PORTABILITY WATER ANALYSIS OF CONDENSATE WATER

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ABSTRACT

- A major part of the world is facing water shortages today. While the world's population has grown to more than 7.75 billion, the quantity of sweet water has remained the same. The ever-increasing use of water by such a large population has resulted in pollution of many water sources. The developing world where a large fraction of total world population is located faces water scarcity in a more severe manner than the developed world. The developed world has managed to control human population and preserve natural water resources more effectively. As a result of this and also due to a stabilized population, they face lesser problems with water availability. Indian population stands at 1.386 billion as nowadays.
- The erratic monsoon rains over the last few years have resulted in floods and subsequent water shortages in summer months in major parts of the country. A similar situation is faced by many Asian and African countries. The means of recycling and using every possible source of water are always welcome in these countries. Since many of these countries lie in tropical or semitropical zones, the average relative humidity is more than 50% for most of the year. Changing lifestyles in these countries and the spread of information technology-based sectors have resulted in a growth spurt in air conditioning facilities.
- An air conditioner draws heat from surrounding air and cools the premises to desired temperature. During this process, a large amount of moisture in the atmosphere gets condensed and is drained out. There are no efforts made to recover this water in India and neighboring countries. We have undertaken studies to check the quality of this water and see the feasibility of its use in a decentralized but effective manner. The results show that this water condensate from air conditioners is highly pure, substantial and available almost round the year.
- This can help in recovering millions of liters of good quality water daily. This water would find uses in industries, laboratories, households and farming. It would also create good business opportunities.

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CHAPTER 1 INTRODUCTION

1.1 GENERAL

Both industrial refrigeration and air-conditioning are based on the same mechanism: a fluid, generally water or air, is cooled by evaporation of another fluid, called the refrigerant. The refrigerant circuit, comprising the compressor, evaporator, condenser and expansion device, is an integral part of both systems. Nonetheless, there are substantial differences between refrigeration and air-conditioning systems, for example as regards the components, the design methods, the commercial or industrial structures where they're installed and their operation, such as to justify the existence of two distinct market sectors. Air-conditioning is that process used to create and maintain certain temperature, relative humidity and air purity conditions in indoor spaces. This process is typically applied to maintain a level of personal comfort.

It's also used in industrial applications to ensure correct operation of equipment or machinery that need to operate in specific environmental conditions or alternatively to be able to carry out certain industrial processes, such as welding, which produce considerable amounts of heat that needs to be disposed of in some manner.

An air-conditioning system must be effective regardless of outside climatic

The distinction between industrial and personal comfort applications is not always clear cut. Industrial air-conditioning usually requires better precision as regards temperature and humidity control. Some applications also demand a high degree of filtering and removal of contaminants. Comfort air-conditioning on the other hand, as well as needing to satisfy personal temperature-humidity requirements, also involves other fields such as architectural design, weather forecasting, energy consumption and sound emissions to recreate the ideal conditions for human psychophysiological well-being. Home air-conditioners, for example, mainly cool the air taken in from the air-conditioned space in a closed circuit. Such cooling also dehumidifies the air as some of the moisture this contains condenses inside the air-conditioner (in the form of droplets) and is then collected and discharged outside via a rubber hose.

Home air-conditioners, for example, mainly cool the air taken in from the air-conditioned space in a closed circuit. Such cooling also dehumidifies the air as some of the moisture this contains condenses inside the air-conditioner (in the form of droplets) and is then collected and discharged outside via a rubber hose. The ventilation, filtering, mixing and often heating functions are managed using relatively simple dedicated components, respectively fans, filters, dampers and electric heaters or boilers, while the principle and more complex functions are managed by likewise complex systems such as refrigerant circuits and humidifiers

Special mention also needs to be made of the solution commonly used to deliver cooling capacity that exploits the evaporation of a fluid inside a circuit placed in contact with the environment being cooled. The principles underlying this technology are again quite complex. Air conditioners circulate and filter air, removing pollutants and mold from the air. This is especially important for people who suffer from allergies and asthma because it minimizes the irritants that trigger an attack. This only holds true, however, if your system is kept clean and filters are regularly changed. Otherwise, the AC can contribute to indoor air pollution. An Environmental Protection Agency study of heat-related deaths found that more than 9,000 Americans died from the heat between 1979 and 2013, a figure which does not even fully capture the magnitude of the problem. Many more deaths have heat as a contributing factor but not the main cause. Keeping cool with an efficient air conditioner is the best means of preventing heat-related deaths and illnesses, according to the Centers for Disease Control and Prevention.

1.2 REFRIGERANT

Most people know that refrigerant evaporates at some point inside the system, but that's only part of how it works. Pressure and temperature are related: when one decreases or increases, so does the other. When liquid refrigerant passes through the expansion valve, its pressure is reduced downstream of the valve. That reduces its temperature, and if it's colder than its surroundings, liquid refrigerant will absorb heat. The lower pressure also reduces the liquid's boiling point. When a liquid evaporates, it absorbs heat from its surroundings, lots of heat. The greater the mass of liquid evaporating, the greater the amount of heat absorbed. However, when liquidrefrigerant evaporates in an air conditioning system, it doesn't just vaporize like steam from a cup of tea; it remains captured in the system as vapor, and it continuesabsorbing heat. Just about any liquid or gas will work as a refrigerant, even air, but some work better than others. In broad terms, a liquid that has a higher mass and vapor pressure will carry more heat, while a gas with a lower mass and vapor pressure will compress more easily to a liquid and therefore require less energy to run the compressor. Real-world refrigerants are a balance between those two extremes, but to put automotive A/C into perspective, R-134a can still be a vapor even at the highest pressure generated by the compressor. To condense this high- pressure vapor to a liquid, we need to remove heat. That's done in the condenser. Nomatter which refrigerant is chosen, the rest of the system must be designed around it. One of the primary design criteria of every air conditioner and refrigeration system, from cradle to grave, is its potential contribution to global warming.Therefore, certain refrigerants are on a world-wide schedule to be phased out at somepoint, including R-134a. Right now, the only replacement that's ready is another class of fluorocarbon refrigerants called hydrofluoric-olefin (HFO), which we knowas R-1234yf. It has similar physical characteristics to R-134a, so its primary advantage, other than its low global warming potential, is that it can be used with existing refrigeration system designs and most of the same technology.

CHAPTER 2 - LITERATURE SURVEY

Since in the country like Lebanon, Pakistan, Turkey, Qatar, Afghanistan, there is a huge problem in dealing with the availability of clean drinking water. Since there was a report published by the U.N. in the investigation of water scarcity, it was found out to be that by the end 0f 2050 around 5 billion people are vulnerable to suffer from water scarcity depending on the rate of climate change nowadays. Also, humans consume about 4600 cubic km of water every year, 70% goes to agriculture, 20% goes to industry and the remaining 10% is consumed by households. Because of the industrial pollution contaminated the water, the problem has been worsening since the 1990s which is adding more stress to the demand of making to consume and meet their needs. But if it keeps on going with any considerations and preventive measures, dry regions will get drier, wet regions will get wetter and they will soon be a lost jewel that keeps everyone alive and living healthy. Based on such concerns, our team, just like any other environmentalist, has come up with a plan of devising an atmospheric water generator which will be working purely with the help of solar power. As water is an essential necessity for living, it is our duty as residents of this world to take care of the resources and refrain from wasting them. Qatar has experienced rapid economic growth due to the discovery and production of fuel oil and natural gas (NG). The natural renewable water resources (rainfall and groundwater [GW]) are depleted; and are estimated as 71-m^3/per year per capita in 2005. Desalination technology is finding new outlets in supplying water to meet growing municipal domestic consumption needs in water scarce countries with a per capita availability below 1,000 m^3/y. An expansion of the current municipal water desalination market was related to the population growth and the groundwater scarcity in the coming 25 years in various regions of the world: Europe, The Caribbean, Southeast and Western Asia, GCC States and North Africa. First, the current impact of desalination on the renewable groundwater resources in these selected areas was determined. Results indicated that the desalination capacity exceeds 2–10 times the renewable groundwater resources in Qatar, Kuwait, Malta and Saudi Arabia, 10–50% in Libya and Barbados, and less than 0.5% in Jordan, Yemen and Singapore.

2.1 PREVIOUS WORK

Atmospheric Water Generator Works on the same principle as a refrigerator and air conditioner i.e., on the principle of cooling through evaporation. The Atmospheric water generator works by converting atmospheric air to pressurized air using a Compressor and then this air is regarding water projects for developing and under-developed countries such as in Africa, numerous amounts of work and projects have been done to help the African people survive and meet proper nutrition. The world desperately needs alternative "water cultivation" methods and producing water from air is one of the most viable and sound solutions presented as the world's freshwater needs increase daily. This technology could meet and fill the growing demand for economical, safe, great tasting drinking water in clean drinking water is to health and wellness for people everywhere. We have designed and developed a prototype system for removing clean (potable) drinking water from the air using a traditional power grid. Use a traditional power grid to generate electricity; use electricity to cool air (or increase pressure) resulting in condensation of water; capture water vapor from air that condenses into water to obtain 99% pure and safe drinking water from the moisture in the air. Implementation of process using the most efficient and cost-effective method is also an important concern in the project. Similarly, a research paper explains how the global water challenge is the motivation to find new sources of drinking water. The Earth's atmosphere holds enormous amounts of water in the form of vapor which could serve for that purpose. Various technologies already exist, and are described here, that make use of the atmospheric water vapor as a freshwater source. Yet, for active cooling technologies, humidity harvesting is an energy intensive application, as water vapor is embedded in ambient air. Therefore, a method is introduced that uses water vapor selective membranes to concentrate the water vapor prior to the cooling process. The successful implementation of such membrane separation processes in other applications (flue gas dehydration) is described and the main challenges concerning their use in humidity harvesting are stated. The way these challenges will be dealt with is described in the outline of the thesis, where the content of the individual chapters is stated briefly. Also, An Atmospheric Water Generator is an appliance that employs dehumidification/condensing technology that extracts water from the humidity in the air. The water is then filtered and purified through several filters including carbon, reverse osmosis, and UV sterilization lights. The result is pure drinking water from the air. A then passed through Condenser pipes which decreased its temperature to dew point. The air condenses to liquid and is passed through a filtration system, and it is then stored in a tank. The major aim or objective of our project is to provide safe and clean drinking water to those areas which are facing water shortage problems or where water transportation through regular means is expensive (especially rural areas). Our project hopes to reduce this problem by providing an atmospheric water generator that will run via bicycle-gear arrangementor stand-alone renewable source of energy i.e., either solar or wind or by battery. Comparative Work for our team to get a proper insight and an approach to successfully execute a plan in building and developing our project. Since the projectwill mainly assist solar panels to power the Peltier (Thermoelectric Cooler) and thefan, below is a presentation of a comparison of how the previous projects were executed. Firstly, the paper presents the method to develop a water condensation system based on thermoelectric coolers. The system consists of cooling elements, heat exchange unit and air circulation unit. A solar cell panel unit with a relevant high current output drives the cooling elements through a controlling circuit.

Atmospheric Water Generator is a device that can convert atmospheric moisture directly into usable and even drinkable water. It is such a device which uses the principle of latent heat to convert molecules of water vapor into water droplets. It has been introduced a bit before, though it is not very common in India and some other countries. It has a great application standing on such age of technology where we all are running behind renewable sources. This paper also describes the experimental results and the system's performance [6] Secondly, a group of students conducted a senior design project which was to design and prototype an atmospheric water generator.

2.2 OBJECTIVE:

Air conditioners are great appliances that make summers more enjoyable and more bearable. Because they run during the summer when it's hot and humid, they produce condensation which comes in the form of water while in operation. Water produced by your air conditioner isn't safe to drink for humans.

It’s the result of warm air inside your home encountering the ice-cold air conditioning coils above your furnace. Water forms and gets redirected to a condensate drainpipe attached to your furnace. Because these coils and pipes are often dirty, the condensation from air conditioners shouldn’t be ingested. Condensate from air conditioners or A/C is essentially distilled water, and is low in mineral content, but it may contain bacteria. Air conditioning water can amplify Legionella bacteria and other airborne bacteria, and it has been shown to be the source of outbreaks in hospitals, motels, and cruise ships. So, think twice about drinking it. But it doesn’t mean it should go to waste. In hot, humid areas, an air conditioner can produce 18 gallons (68 liters) of water a day

– although in arid areas the gain is much more modest, maybe only one liter daily. But most often it goes to waste, dripping down to the side of buildings and evaporating away.

