fig 5 Comparasion of COP vs Refrigerant charge



Fig; 6 Global warming comparison of r-410a and r-32

Working

The working process of the air conditioning cum water dispenser system is same as the actual air conditioning system but the three rival properties like hot water cold water and conditioned air are obtained in the single unit .

The various processes are

1-2 Compression process

2-2` Some amount of heat is rejected by water in water bowl(Hot Water)

2`-3 Condensation process (heat is rejected by the fan –Hot Air)

3-3` Expansion Process

3`-4 Heat is absorbed by the water in water bowl(Cold Water)

4-1 Evaporation process(Cool Air)

Compression Process:

It is the first stage of process of this project. In this process the saturated Vapour Refrigerant is compressed by the compressor so that the temperature and pressure of this refrigerant increases. then it is formed as high pressure and high temperature vapour refrigerant.

Some Amount of heat is rejected by the water in water bowl:

In this Process, The high pressure and high temperature vapour refrigerant flows in copper tubes here the copper tubes wounded around the water bowl, By flowing high pressured and temparature refrigerant in this wounded tubes around the bowl, here some amount of heat is rejected by the water in the water bowl, finally we get in this process is Hot Water.

Condensation Process(Hot Air is Output):

In this Process, Condensation is happened by the Exhaust Fan. From The Compressor The high pressure and temperature refrigerant is flowing through the copper tubes, Here we placed A Exhaust Fan behind the condenser coils so that, Condensation process will happen here. Thus we get Hot air as output.

Expansion Process:

In this Process, The low temperature and high pressure vapour refrigerant is entered into the capillary tube, By flowing the refrigerant in the capillary tube, the pressure will decrease so that the vapour refrigerant is converted into liquid refrigerant.

Heat is absorbed by the water in water bowl (Cold Water):

In this process, The liquid refrigerant flows through the tubes wounded around the water bowl filled with water, by this action the amount of heat is absorbed by the water so that water is converted into cold water, Finally we get here Cold water.

Evaporation Process:

In this Process, Evaporation will happen. The liquid refrigerant entered into the evaporative coils, here we place a blower for extracting the heat from the Liquid refrigerant flowing in evaporative coils. By in this Process, the heat is extracted by the blower the liquid refrigerant converted into saturated Vapour refrigerant Thus the we finally get the Cool Air as output.

Finally by using this system we get four condition in one system(4-1) they are

1.Hot Water

2.Hot Air

3.Cold Water

4.Cool Air

International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 12 Issue 6, June-2023, Impact Factor: 7.957

EXPERIMENT SET UP LAYOUT:

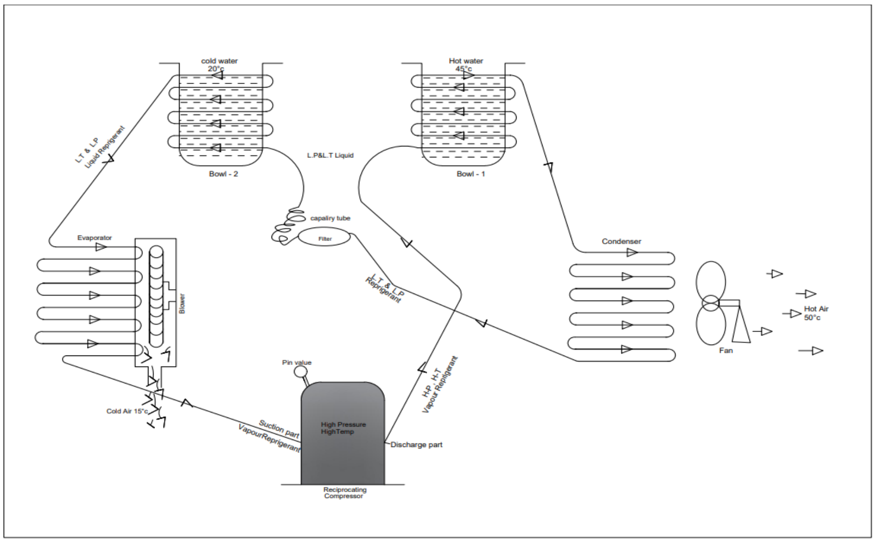


Fig 7 P-H &T-S DIAGRAMS OF VCR SYSTEM

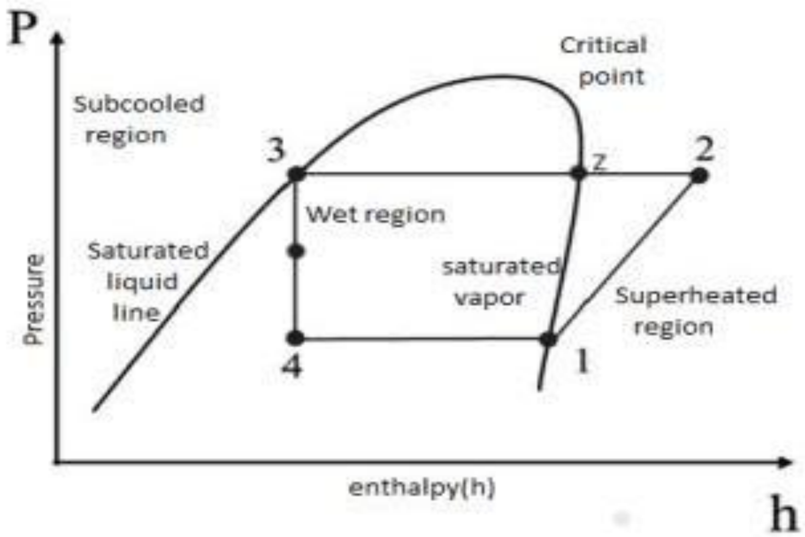


Fig 8 P-H diagram of VCR system

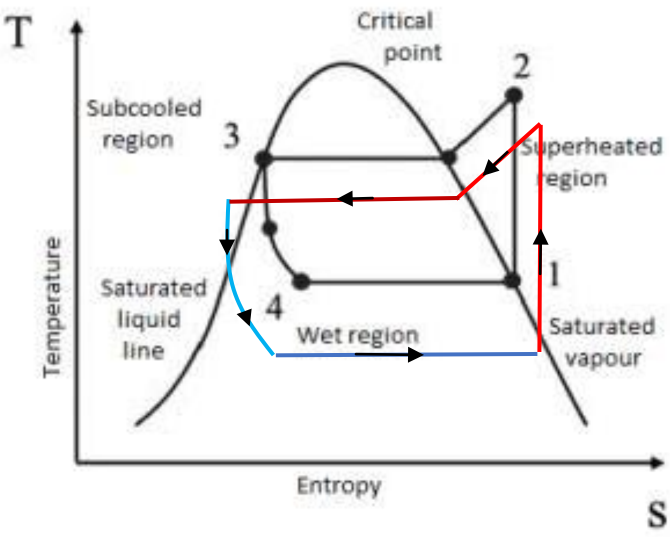


Fig 9 T-S diagram of VCR system

FABRICATON OF PROJECT

INTRODUCTION TO FABRICATION

Air conditioner is a device which provides cooling effect by use of four main components compressor, condenser expansion device and evaporator. These system. Therefore, Heat rejection capacity depends on difference between refrigerant components operate with the help of refrigerant, which works as heat carrier in this rejection will result in more heat absorption. Temperature at condenser and atmospheric temperature. It is clear that more heat rejection will result in more heat absorption.

For the project, we are replacing the condenser, which is air, cooled with water cooled condenser which gives hot water as aout put and the evaporator is splitted into two systems one is for air conditioning system and another one is for cold water outlet.

OPERATIONS PERFORMED:-

In order to achieve the required work we have to perform certain prerations. After selecting the material for the components they have to undergo specific gerations to fabricate hydraulic lift pallet truck. The operations performed are:

MARKING:-

The material we chose won't be in our required dimensions. In order to get +ve dimensions we have to mark the dimensions on the material. We need metal tape for measuring the dimensions. The scriber is used to mark along the required dimensions on the material. To highlight the marks we use chalk to draw along the scriber marks.
The actual dimensions of the parts required were obtained by taking measurements with steel tape, measuring tape and necessary marking was made with a `divider. Major marking out was done on the materials used for the casing, the cover and joining

CUTTING

Cutting is mainly required in the reduction of length and diameter of the material to get the desired parts. After the marking, to get the material we have to cut along the markings. This can be achieved by using the grinding wheel cutting machine.It is the machine which consists of a rotating sharp wheel for cutting along the marks.

Fig; 10 cutting

DRILLING:-

After cutting of the material to required dimensions, we have to make sure whether the holes are to be drilled or not. The drilling machine is used for the drilling of the holes in the material. The holes are drilled with 10mm cobalt metric drill bit for the nut to get in.