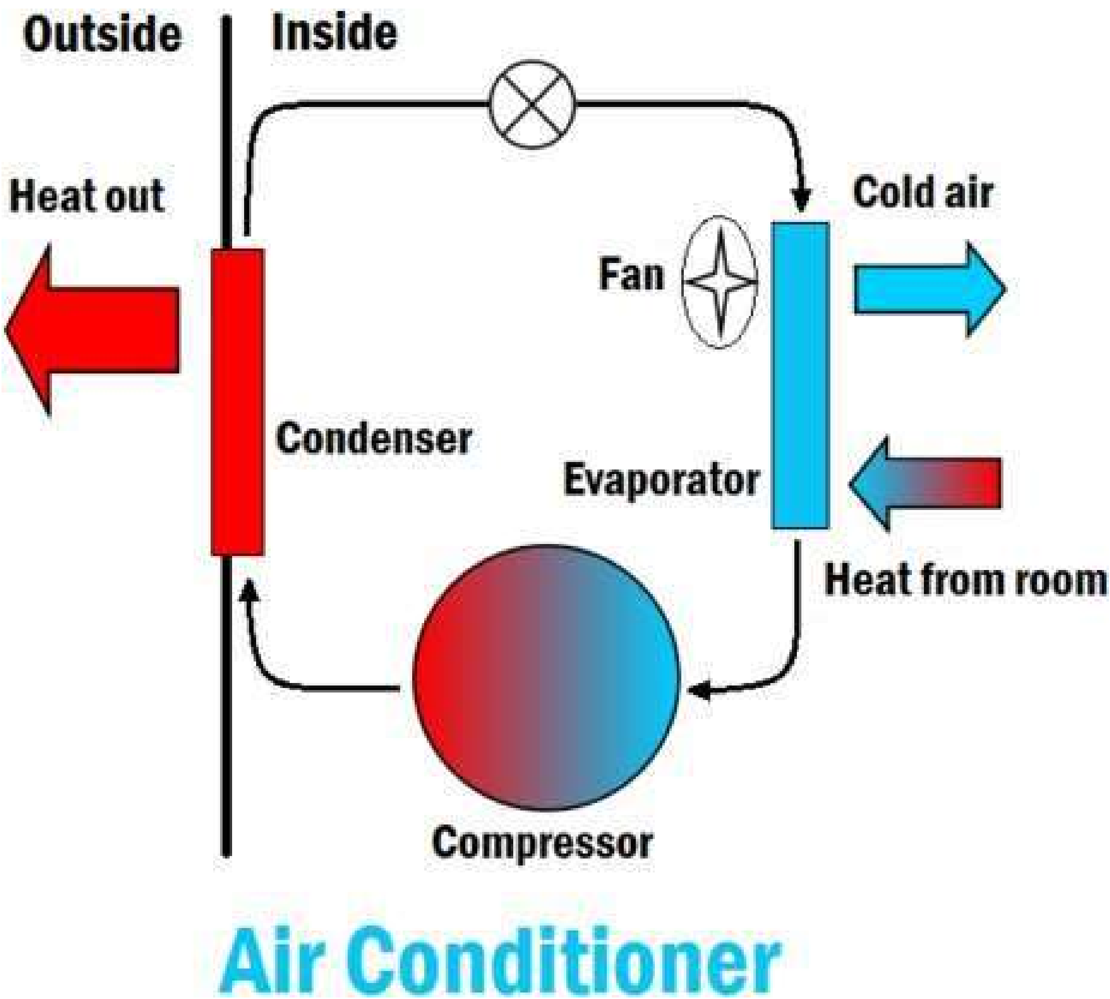
A/C drip water isn’t safe for drinking, as you can’t determine how pure it is when it leaves the A/C unit. Being basically distilled water, it lacks the essential calcium, magnesium, and potassium obtained from ordinary water sources. If filtered and sterilized, it could theoretically serve for emergencies, but wouldn’t supply the minerals humans need. But you can still use it. So, we designed a device called “portable air conditioner and water purifier” in a single device. We combined two technologies in one device. Air conditioner water can be used for Washing windows and tiled floors. A/C condensate is also the logical choice for outdoor chores like washing patio floors and garden paving, your car, and garden furniture. And plants like it. Whether you have a few potted plants on a sunny windowsill or an entire vegetable garden, go ahead and water your plants with a/c condensate. We have several of our units dripping right into the garden, Steam ironing. No need to buy distilled water for your iron; you can get it free, Washing clothes, especially delicate hand-washables, Flushing toilets. Using A/C condensate, you’ll save money on your water bills and conserve the earth’s dwindling water resources. Overhead expenses, performance and safety are all major concerns for every business enterprise that must be managed properly.

CHAPTER 3 - WORKING PRINCIPLE:

An air conditioner collects warm air from a given location, processes it with the help of a refrigerant and a series of coils within it, and then releases the cold air to the place where the hot air was initially collected. Virtually all air conditioners system works on this principle. Most people believe that an air conditioner produces fresh air with the help of machines installed inside it, which can cause it to cool a room so quickly. Hence, they ask why it consumes so much electricity. However, this is a delusion. The air conditioner is not a magic device as it follows a set of physical and chemical phenomena to cool a place very effectively when you turn on an AC and set your desired temperature around 16-32 degrees, the thermostat installed in its senses that there is a difference between the room air temperature and the temperature you choose. This hot air is drawn from the base of the indoor unit through the grille; the air flows through some of the pipes through which the refrigerant or the cooling fluid is leaking. As a result, the refrigerant liquid absorbs heat and becomes hotter than before. This way, the weather is removed from the air falling on the evaporating coil. The evaporator coil absorbs heat and expels moisture from the incoming air, which helps reduce condensation from the room. This hot refrigerant gas is then passed to the compressor located on the external unit in case of split AC. The compressor compresses the cooling gas to heat up because compressing the gas raises its heat. This hot, high-pressure gas then moves to the third section called a condenser.

3.1 Phenomena That affect the Cooling

Again, the condenser condenses the hot air vapor to become a liquid. Finally, the refrigerant reaches the capacitor in the form of hot gas but quickly becomes a cold liquid as the heat of the hot gas is transmitted to the surrounding atmosphere through metal fins. So, as the refrigerant leaves the condenser, it loses its high temperature and becomes a more cooling liquid. Then, it flows through an expansion valve - a small hole in the system's copper tubing - that controls the flow of cold liquid refrigerant into the evaporator. Hence, the refrigerant arrives at the point where its journey began. Although all the types of machinery involved in the air conditioning process in the window AC are located inside the same metal box, the basic operation of cooling remains the same. The entire process is repeated until the desired temperature is attained in the given space. In short, an AC unit draws hot air in and exits back into the room until more hot air cools. So, these AC principles can offer you to achieve optimum cooling as per the unique issue. As many as we depend on an air conditioner, it is surprising to note that they were not planned for human comfort when they were initially industrialized. The inspiration for the first modern air conditioning system was to eliminate some of the problems in the AC working principle so that the AC gives you optimum cooling because of the strict AC principle.



Air conditioners cool air through refrigeration. Inside your air conditioner are two sets of coils that are connected by a condenser. One of the coils is kept hot, the other cold. Chemicals inside the coils evaporate and condense repeatedly, cooling the coils. This in turn cools the air blowing over them. The cooled coils also force moisture out of the air; when the air condenses on the coils, it wrings water out the same way that air condensing on a cold can of soda produces moisture on the sides. Some of this water will re-evaporate and help to keep the coils cool. The rest of the water runs out of the back of the air conditioner. The condensed water produced by the air conditioner store in its water tank in which the water is purified with 5 microns spun filter followed by 1 micron spun filter and the filtered water will be passed through with UV light to kill the microbes present in the water, then the will purely edible water.

CHAPTER-4 CONSTRUCTION AND WORKING

4.1 PRINCIPLE AND WORKING

4.1.1 LIST OF PARTS

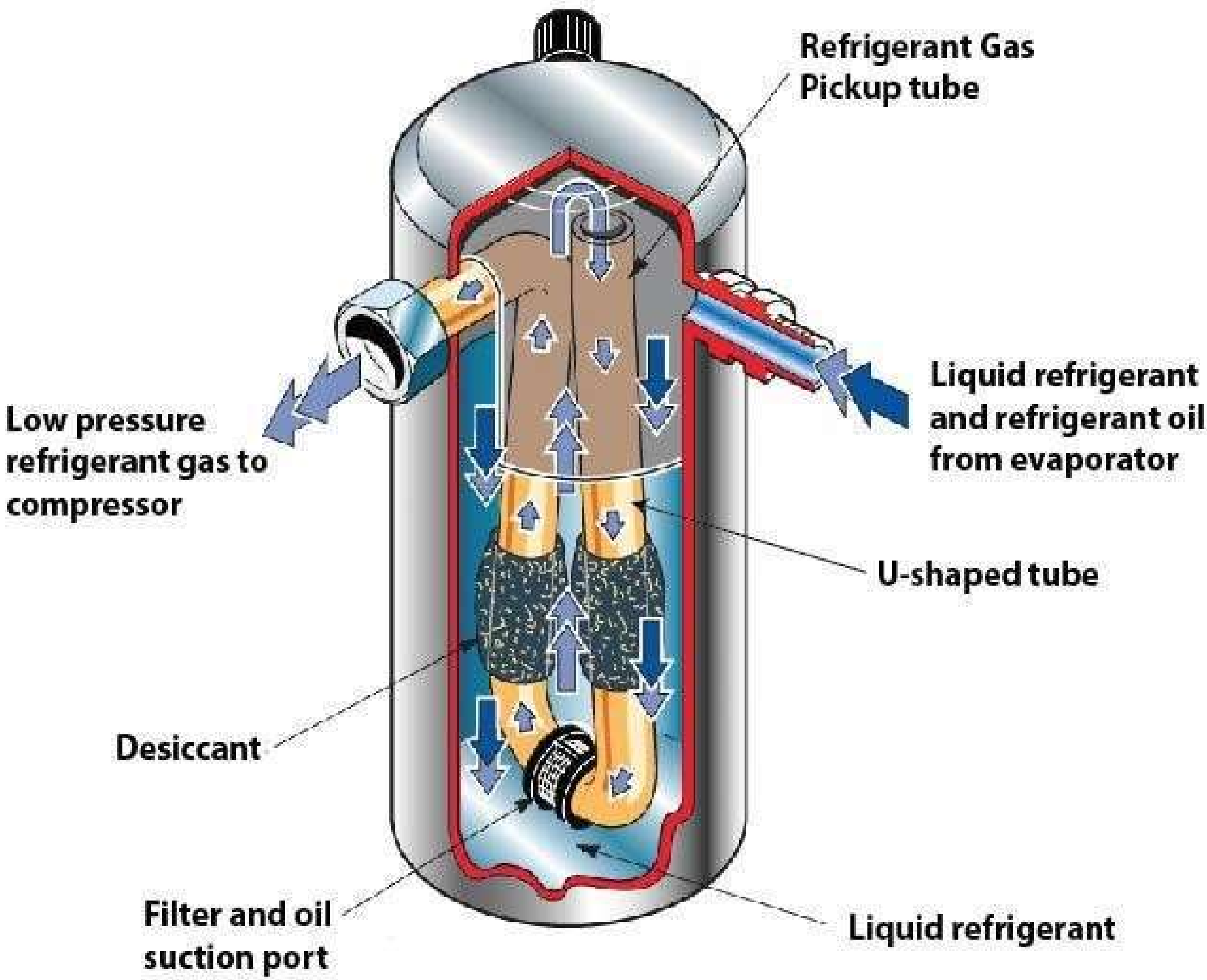
The DESIGN AND ANALYSIS Of AIR CONDITIONING COGENERATION PLANT (water purifier) is made up of several components, all of which will be discussed below.

- Accumulator
- Blower
- Condenser
- Compressor
- Evaporator
- Expansion valve
- Refrigerant-R22
- Sediment filter
- UV filter
- UV lamp with housing
- Water pump
- Thermostat
- Tank

ACCUMULATOR

Air conditioners contain a number of working parts. Each of these parts performs a function or functions essential to the operation of the entire air conditioning system or unit. The accumulator constitutes one such part. Simple descriptions define an accumulator as a tank. However, the actual functions of an accumulator prove more complex than such a description indicates – accumulators serve an essential task for air conditioning units and systems.

A bladder type accumulator, sometimes known as a hydro-pneumatic accumulator, is a metal tank that contains a rubber bladder filled with compressed gas. There is also a poppet valve in the discharge port and a gas valve used to recharge the bladder.



An accumulator is a small, cylindrical structure containing a system of pipes. An input pipe connects the accumulator to the evaporator of an air conditioning unit. An output pipe connects the accumulator to the compressor of the air conditioner. Evaporators exist as part of an air conditioner's low-pressure system, while compressors comprise part of the high-pressure system. Accumulators serve as a transition between these two systems, converting refrigerant from its low-pressure form to its high-pressure form.

Principle:

The accumulator protects the system components. It is located on the low-pressure side of the circuit between the evaporator outlet and the compressor suction port. The accumulator has different roles: To provide compressor protection, preventing compressor failure due to liquid slugging.

Working:

The accumulator can act as a receiver during the heating and defrost cycles when system imbalance or an overcharge from field service could result in excessive liquidrefrigerant in the system. The accumulator can store the refrigerant until needed andfeed it back to the compressor at an acceptable rate.

BLOWER:

The blower motor is the heating and cooling systems component that sends conditioned air from the furnace, heat pump, or air conditioner into the home. Once the system heats or cools the air, the blower motor forces it through the duct system and out the vents in rooms throughout the house.

Air conditioner blower or fan is one of the key components that is needed as part of the air conditioning system. The function of the blower is to produce air movement to the space that is being conditioned. There are basically four types of fan that are commonly used in the HVAC equipment. They are the **propeller fan**, **centrifugal fan**, **vane-axial fan** and **tube-axial fan**

In air conditioner blower where the motor capacity is 5 tons or below, direct drive permanent split capacitor motor has been used due to its better reliability and lesser parts to maintain compared to the belt driven type. The belt driven type has pulleys and fan shaft bearings that will wear off over time hence regular servicing is required. The PSC motor has a RUN winding, START winding and a RUN capacitor which are active when the motor is running. It is quiet and starts slowly before running at a steady state speed. The fan turns at the same speed as the motor and multi-speed fan can be achieved.

You can see many wires coming out of the windings of the motors for speed selection. Four fan speeds with speed ranging from 800 rpm to 1500 rpm is commonly available. By using relays to select the windings to be connected to the AC power supply, the speed of the air conditioner blower can be controlled.

Principle:

Blowers increase the pressure of the absorbed gas by a series of vortex motions formed by the centrifugal movement of the impeller. When the impeller is rotating, the channels in the impeller push the air forward by the centrifugal movement and a helical movement occurs.

Working:

It is the job of the AC blower motor to turn the fan, which causes airto move through the AC system. Among other things, this makes air move over theevaporator coils, a process which allows heat to be absorbed by the refrigerant and moved outside the house.

CONDENSER:

A condenser (or AC condenser) is the outdoor portion of an air conditioner or heat pump that either releases or collects heat, depending on the time of the year. Both split air conditioner and heat pump condensers are made of the same basic parts.

The air conditioner condenser is the outside unit that receives high-pressure, hot refrigerant from the compressor and allows it to cool by flowing through a set of coils. By the time the air reaches the end of the coils, it is still a pressurized liquid, but the heat has dissipated. Then it flows out of the condenser through a very small valve and converts back into gas.

condenser (or AC condenser) is the outdoor portion of an air conditioner or heat pump that either releases or collects heat, depending on the time of the year.

Both split air conditioner and heat pump condensers are made of the same basic parts. The condenser cabinet contains the condenser coil, a compressor, a fan, and various controls. The condenser coil can be made of copper tubing with aluminum fins or all-aluminum tubing so heat can be rapidly transferred

Principle:

A condenser is designed to transfer heat from a working fluid (e.g. water in a steam power plant) to a secondary fluid or the surrounding air. The condenser relies on the efficient heat transfer that occurs during phase changes, in this case during the condensation of a vapor into a liquid.

Working:

A condenser is designed to transfer heat from a working fluid (e.g., water in a steampower plant) to a secondary fluid or the surrounding air. The condenser relies on theefficient heat transfer that occurs during phase changes, in this case during the condensation of a vapor into a liquid.

COMPRESSOR:

A compressor is the engine of an air conditioning system. It's the part that changes the refrigerant from a cool, low-pressure liquid to a hot, high-pressure gas, and then back again.

The compressor is housed within the condenser unit and the component that starts the chain reaction cools the refrigerant. It should be noted that heat moves toward cooler areas. When the room temperature air passes through the evaporator unit, heat is eliminated from the air. The heat from the air passes along to the refrigerant, which is then fed into the compressor.

The refrigerant is then compressed, which condenses into a fluid, and is then released under pressure. At this point, the refrigerant is much hotter than when it came in, but the heat is then dissipated through the condenser coils. By the time it reaches the end of the loop, the refrigerant is cold again and fed into the evaporator coils. This cycle continues as long as the air conditioner is turned on. Certain HVAC systems feature compressors that reverse the process, the output becomes hot air instead of cold.

Principle:

The air conditioner's compressor works by compressing refrigerant vapour, which increases its pressure and turns it into a hot gas. The cooling/condensing of the hot gas is achieved by drawing ambient air through the condensing coil using a fan, which leaves as hot air.

Working:

The compressor is the "heart" of a refrigerator. It circulates the refrigerant throughout the system and adds pressure to the warm part of the circuit and makes the refrigerant hot. It's similar to when you are pumping air into a bicycle tube - you can sense a heat increase in the pump while you compress the air.

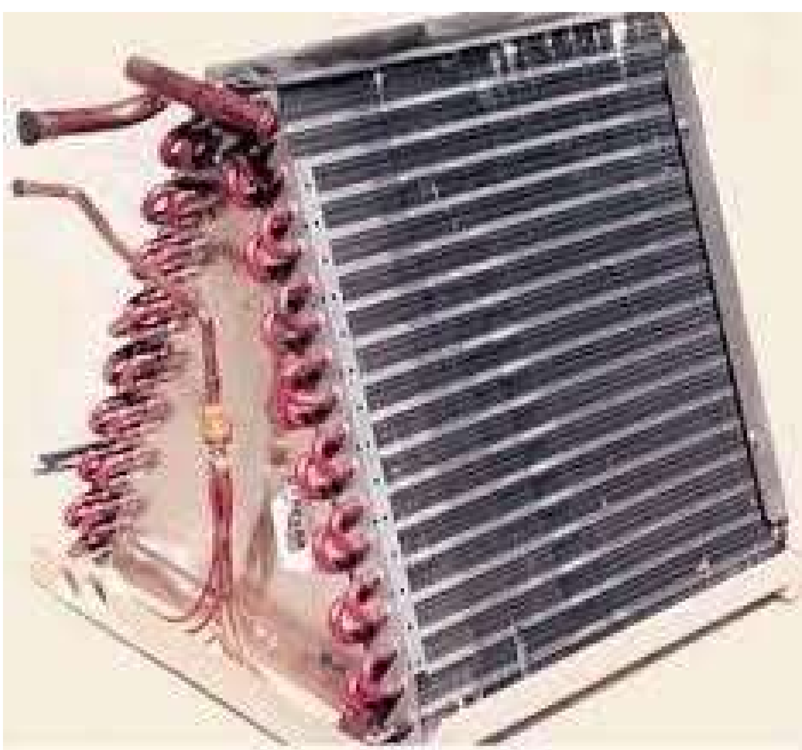
EVAPORATOR:

In refrigeration, an evaporator is the heat exchanger where the refrigerant circulating inside the refrigeration circuit absorbs the thermal energy from the environment, which is then cooled. This is how the state of the refrigerant changes from liquid to vapor, giving it its name.

Located inside the blower compartment or air handler, the evaporator coil holds the chilled refrigerant that the compressor moves into it.

As the air from the blower fan moves over the coil, the cold refrigerant removes the heat from your home's air. The refrigerant becomes warmer and travels to the condenser coil outdoors.

With a heat pump, the process reverses in the winter and the evaporator coil expels heat from the refrigerant into your home, instead of absorbing it and taking it outdoors. Most heat pumps have auxiliary heating elements that are part of the evaporator coil components to supply heat when temperatures fall below a certain point.



Principle:

The operation is based on gravity. The air cooled in the evaporator, which is colder and denser than the ambient air, flows downwards, circulating the air in the space being cooled. The evaporator block is made of copper pipes and aluminum fins at a spacing of 7–10 mm. This ensures sufficiently low flow resistance.

Working:

The function of evaporator is to absorb heat from surrounding location or medium which is to be cooled by means of refrigerant. The refrigerant either boils as it flows through a pipe, tube or other type of space so that liquid is continuously wetting all the inside surface, or it boils in a shell around submerged tubes through which the fluid to be cooling is flowing. Various methods are used for evaporators, depending upon the refrigerant to be used and evaporator application, but iron, steel and copper predominate.

EXPANSION VALVE:

- The expansion valve reduces the pressure of the refrigerant fluid upstreamof the evaporator. This drop in pressure cools the fluid, it is then sprayed into the evaporator. The expansion valve is always attached to the evaporator.
- The expansion valve for Air Conditioner has a few different roles:
- It controls the drop in pressure in the A/C system needed to evaporate the refrigerant and generate cold
- It controls the flow rate of the fluid in the evaporator
- It controls the evaporator output temperature (superheating)

- The expansion valve is located downstream of the receiver drier in the A/C loop.
- The expansion valve receives the refrigerant fluid in an already-filtered, 100% liquid state. It then reduces the refrigerant fluid

pressure before it enters the evaporator.
- This pressure drop cools the fluid, which is then sprayed into the evaporator. The expansion valve for car A/C is always attached to the evaporator.

Principle:

Whenever the bulb senses an increase in suction line temperature, the liquid expands, increasing the pressure in the fixed volume, and pushes the diaphragm down, thereby opening the valve and allowing more liquid refrigerant into the evaporator.

Working:

A thermostatic expansion valve (TXV) (see Figure 1) is a refrigeration and air conditioning throttling device that controls the amount of refrigerant liquid injected into a system's evaporator—based on the evaporator outlet temperature and pressure—called the superheat. Figure 2 shows the different phases and pressures the refrigerant goes through as it is pumped through the system, moving through the evaporator, the compressor, the condenser, and the throttling device which injects liquid refrigerant into the evaporator before it moves into the compressor.

R22 REFRIGERANT:

R22 refrigerant is one specific type of refrigerant, which is the main chemical your HVAC system uses to cool your home. Generally speaking, all kindsof refrigerants run through your air conditioner or heat pump, and they continuouslyabsorb and release heat in order to cool your home.

Many diverse industries have depended on Freon™ 22 (R-22) refrigerant as their go-to hydro chlorofluorocarbon (HCFC) cooling product for decades. It's been the most widely used choice for air conditioning (AC) and medium- to low-temperature commercial refrigeration because of its dependability—and because it works.

If your home's air conditioning unit is more than 10 years old, there's a good chance it uses R22, commonly known as "Freon." R22 is an A/C refrigerant — a substance used for cooling in air conditioners— that was once widely used in air conditioning units in homes and businesses alike. But, after years of using R22 in air conditioning units of all sizes, it was discovered that R22 is a dangerous chemical that was significantly contributing to the thinning in the ozone layer.

Principle:

R-22 (also known as HCFC-22) is an ozone-depleting refrigerant which has been widely used in home air conditioning systems and its supply is now being phased out in response to the Montreal Protocol.

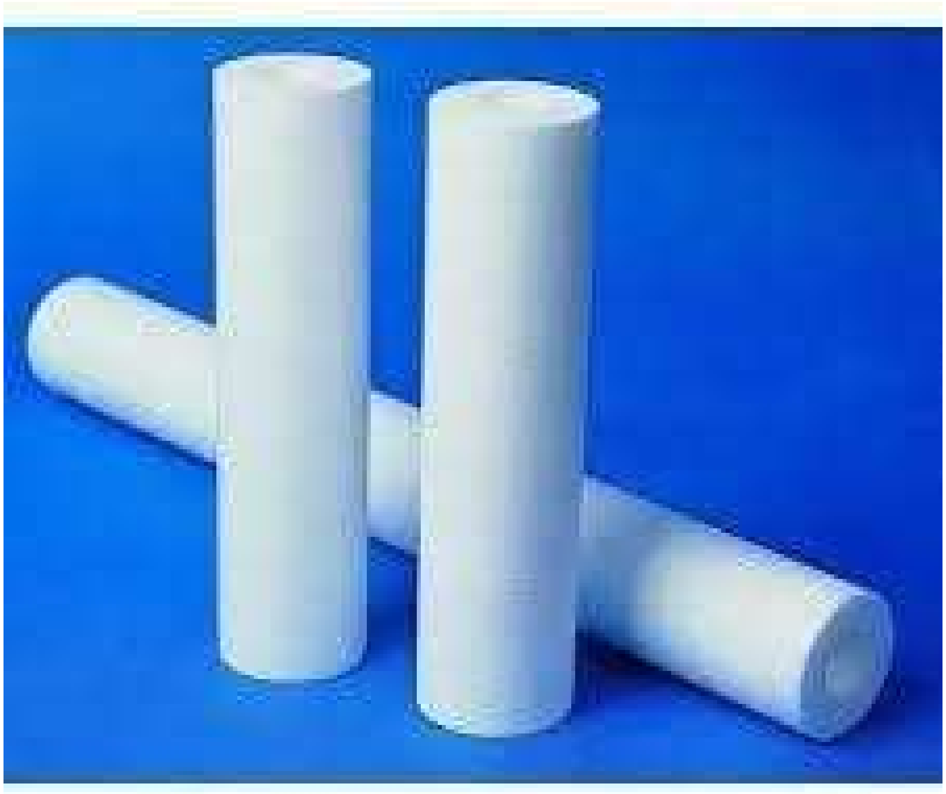
Working:

R22 refrigerant is one specific type of refrigerant, which is the main chemical your HVAC system uses to cool your home. Generally speaking, all kinds of refrigerants run through your air conditioner or heat pump, and they continuously absorb and release heat in order to cool your home.