WELDING:-

Now the required operation to be performed is the joining of materials together permanently by welding. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that, based on weld configuration (butt, full penetration, fillet, etc.), can be stronger than the base material (parent metal). Pressure may also be used in conjunction with heat, or by itself, to produce a weld. Welding also requires a form of shield to protect the filler metals or melted metals from being contaminated or oxidized.

Fig; 11 welding

SPOT WELDING:

Spot welding (or resistance spot welding[l]) is a type of electric resistance welding used to weld various sheet metal products, through a process in which contacting metal surface points are joined by the heat obtained from resistance to electric current. The amount of heat (energy) delivered to the spot is determined by the resistance between the electrodes and the magnitude and duration of the current.

Fig:12 spot welding

Assembling:

In assembling process all the components like compressor, condenser, expansion device, and the evaporator are assembled with the gas welding process. in that a way that we obtain hot water cold water and conditioned air as output.

Fig 13 Project While Fabrication

Assembling of compressor

Fig 14 Our Project While Fabrication

Assembling of water cooled condenser:

Fig 15 Our Project While Fabrication

Assembling of capillary tube

Fig 16 Our Project While Fabrication

MAKING OF AIR PASSAGE DUCT:

Fig 17 Our Project While Fabrication

Assembly of evaporator:

Fig 18 Our Project While Fabrication

COMPRESSOR WIRING:

Fig 19 compressor wiring

International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 12 Issue 6, June-2023, Impact Factor: 7.957

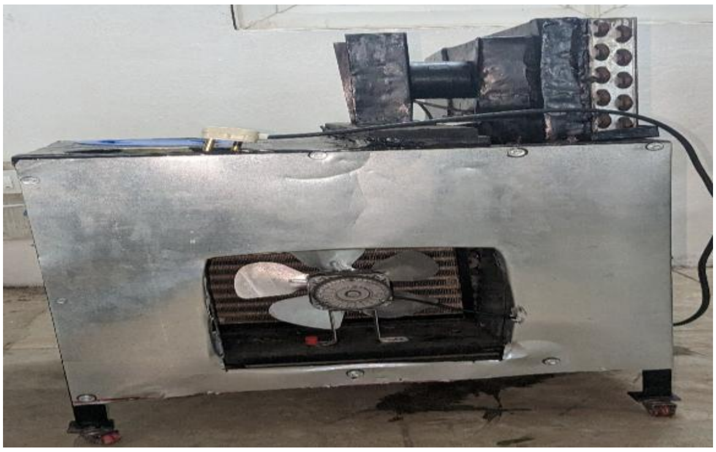


Fig 20 Right view of project

Fig 21 Left view of project

Fig 22 Back view of project :

Fig 23 Final project

ANALYSIS OF RESULTS

COEFFICIENT OF PERFORMANCE: The coefficient of performance is the ratio of heat extracted in the refrigerator to the work done on the refrigerant

Mathematically, C.O.P = Q/W

Q = Amount of heat extracted in the refrigerator

W = Amount of work done

Suction temperature (T_1) = 2 °C (or) 2°C + 273 k = 275 k.

Discharge temperature (T_2) = 60 °C (or) 60 °C + 273 k = 333k.

Capacity of the system (Q) = 5 Tr 5 * 3.5 = 17.5 kw (1Tr = 3.5 kw)

Specific heat (CPv) = 0.74 kj/kgk.

Compressor speed (1.5 ton) = 18000 BTU.

Suction pressure = 6 bar .

Discharge pressure = 24 bar.

1-2 Compression process

2-2` Some amount of heat is rejected by water in water bowl(Hot Water)

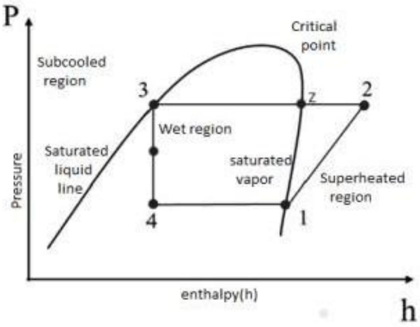
2`-3 Condensation process (heat is rejected by the fan –Hot Air)

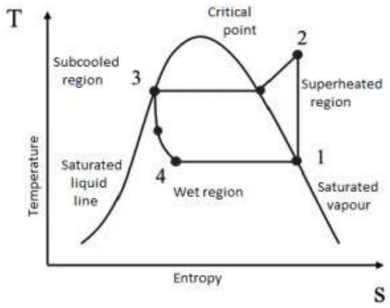
3-3` Expansion Process

3`-4 Heat is absorbed by the water in water bowl(Cold Water)

4-1 Evaporation process(Cool Air)

- Dry saturated at the suction of the compressor.
- Taking the enthalpy and entropy values freon gases or refrigeration tables.
- First we need to draw the P-H diagram and T-S diagram.