SEDIMENT FILTER:

As the name suggests, a sediment filter acts as a barrier against different types of sediments or suspended solids. It sieves or holds back physical impurities like dust, slit, and other solid particles

Sediment filters remove suspended matter such as sand, silt, loose scale, clay, or organic material from the water. Untreated water passes through a filter medium, which traps suspended matter on the sur- face or within the filter.



Principle:

Sediment filters remove suspended matter such as sand, silt, loose scale, clay, or organic material from the water. Untreated water passes through a filter medium, which traps suspended matter on the sur- face or within the filter.

Working:

A sediment filter captures and removes particulate matter like dirt and debris from your water. Sediment is a generic term for all the particulate matter in your water that is not liquid. Flakes of rust can enter your water supply from corroded galvanized plumbing. Rainwater can carry silt, clay, soil, and grains of sand into your well groundwater supply. Flow changes in your water main can also transport sediment to your home. The sediment filter is the first line of defense against this dirt and debris. It prohibits all this solid particulate from entering your water supply and impeding the performance of your water filtration systems.

Sediment filters exist in a multitude of applications. Restaurants and coffee shops use sediment prefilters to ensure the quality of their food and beverages. Whole house filtration systems employ sediment filtration to eliminate particulate matter from entering your faucets and showers and to protect the lifespan of other filters. Your pool filter cartridges are a form of sediment filter, blocking dirt and clay from muddying your pristine swimming water. Any instance in which clean water is imperative, you will likely find some form of sediment filter.

UV FILTER:

A UV water purifier treats micro-biologically unsafe water with germicidal ultraviolet light. The UV wavelength scrambles the DNA of living organisms in the water, so they can no longer reproduce and make you sick. If you drink bacteria-infested water, the organisms can embed in your digestive tract and replicate. Ultraviolet radiation renders bacteria, viruses, parasites, and fungi unable to replicate by damaging the nucleic acids of their DNA.

A UV water purifier exposes living organisms, such as bacteria, viruses, or cysts (like Cryptosporidium and Giardia) to a germicidal ultraviolet wavelength. With enough energy, UV radiation at the 254-nm wavelength disrupts the DNA in pathogenic microorganisms so they cannot reproduce. The ultraviolet light prevents bacteria from spreading disease through drinking water. UV dosage is the measurement of energy (in mg/cm^2) delivered by a UV water purifier. The more dosage provided; the more energy delivered to treat contaminated water. At a certain threshold, this energy becomes sufficient to inactivate most of the microorganisms present in water

Principle:

Using a RO water purifier for low TDS input water, say less than 200 ppm, may be detrimental to your health in the long run, as the water is stripped of essential minerals and salts. UV water purifier kills bacteria and viruses but does not remove dissolved impurities such as pesticides, rust, arsenic, fluoride, etc.

Working:

In a UV water filter system, UV (Ultraviolet) rays kill the harmful bacteria from the water. Hence the water is completely disinfected from pathogens. The UV water purifier is good for health because it kills all the harmful microbes present in the water without affecting the taste.

WATER PUMP:

A water pump is an electromechanical machine used to increase the pressure of water to move it from one point to another. Modern water pumps are used throughout the world to supply water for municipal, industrial, agricultural, and residential uses.

Exposure to UV radiation can cause damage to your skin, especially if you're exposed over time. For example, it can lead to premature wrinkles, age spots, and even skin cancer. But the FDA views nail curing lamps as low risk when used as directed by the label.

Cooling water pumps (CWP) provide the fresh water to cool the exhaust steam in the condenser and pump it back to the wet cooling tower or the outlet of open cooling system. The major characteristic of the CWP is their high flow.

When the pressure between the drive part and the output liquid part reaches equilibrium, the booster pump stops running and no longer consumes air. When the output pressure drops or the air drive pressure increases, the booster pump will automatically start running until the pressure balance is reached again, and it will automatically stop.

A single air-controlled unbalanced gas distribution valve is used to realize the automatic reciprocating motion of the pump, and the air drive part of the pump body is made of aluminum alloy. The wetted part is made of carbon steel or stainless steel according to different media.

Generally, the pump has two ports for air intake and exhaust. The air pressure that can produce air pressure lower than normal pressure (ie atmospheric pressure) at the air inlet is called "negative pressure"; the air pressure that can produce air pressure higher than normal pressure at the air outlet is called "positive pressure". For example, the vacuum pump is often referred to as a negative pressure pump, and the booster pump is a positive pressure pump. Positive pressure pumps are very different from negative pressure pumps. For example, the gas flow direction, the negative pressure pump is that the external gas is sucked into the exhaust nozzle; the positive pressure is ejected from the exhaust nozzle; such as the level of air pressure, etc.

Principle:

The booster pump is driven by the low pressure gas (2-8bar) of the large area piston to generate high pressure gas/liquid on the small area piston. It can be used for compressed air and other gases, and the output air pressure can be adjusted steplessly by driving the air pressure. Gas pipeline booster pump has single-acting pump and double-acting pump. The double-acting pumping piston compresses the gas on both strokes of the reciprocation. When the driving gas acts on the gas piston, the working piston can be driven with the gas to obtain a larger output flow.

Working:

The working principle of the gas-liquid booster pump is similar to that of a pressure booster, which applies a very low pressure to the large-diameter air-driven piston. When this pressure acts on a small-area piston, a high pressure is generated. The booster pump of the water purifier can run continuously through a five-position, two-position air-controlled reversing valve. The high-pressure plunger controlled by the one-way valve continuously discharges the liquid, and the outlet pressure of the booster pump is related to the air driving pressure.

THERMOSTAT:

Thermostat, a device to detect temperature changes for the purpose of maintaining the temperature of an enclosed area essentially constant. In a system including relays, valves, switches, etc., the thermostat generates signals, usually electrical, when the temperature exceeds or falls below the desired value. It usually is used to control the flow of fuel to a burner, electric current to a heating or cooling unit, or of heated or cooled gas or liquid into the area it serves. The thermostat is also an element in some types of fire-detection warning systems.

Thermostat is a regulating device component which senses the temperature of a physical system and performs actions so that the system's temperature is maintained near a desired set point.

Thermostats are used in any device or system that heats or cools to a setpoint temperature. Examples include building heating, central heating, air conditioners, HVAC systems, water heaters, as well as kitchen equipment including ovens and refrigerators and medical and scientific incubators. In scientific literature, these devices are often broadly classified as thermostatically controlled loads (TCLs). Thermostatically controlled loads comprise roughly 50% of the overall electricity demand in the United States.

A thermostat operates as a "closed loop" control device, as it seeks to reduce the error between the desired and measured temperatures. Sometimes a thermostat combines both the sensing and control action elements of a controlled system, such as in an automotive thermostat. The word thermostat is derived from the Greek words θερμός thermos, "hot" and στατός statos, "standing, stationary".

Principle:

The instrument can send electrical signals to maintain the optimum temperature. They are based on the principle of thermal expansion, which means the matter will expand on heating and will shrink on cooling. Thus, this phenomenon will help in switching on and off the circuit.

Working:

The mechanism of Thermostatic Mixing Valves is a basic waxthermostatic principle which limits the quantity of hot water and cold water by blending. Also, if the temperature rises above the requirement point then the mixing valves automatically shut down thus preventing extra hot water from flowingthrough the pipe.

UV LAMP WITH ALUMINIUM HOUSING:

They are often used to disinfect and also treat water. Hospitals often used them to sterilize equipment quickly and effectively. Uv lights are also in your heating and cooling system. The UV light is used to sterilize the aireven more than a simple filter can.

Phototherapy UV lamps treat a host of medical conditions such as variety of skin conditions, mood disorders and successfully treat neonatal jaundice. Some of the most common applications of UV light for medical use include effective treatment for many skin conditions including acne, eczema.

Exposure to UV radiation can cause damage to your skin, especially if you're exposed over time. For example, it can lead to premature wrinkles, age spots, and even skin cancer. But the FDA views nail curing lamps as low risk when used as directed by the label

Most of the UV lamps in HVAC equipment are “stick type” lamps that can be installed inside the equipment and wired into the same electricity as the HVAC unit itself.

It is important to install the UV lamp where it will do your unit the most good. That means selecting a place where the UV light will shine directly on the unit’s coils. The parts of your HVAC unit that are not directly in the UV light will still grow contaminants.

Some HVAC units are manufactured with UV lamps already in place, but others can be retrofitted with a UV lamp.

Principle:

A UV lamp artificially creates UV light so it can be put to various uses, such as sterilizing and purifying. UV lamps come in many different sizes and shapes, allowing them to be used for various purposes, such as detecting counterfeit money, inspecting artwork, or by a ticket agent checking your re-entry stamp at a concert.
A UV lamp is different from a regular lamp because it’s typically made of quartz instead of glass. Inside, there is an inert gas mixed with mercury. When the lamp is plugged in, electricity reacts with the mercury, and the lamp produces UV light. The type of UV light emitted depends on the pressure inside the lamp. Not all UV lamps produce the UV-C germ-killing wavelength.

Working:

The principle of UV visible spectroscopy is based on the absorption of ultraviolet light or visible light by chemical compounds, which results in the production of distinct spectra. Spectroscopy is based on the interactionbetween light and matter.

TANK:

Aqua guard purifiers are designed for high water saving and retention of natural minerals. They can remove physical impurities, chemicals, pesticides, biological contaminants and heavy metals (lead, mercury, arsenic) to give pure and healthy drinking water.

PURPOSE OF TANK

The UV light of the tank attracts the genetic core or DNA of the micro-organism that are responsible for causing various water borne diseases like flu, cholera, hepatitis, typhoid, etc. This destroys their ability to reproduce and multiply. Its 4-stage purification system makes it a perfect choice to bring it home.

CHAPTER 5 - COMPONENTS

5.1 MATERIALS USED

- Chimney aluminum pipes
- PVC flexible pipes
- Connector
- Thermacol

5.2 ASSEMBLY

The above-mentioned parts are used in assembly and used in required numbers.

- Plastic
- Thermacol
- Aluminum

5.3 ANALYSIS

We had to make sure to utilize all our knowledge and to challenge ourselves to see how much we have learnt over the past few years. This also includes, that we had

to undergo some of the difficulties we weren’t ready to encounter but that is how we would be able to fight back strong and accomplish the goals we managed to set for over these three months of pure dedication and hard work. Furthermore, it has and will refine us as a person because we gained the knowledge of how to lead a team and completely abide by the timelines set for each task and with all due respect, it has been extremely helpful for us now and in our future.

5.4 HARDWARE SKILLS:

To conduct and perform experimental tests, we have managed to successfully make use of hardware equipment such as a humidity meter to measure the moisture contentto give us an idea of how effective water production is going to be. Moreover, as a hardware device, digital thermostat was also used for the sake of properly detecting and varying the temperature within the compartment for proper temperature to facilitate humidity.

5.5 TIME MANAGEMENT:

We had about three months of total time to complete the project, we really needed to manage our time in an efficient manner to be ahead of time for unpredicted difficulties and obstacles we might face. Thankfully, all group members were in close contact, and everyone was on the same page when making decisions, which really helped with cutting time and completing work more effectively than planned. We divided works equally and was in full focused at the work, we kept ourselves unoccupied during these days for completion of work. We all without any hesitation done field work and this makes us understand the concept well and made us fully involved without any doughtness.

5.6 PROJECT MANAGEMENT:

In achieving something of this big task as our project, we needed a proper plan and time management so every task can be accomplished in a timely fashion. It also shows us the properly managed teamwork among us all as a group because without proper communication, understanding, dedication and commitment with responsibility it was not possible to achieve the number of goals set for us and our group.

5.7 SOCIETY:

As the project we selected already was biased towards many people being unable to consume clean drinking water in most of the developing or underdeveloped countries globally, we ensured that our project can be constructed in such a way that it requires very less financial support to produce. Once produced successfully, the common majority can drink the water being generated from the humidity present in the surrounding atmosphere.

5.8 ECONOMY:

Similarly, the amount of money spent on this project is not too much for a prototype. But it can be refined a lot for just the fraction of amount we have used to make this prototype possible. With more refined tuning and proper optimization of the system, it would be a great deal of worth for what we have achieved to solve the world thirst for water.

5.9 ENVIRONMENT:

Since our project is to serve humanity in trouble and deficiency of water, we have already taken care of the environment as well as it does not really produce any pollutants and does not even produce waste that would harm the environment. Instead, it uses the environmental source i.e., humidity present in the air to condense and generate water which I guess is very environmentally friendly and one of the very effective ways to contribute to saving the environment and mankind from thirst in one go.

CHAPTER 6

IMPACT OF AIR CONDITIONING COGENERATIONPLANT

6.1 ADVANTAGES

- No moving part, so maintenance is required less frequently
- No use of chlorofluorocarbons.
- Temperature control within fractions of degrees can be maintained
- Can be used in environments that are smaller or more severe than conventional refrigeration.
- Has a long life, Flexible shape Controllable via changing the input 12 voltage/current very easily.
- Draw comparatively low current than a compressor-based refrigeration system

6.2 MERITS

The atmospheric water generator using Peltier effect is a device used to generate the water from the humid air in our atmosphere much amount of humid air is available it contains large amount of water this amount of water can be used by implementing a device like Atmospheric Water Generator. This technology is far less commonly applied to refrigeration than vapor compression refrigeration is. The primary advantages of a Peltier cooler compared to a vapor-compression refrigerator are its lack of moving parts or circulating liquid, very long life, invulnerability to leaks, small size, and flexible shape.

CHAPTER 7 – Calculations

7.1 EXPERIMENT DATA

Date: 08/03/2023 Unit Capacity: 2 TR Model no: GS-24V/I

Location: Chennai Metropolitan water supply and sewerage board, kilpauk.

7.2 Typical Calculation for Condensed Water (Theoretically Calculated)

- Initial Condition: Dry bulb temperature (DBT) = 300 C Wet bulb temperature (WBT) = 27.50 C Relative humidity (RH) = 84%

- Final Condition: Dry bulb temperature (DBT) = 28.70 C Wet bulb temperature (WBT) = 26.50 C Relative humidity (RH) = 79%, Air Flow Rate, V= 1000 m3 /hr. By using this data, from Psychrometric Chart Specific volume of air, Vs = 0.87 m3 /kg dry air, Specific humidity in InitialCondition, W1= 0.0229 kg/kg of dry air Specific humidity in Final Condition, W2= 0.0199 kg/kg of dry air.

Calculations

Amount of Water Condensed

= (W1 -W2) ma [Where, ma is mass of air]

= (W1 -W2) V/Vs

= (0.0229-0.0199) (16.67/0.87) kg/min

= 0.0574kg/min

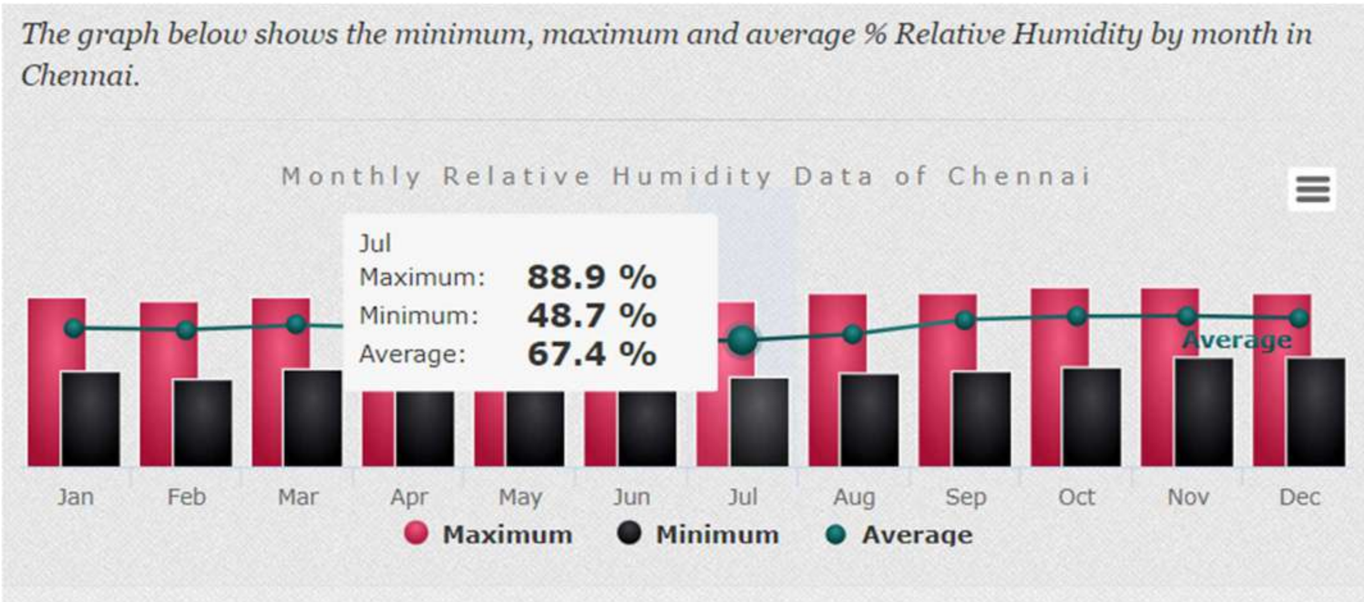
= 1.124 kg/20min= 1124 ml/20min = 3372 ml/hr.

Relative Humidity table:

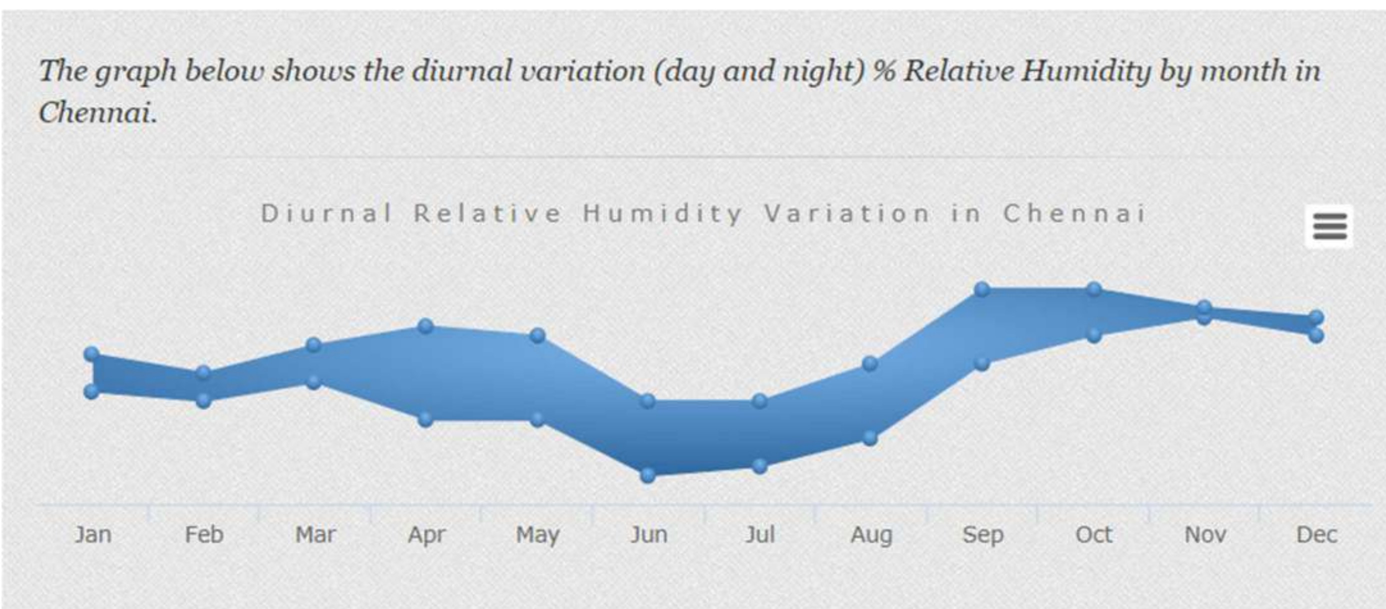
The table below shows the minimum, maximum and average % Relative Humidity over the year in Chennai.

Parameter	Relative Humidity, %			
	Minimum	Maximum	Average	Stantard Deviation
January	51.7	91.3	74.2	± 10.2
February	47.1	89.1	73.4	± 9.9
March	52.1	90.8	75.7	± 10.1
April	54.3	89.2	74.2	± 9.3
May	48.2	86.2	73.2	± 8.8
June	41.7	87.0	67.1	± 10.3
July	48.7	88.9	67.4	± 9.2
August	50.4	92.7	71.0	± 10.2
September	51.4	93.1	78.7	± 8.6
October	53.6	96.6	80.3	± 8.6
November	59.1	96.9	80.6	± 8.3
December	59.1	93.4	79.6	± 7.0

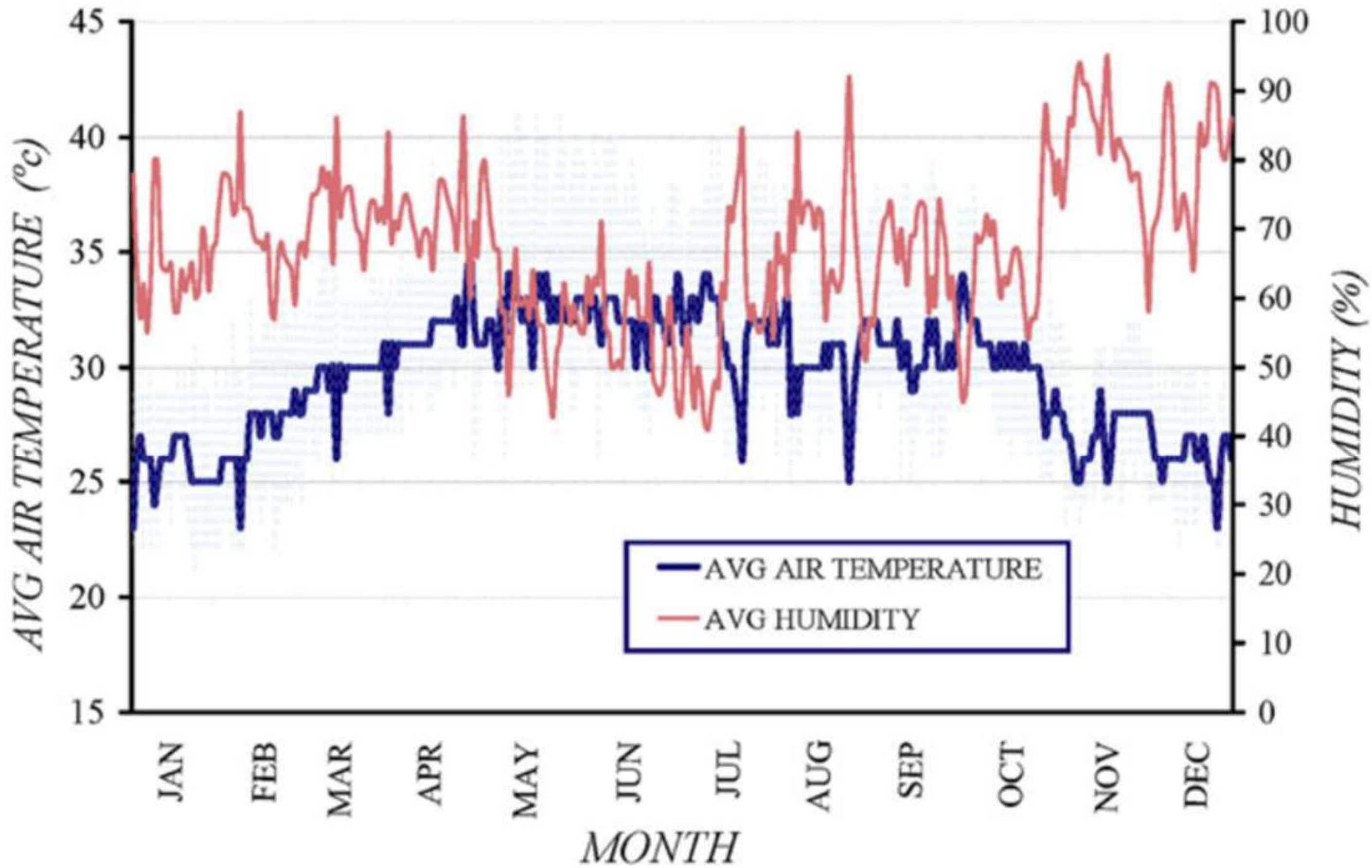
Monthly Relative Humidity of Chennai



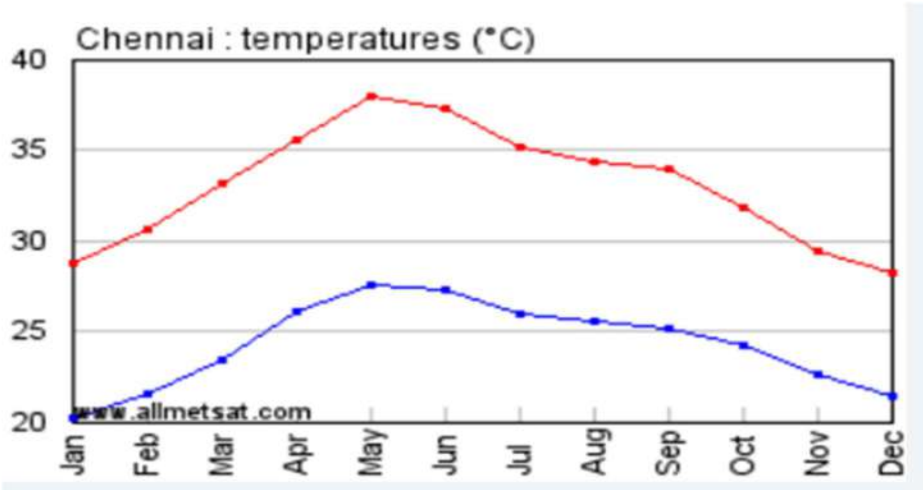
Diurnal variation



Annual average values



Annual average values of T a and RH for Chennai city.