F P-H diagram of the system T-S diagram of the system

Table 5 Enthalpy entropy Table

Temperature (T) °C	Pressure (P) bar	Specific Enthalpy		SpecificEntropy	
		Saturated liq (hf) kj/kg	Saturated vapour (hg)	Saturated liq (sf) kj/kg	Saturated vapour (sg)
2	6 bar	47.46	250.64	0.1857	0.9243
60	24 bar	122.35	261.96	0.384	0.8603

We know that from p-h diagram the point 1 is on vapour line, So that at 2°C the value of h1 is hg
Therefore, h1 = hg = 250.64 kj/kg
In the same way the point 4 in between liquid line and vapour line, So that the h4 becomes hf at 60°C
Therefore, h4 = hf = 122.35 kj/kg
Then we need to find out enthalpy at point -2 (h2)
Therefore, h2 = hg + Cp ln (T2 – Tsup) at superheated region.
We don't know Tsup , So we need to find out this from this equation or formula
S1= S2 → From T-S diagram.
Sg1= Sg2 + Cp ln (T2 / Tsup)
0.9241= 0.8603 + 0.74 ln (333/ Tsup)
Therefore, Tsup = 305k
Then,
h2 = hg2 + Cp ln (T2 – Tsup)
h2 = 261.96 + 0.74 ln (333 – 305)
h2 = 265 kj/kg
Therefore, Coefficient of performance = Refrigeration of effect / Work done
Refrigeration of effect = h1 – h4
Work done = h2 – h1
Cop = h1 – h4 / h2 – h1
= 250.64 – 122.35 / 265 – 250.64
Therefore , COEFFICIENT OF PERFOMANCE (Cop) = 9
Power (P) = Mass * Work done
P = m * (h2 – h1)
Where m is mass flow rate of gas ,m = Q / h1 – h4 = 17.5 / 128.29
m = 0.1364 kg/s
P = 0.1364 * (14.36)
Therefore, Power (P) = 1.95 kj/s (or) kw
Cop = Q / P = 17.5 / 1.95
COEFFICIENT OF PERFORMANCE (Cop) = 9
RESULT

- Hence from the above calculations the coefficient of performance comes out to be 9.
- Higher compatibility and portability is achieved which is more efficient than other cooling units.

CONCLUSIONS

Conclusion

This project is very cheap and effective as compared with the conventional cooler and air conditioner system as it based on VCRs system. It has very low power consumption which ultimately increases the cop of the system which increases the cooling effect (refrigeration effect) of the system. It is portable. It has very low effect on environment as it saves electricity and water. The concept is very cost effective as compared to AC. Very Energy Effective system.

An effective integrated air-conditioner, refrigeration and heating system is suggested.
A simple working model of the system is fabricated and tested.
The heating unit in the system utilizes heat lost through the condenser and There by Save energy.

CONCLUSION TABLE

Table 6 Conclusion Table

TYPE	TEMPERATURES				COP
FOR ORDINARY AIR CONDITIONING UNIT	HOT WATER	COLD WATER	CONDITIONED AIR	HOT AIR	
	40^0c	20^0c	16^0c	45^0c	6.5
OUR PROJECT	45^0c	18^0c	15^0c	50^0c	9

REFERENCES

[1]. Engineering Thermodynamics, Fourth Edition by P.K Nag, Page 583
[2]. Air conditioning and refrigeration by Rex Miller and Mark R. Miller, Page 56
[3]. Refrigeration and air conditioning by G.F Hundy, Page 16
[4]. Engineering Thermodynamics, Fourth Edition by P.K Nag, Page 583
[5]. Térmica (Thermal Engineering), Vol. 5 •No 02 • December 2006 • p. 09-15
[6]. International journal of research in computer application and robotics (IJRCAR) ISSN 2320-7.
[7]. International Journal for Innovative Research in Science & Technology (IJIRST)| ISSN: 2349-6010
[8]. International Journal of Engineering Trends and Technology (IJETT)
[9]. International Journal of Science Technology & Engineering (IJSTE) ISSN : 2349784X
[10]. hhttps://en.wikipedia.org/wiki/difluoromethane
[11]. hhttps://en.wikipedia.org/wiki/Refigeration
[12]. hhttps://www.youtube.com/watch?v=mWVFXwhyn8g
[13]. https://energy.gov/eere/energybasiscs/articles/air-conditioning-basics