7.3 Typical calculation of mass of water removed by air conditioning condensation

Relative humidity= (actual pressure of H_2OH_2O pressure/partial pressure of H_2OH_2O if saturated) * 100
So, my first step was to find the actual pressure of the initial and final conditions.
X/355.1=0.80
X=284.08 Torr
Then X/23.76=0.15
X=3.564
284.08 Torr−3.564 Torr=280.516 Torr (water removed,)

Step I) Assemble parameters applicable before and after cooling:
R= gas constant =8.31 m^3 bar mol^{-1} K^{-1}
V=245 m^3
MW_{water}=18.0 g mol^{-1}
n=PV/RT

Step II) Calculate water mass before cooling:
$T=33\ ∘C=306\ K$
$P_{saturation}=50.3$ mbar (1)
$P=80\%$ of $P_{saturation}=40.2$ mbar
$n=0.0402\ bar\ ˙245\ m38.31\ m3\ bar\ /8.31\ m3\ bar\ mol-1\ K-1\ ˙306\ K=387\ mol\ H2O$
$387\ mol\ H2O\ ˙18.0\ g\ mol-1=6.97\ kg\ H2O$

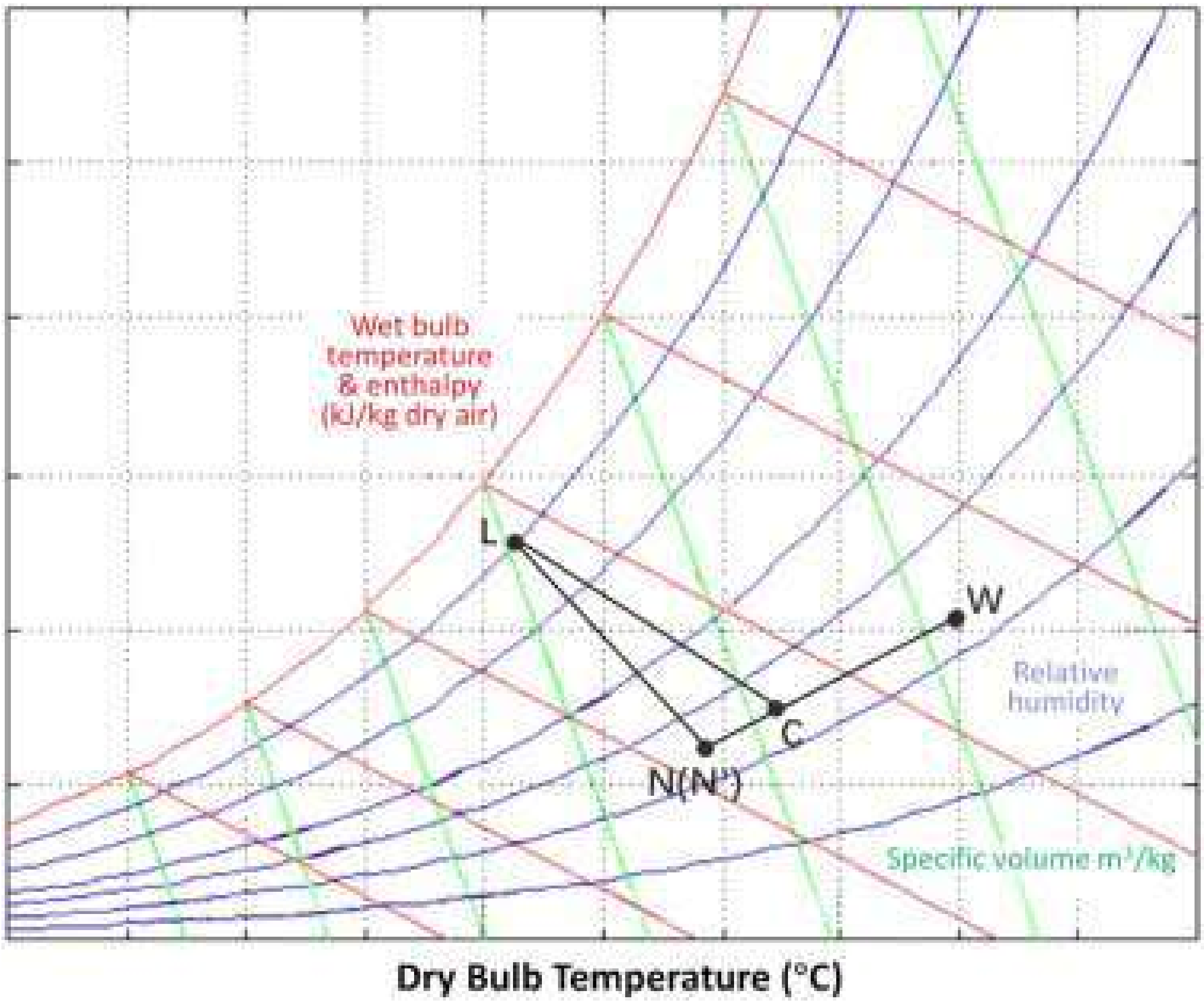
Step III) Calculate water mass after cooling:
$T=25oC=298\ K$
$P_{saturation}=31.7$ mbar(1)
$P=15\%$ of $P_{saturation}=4.76$ mbar
$n=0.00476\ bar\ ˙245\ m3/8.31\ m3\ bar\ mol-1\ K-1\ ˙298\ K=47.9\ mol\ H2O$
$47.9\ mol\ H2O\ ˙18.0\ g\ mol-1=0.862\ kg\ H2O$

Step IV) Calculate total water removed from the house:
$6.97\ kg\ H2O-0.862\ kg\ H2O=6.11\ kg\ H2O$

7.4 Calculate Feasibility of Condensate Water

7.4.1 Theoretical calculation of the condensate water

Theoretical analysis was further done to calculate the condensate production of a comparable SAHU for a 30-day course timetabling from 8:00–18:00 in June, which is the main air-conditioning season for university buildings. Figure showed the air-conditioning process on the psychometric chart. Fresh air (*W*) went into the room through gaps of doors and windows, and then was mixed with the indoor air (*N*) in a certain proportion to the point *C* in the air conditioner. The mixed air was cooled and dehumidified by the evaporator to the dew point temperature *L* and reached the indoor set point *N'*after the air supply. The moisture evaporation of indoor occupants did not be considered in the calculation because of the unmanned air-conditioned rooms with closed doors and windows in the measurement.


Wet bulb
temperature
& enthalpy
(kJ/kg dry air)
L
W
Relative
humidity
C
N(N')
Specific volume m³/kg
Dry Bulb Temperature (°C)

The mixing processes of outdoor and indoor air were calculated by Eq.(1) and (2).

$$d_c = m \times (d_w - d_n) + d_n \tag{1}$$

$$h_c = m \times (h_w - h_n) + h_n \tag{2}$$

According to the cooling capacity calculated by Eq.(3), the enthalpy value of the dew point L could be expressed by Eq.(4).

$$Q = \frac{\rho G(h_c - h_l)}{3600} \tag{3}$$

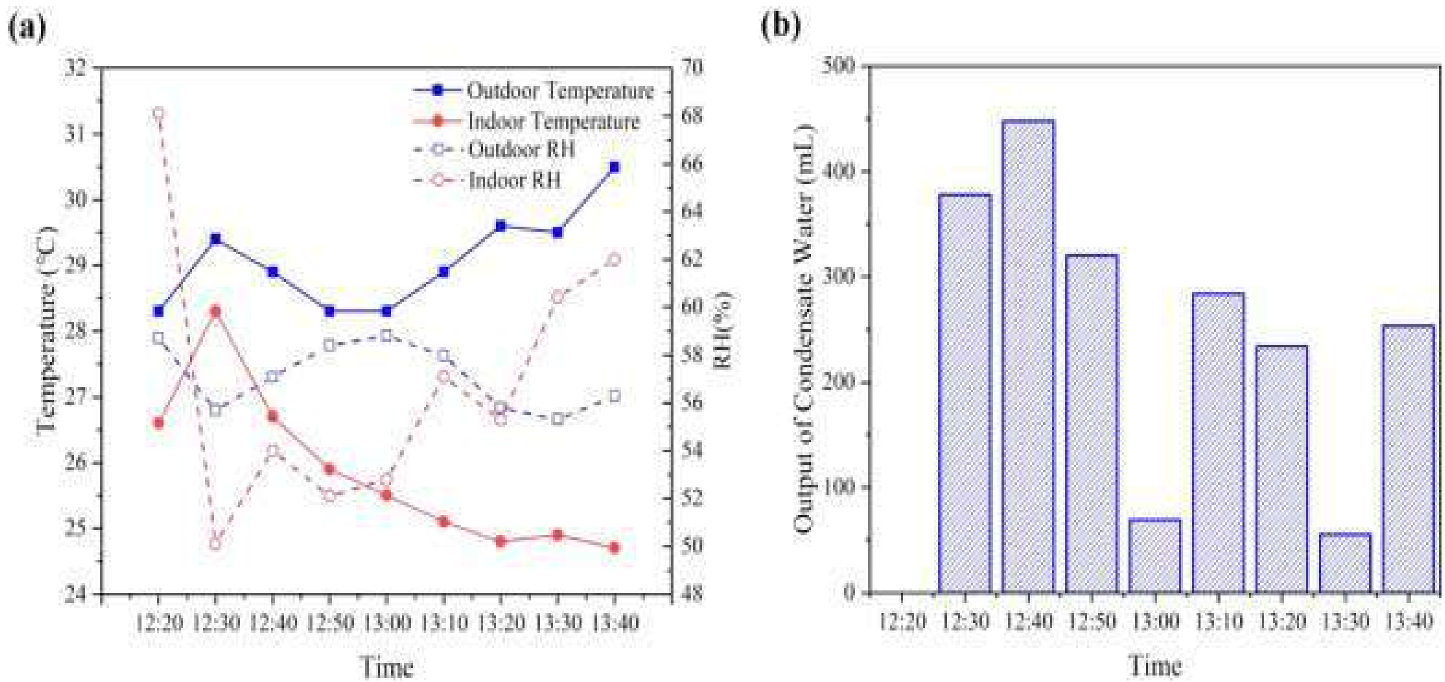
$$h_l = h_c - \frac{3600Q}{\rho G} \tag{4}$$

The specific humidity of point L could be calculated when taking the relative humidity of L as 95%, and the output of the condensate water could be obtained by Eq.(5).

$$M = \rho G(d_c - d_l) \tag{5}$$

7.4.2 Experimental and calculation results

Figure presents the variations of the test values during the measurement. The outdoor air temperature varied between about 28.0 °C - 31.0 °C, with a maximum range difference of 2.2 °C. The maximum indoor air temperature was 26.7 °C at the initial time. After starting air conditioning, the indoor air temperature was reduced from 26.7 °C to 24.7 °C. The indoor air temperature was lower than the outdoor air temperature at about 12:48 The outdoor relative humidity fluctuated between 53.3% and 58.8%, while indoor relative humidity gradually increased to 62.0% after air conditioning. The compressor in the SAHU stopped and started frequently in practice, resulting in the intermittent generation process of condensate water. Table 2 showed the operating condition of the SAHU during the measurement. There were four work intervals during the operation of the air-conditioning, which caused the stop of the compressor. Therefore, the condensate water output rate decreased, and the output reached the lowest value at 13:00 and 13:30. Figure showed the amount of condensate water generated during the test. The measured total output of air conditioning condensate water in one hour was 1.6 kg. The average production rate of condensate water was 22.68 mL/min. The laboratory results showed that the average water temperature was 13 °C, and the pH value was about 8. The quality was acceptable for domestic or industrial applications but not suitable for human consumption, so that the condensate water collected was of great value in the gray water recycling system in university buildings. During the measurement, impacts of weather conditions on the condensate water production could be found. When the SAHU was working normally, there was a large amount of condensate water production with large temperature and relative humidity differences between indoor and outdoor air. When the difference between indoor and outdoor relative humidity was small, the condensate water production was small even with a large temperature difference between indoor air and outdoor air.



The variations of the test values during the measurement

((a) dry-bulb temperature and relative humidity;

(b) production of the condensate water).

Time	Working state
12:40–12:48	Operating
12:48–12:56	Interval
12:56–13:03	Operating
13:03–13:11	Interval
13:11–13:18	Operating
13:18–13:28	Interval
13:28–13:34	Operating
13:34–13:40	Interval

Moreover, the condensate water output in June, which was the main air-conditioning season of university buildings, was calculated through the theoretical methods which was validated by the measurement. In the calculation, the atmospheric pressure was set at 101,325 Pa, the indoor air dry-bulb temperature was 26 °C, and the relative humidity was 50%. The weather data were obtained from the weather station. Through consulting the campus management department, the calculation period was 8:00 −18:00 each day because of the course schedule. Figure represents the theoretical condensate water output of a SAHU in June. The output of a SAHU could reach 1589.7 kg in June, with average daily output of 52.99 kg. A total number of 300 air conditioners were operated during the cooling seasons on the tested campus. Therefore, the total condensate water output could reach about 476,910 kg in the whole month, meaning the great potential for recovery. According to Chinese standard GB 50015–2019, the average daily water consumption per student in teaching buildings is 35 - 40 L. For the studied campus with around 7000 students, the total condensate production in June could meet 5.68% - 6.49% of the total water demand, indicating a great water-saving potential.

7.4.3 Influence on the output of condensate water

The in-site experiment and the quantitative prediction showed that the condensate water of university SAHU had great recycling potential in hot summer and cold winter zone. However, the recycling potential of air-conditioning condensate in other climate conditions is ambiguous. Thus, the condensate production in 31 provincial capitals in mainland China was further calculated.

7.5 Parametric studies: detail analysis of the representative cities

The outputs of air-conditioning condensate water in different climate zones vary greatly, and the most important affecting factor is the outdoor climate condition. In order to clarify the most important factor of the condensate water output, five typical cities in five climate zones were chosen to investigate the influences of dry-bulb temperature, wet-bulb temperature, relative humidity, and dew-point temperature on the output amount. presents the climatic parameters and the condensate water outputs of the 5 representative cities. The dry-bulb temperature and relative were the monthly average values, while the calculation results of the condensate water outputs were the daily average values. Under the same thermostat of the indoor thermal environment (the indoor dry-bulb temperature of 26 °C and the relative humidity of 50%), the production of condensate water per single SAHU in June could be found. The largest value of condensate water output in Guangzhou indicated that the high wet-bulb temperature and relative humidity could benefit to generate more condensate water, which was also illuminated in references. The relative humidity of the outdoor air in Beijing was 42.53%, which was lower than the set value of the indoor relative humidity, so that the outdoor fresh air needed to be humidified in the air conditioning system. For areas where the dry-bulb temperature and relative humidity were relatively small, setting the indoor relative humidity to the low value within the design range could increase the production of condensate water. The outdoor dry-bulb temperature and the wet-bulb temperature in Harbin and Kunming were both lower than the indoor set point dry-bulb temperature of 26 °C. There was no need for air-conditioning, so that the output of the air conditioning condensate was low.

The climatic parameters and the daily average condensate water outputs of the 5 representative cities.

Climate zone	Dry-bulb temperature (°C)	Wet-bulb temperature (°C)	RH (%)	Moisture content (g/kg)	Condensate water generation (kg/h)
Severe Cold	22.83	18.03	64.95	11.12	0.89
Cold	29.37	19.69	42.53	10.56	4.21
Hot Summer and Cold Winter	28.19	22.61	64.25	15.14	3.68
Hot Summer and Warm Winter	30.80	25.35	65.96	18.24	5.15
Temperate	24.06	18.53	60.19	11.15	0.73

Chapter 8 – Reports

8.1 Before Filteration

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD

QUALITY ASSURANCE WING, WATER ANALYSIS LABORATORY

NEW AVADI ROAD, CHENNAI - 600 010.

RESULTS OF PHYSICAL AND CHEMICAL EXAMINATION

DRINKING PURPOSE

To:	A.R. Bharath	Challan No	882
	1502/41, Shanthi Nagar Lane 2, Perambur	Challan Date	08.03.2023
	Chennai-11	Amount(Rs)	75/-
Water Sample No/ Source		Bore well	
Sample sent by		A.R. Bharath	
Date of Collection		08.03.2023	
Location		Chennai-11	

S.No	Parameter Name	Result	IS:10500-2012 Acceptable Limit	IS:10500-2012 Permissible Limit in the absence of alternate source
1	Colour	Colourless & Clear	Colourless & Clear	Colourless & Clear
2	Odour	Nil	Agreeable	Agreeable
3	Turbidity (N.T.U)	6	1	5
4	Total Dissolved Solids at 105 °C (mg/l)	104	500	2000
5	Calcium (As Ca) (mg/l)	6	75	200
6	Magnesium (As Mg) (mg/l)	3.4	30	100
7	Total Hardness(As CaCO3) (mg/l)	28	200	600
8	Chlorides (As Cl) (mg/l)	26	250	1000
9	Ammoniacal Nitrogen (as N) (mg/l)	1.12	0.5	No relaxation
10	Albuminoid Nitrogen (as N) (mg/l)	2.8	0.5	No relaxation
11	Nitrous Nitrogen (As N) (mg/l)	Intense	-	-
12	Oxygen absorbed (Tidy's 4 hours test)(mg/l)	8.5	-	
13	Hydrogen Ion Concentration (pH)	7.2	6.5 TO 8.5	6.5 TO 8.5
14	Alkalinity to Phenolphthalein (AS CaCO3) (mg/l)	Nil	Nil	-
15	Alkalinity to methyl orange (As CaCO3) (mg/l)	30	200	600
16	Sulphates (As SO4) (mg/l)	15	200	400
17	Phosphates (as PO4) (mg/l)	0.01	-	-
18	Iron (As Fe) (mg/l)	0.1	0.3	No relaxation
19	Fluorides (as F) mg/l)	0.1	1.0	1.5
20	Specific Conductance(micro Siemens/cm) at 25°c	160	-	-

Report: The given sample shows the presence of Nitrous Nitrogen. The Value of Ammonical Nitrogen & Albuminoid Nitrogen exceeds the permissible limit of Drinking Water Standard. The Value Of oxygen absorbed (Tidy's Test) is high Hence it is unsuitable for Drinking Purpose.

Observation:Unsuitable for Drinking purpose.

15/03/23 WATER ANALYST | 15/3/23 CHIEF ANALYST | 15/03/2023 EXECUTIVE ENGINEER (QA)

8.2 After Filtration

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD

QUALITY ASSURANCE WING, WATER ANALYSIS LABORATORY

NEW AVADI ROAD, CHENNAI - 600 010.

RESULTS OF PHYSICAL AND CHEMICAL EXAMINATION					
DRINKING PURPOSE					
To:	A.R. Bharath		Challan No	882	
	1502141, Shanthi Nagar Lane 2, Perambur		Challan Date	08.03.2023	
	Chennai-11		Amount(Rs)	751-	
Water Sample Nol Source			Bore well		
Sample sent by			A.R. Bharath.		
Date of Collection			08.03.2023		
Location			Chennai-II		
S.No	Parameter Name	Result	ISM 0500-2012 Acceptable Limit	IS:10500-2012 Permissible Limit in the absence of alternate source	
1	Colour	Colourless & Clear	Colourless & Clear	Colourless & Clear	
2	Odour	Nil	Agreeable	Agreeable	
3	Turbidity (N.T.U)	6	1	5	
4	Total Dissolved Solids at 105 °c (mg/l)	104	500	2000	
5	Calcium (As Ca) (mg/l)	6	75	200	
6	Magnesium (As Mg) (mg")	3.4	30	100	
7	Total Hardness(As CaC03) (mg/l)	28	200	600	
8	Chlorides (As Cl) (mg/l)	26	250	1000	
9	Ammoniacal Nitrogen (as N) (mg/l)	0.25	0.5	No relaxation	
10	Albuminoid Nitrogen (as N) (mg/l)	0.25	0.5	No relaxation	
14	Nitrous Nitrogen (As N) (mg/l)	less			
12	Oxygen absorbed (Tidy's 4 hours test)(mg/l)	0.5			
13	Hydrogen Ion Concentration (pH)	7.2	6.5 TO 8.5	6.5 TO 8.5	
14	Alkalinity to Phenolphthalein (AS CaC03) (mg/l)	Nil	Nil		

15	Alkalinity to methyl orange (As CaC03) (mg/l)	30	200	600
16	Sulphates (As S04) (mg/l)	15	200	400
17	Phosphates (as P04) (mg/l)	0.01		
18	Iron (As Fe) (mg/l)	0.1	0.3	No relaxation
19	Fluorides (as F) mg/l)	0.1	1.0	1.5
20	Specific Conductance(micro Siemens/cm) at 25^0c	160		
Report	The given sample shows the presence of Nitrous Nitrogen. The value of Ammonical Nitrogen & Albuminoid Nitogen is at the permissible limit of Drinking Water Standard. The Value of oxygen absorbed (Today's Test is low. Hence it is suitable for Drinking Purpose.			
Observation:Suitable for Drinking purpose.				

15/03/23
WATER ANALYST

15/3/23
CHIEF ANAL... ST

15/03/2023
EXECUTIVE ENGINEER (QA) ... NEER

Chapter 9 - Water Filtration

Sediment Filter Working:

Sediment filters block unwanted particulate matter from getting into your water supply through a process known as mechanical filtration.
It's a bit like a screen door that you'd install in your house to stop bugs getting into your house. You want the lovely breeze flowing into your home, but not the bugs. So the screen door is the mechanical filter. A sediment filter allows water to flow through it but captures the dirt, sand, and any other particulate matter the water is carrying.

Removal of Foreign Particles:

Sediment filters remove particulate matter such as dirt, sand, dust, and debris that can be captured by its micron-rated capacity. Sediment filters also remove turbidity from water; the yellow, orange or brown cloudiness that can appear in water due to the presence of suspended solids.

Sediment filters don't remove chemicals, heavy metals, or dissolved particulate matter. Nor do sediment filters improve the taste or smell of water.

Sediment filters tend to be installed as prefiltres before water passes through a UV or Reverse Osmosis system.

Construction of Sediment Filters:

There are three main types of sediment filter; Pleated, Melt-Blown and String Wound.

Pleated sediment filters look a bit like an accordion with thin sheets of filter media like polyester or polypropylene. The large number of pleats gives this sediment filter much more dirt holding capacity than other types of sediment filters. As the filter’s pleats take on dirt, a layer is formed on the filter that amplifies the filter’s efficiency. Pleated sediment filters that are 5 micron or above can be washed and reused.

Melt-blown sediment filters are made up of layered fibres, where the inner core of the cartridge is denser than the outer core. As the water passes through the filter walls, the filter is able to clarify increasingly finer particulates. They're also often referred to as spun polypropylene filters and are very good at filtering particulates of varying micron sizes because of the graduated layers.

The third type of sediment filter is a variation of the melt-blown. String Wound sediment filters are made of tightly wound cotton, polyester, or polypropylene string. This string is wrapped firmly around a core, creating a graded density that will trap particulate matter. As water travels through the layers of string, finer and finer particulate matter is removed. The strings can begin to loosen when the filter becomes overloaded with sediment and you'll need to replace it.

Washing of Sediment Filters:

Yes, they can and it will extend the cartridges life span.

Washing the sediment cartridges is best done with the jet of water at an angle to the cartridge, up or down, not directly onto it.

However, the pores in the filter medium get blocked with tiny particles that can't be dislodged; so washing only extends the life a certain amount - usually enough for you to get by until you receive new cartridges.

If you've got high water pressure that can cope with a higher pressure drop then you could consider a spun filter cartridge that has a higher dirt holding capacity.

Although these do last longer the downside is that you get a higher pressure drop and also they aren't washable at all.

Reverse osmosis vs ultrafiltration

Many ultrafiltration systems use a hollow fiber membrane, which filters water from the inside out. This provides a large surface area for particles to adhere to. Other membranes, like the spiral wound RO membrane, filter from the outside in. The hollow fiber membrane has a high chemical resistance to oxidants and chlorine, but a TFC reverse osmosis membrane cannot tolerate any chlorine.

A reverse osmosis system provides the most extensive filtration because the RO membrane has the smallest pore size, but this level of filtration is not always necessary or preferred. A UF system retains beneficial minerals that an RO system removes. However, this means that an ultrafiltration system does not remove salts, fluoride, or TDS dissolved in water. An ultrafiltration system also operates on low water pressure, but a reverse osmosis system needs a booster pump to increase water flow.

Usage of Ultrafilteration:

The distinction in pore size and types of particles removed means each type of filtration serves a unique purpose.

Ultrafiltration is the filtration method of choice for people who prefer minerals left in their water but still want microscopic contaminants taken out. A UF system may be selected over an RO system because it wastes less water to the drain. Someone may choose UF in California where water use is regulated. Someone in South Carolina, where the water has few dissolved minerals to begin with, may choose UF since RO wouldn't be necessary. Sometimes, ultrafiltration is used to recycle effluent water after filtration, so the water can be reused for irrigation.

Reverse osmosis is used in situations where all particles including dissolved substance must be stripped from the water. Some people prefer RO water from their refrigerator or tap, especially if they're on well water supply. RO is also favored for saltwater aquariums, where an exact amount of salt can be added back to the clear water. Nano filtration is frequently used to remove heavy solids in dairy and for some softening purposes. Microfiltration removes suspended solids like algae and sediment.

Significance of Ultrafiltration:

The UF membrane is a super fine filter that reduces particles 5,000 times smaller than a human hair. Ultrafiltration gives 90-100% reduction in these contaminants. While UF can't reduce some organics, a .05 micron carbon block prefilter can be added to a system to reduce chlorine taste and odor, lead, cysts, volatile organic compounds (VOCs), and metallic trace elements (MTE). A UF membrane lasts about two years.

Ultrafiltration benefits

- System operates at a low pressure
- Removes bacteria and viruses
- Keeps essential minerals in water
- Installs quickly and easily
- Does not generate waste water
- An ultrafiltration system is eco-friendly.
- Ultrafiltration has a 90-95% recovery rate and can be used to treat wastewater for reuse.
- Using a home ultrafiltration water system benefits the environment by reducing

the amount of plastic water bottles discarded in landfills.

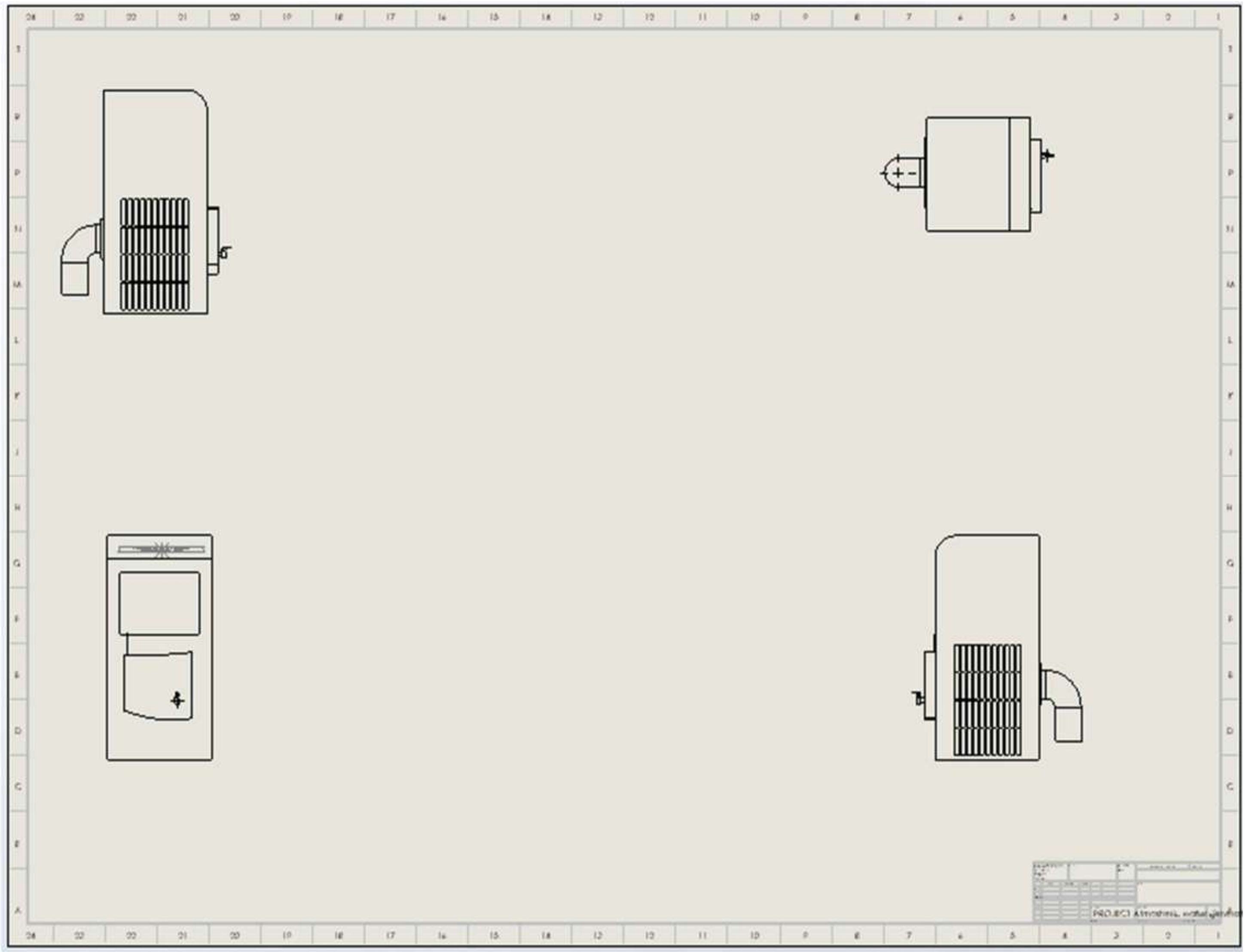
Ultrafiltration for drinking water

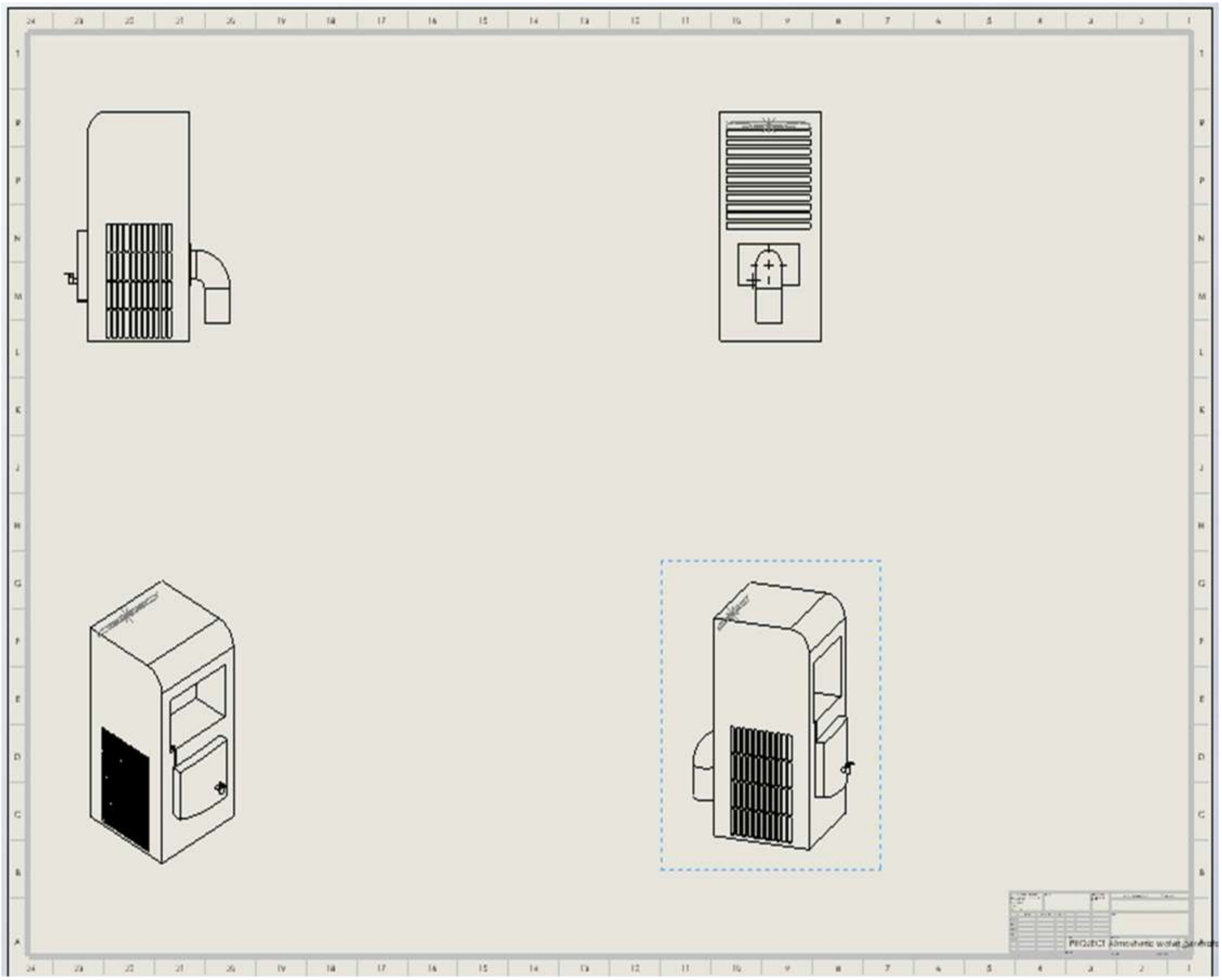
In the past, ultrafiltration was reserved for hospitals and large city water plants. Now, ultrafiltration is offered as an under sink water filter. UF drinking water systems can provide your family with great-tasting water on the go. Using a BPA-free Neo-Vas stainless steel water bottle will prevent any harmful chemicals from leaching into your drinking water.

We developed the Neo-Pure TL3 ultrafiltration system with a more efficient carbon filter and twist-lock cartridges for easy replacements. The system includes a built-in shutoff valve, so you don't have to shut your water off before changing the filters.

Installing a UF system is simple with 1/4" quick-connect fittings. Each system is supplied with a feed supply adapter to hook up to your cold-water supply with the polyethylene tubing provided with the system. Our ultrafiltration systems also come with a chrome designer faucet.

Chapter 10 – Design

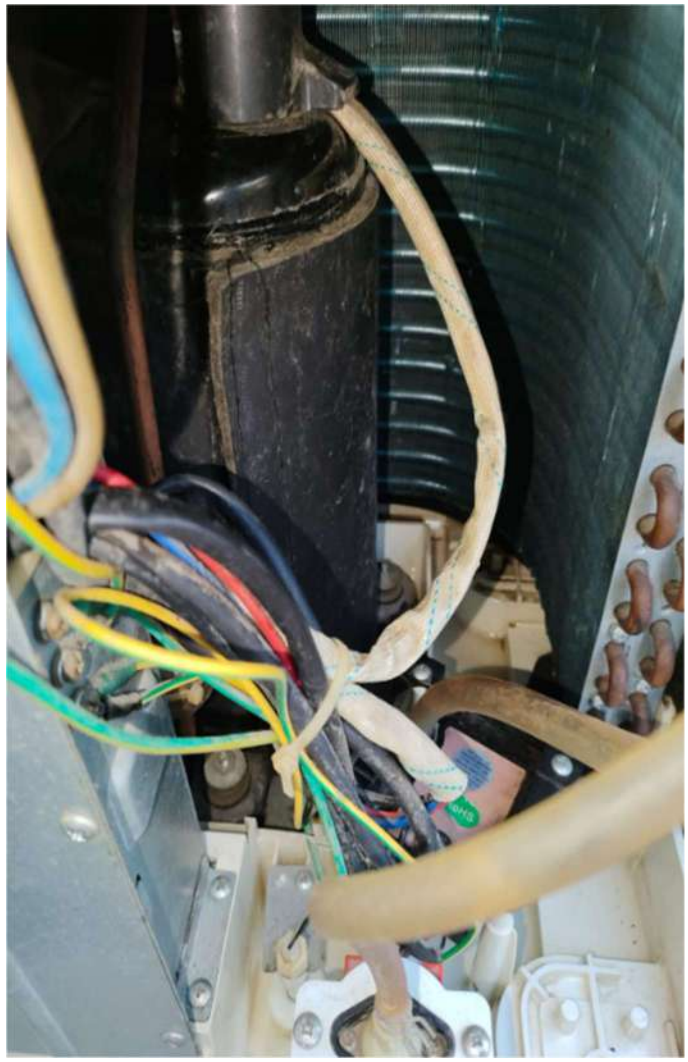




10.1 DESIGN STEPS:

- Open the software and select to draw a new part.
- Click on front view and draw the outer sketch of part usingspline curves.
- Then extrude the surface to the required amount.
- Then click on the front surface and sketch, draw A.C ventsusing lines.
- Extrude cut the surface and draw using lines for making fins.
- Extrude even the drawn area and start drawing fins.
- Using Linear Pattern complete the fins setup, using Mirroroption setup fins even on the other side.
- Make the surface done drawn flexible up to 30 degrees forobtaining the required model.
- Do Fillet at the top of the surface and extrude the surface.
- Boss Extrude the surface and do fillet at edges.
- Then revolve the surface.
- Then to setup tap, setup right view and choose on sketchoption, sketch and extrude the surface.
- Finally, the final setup is obtained.

Chapter 11 – Bibliography



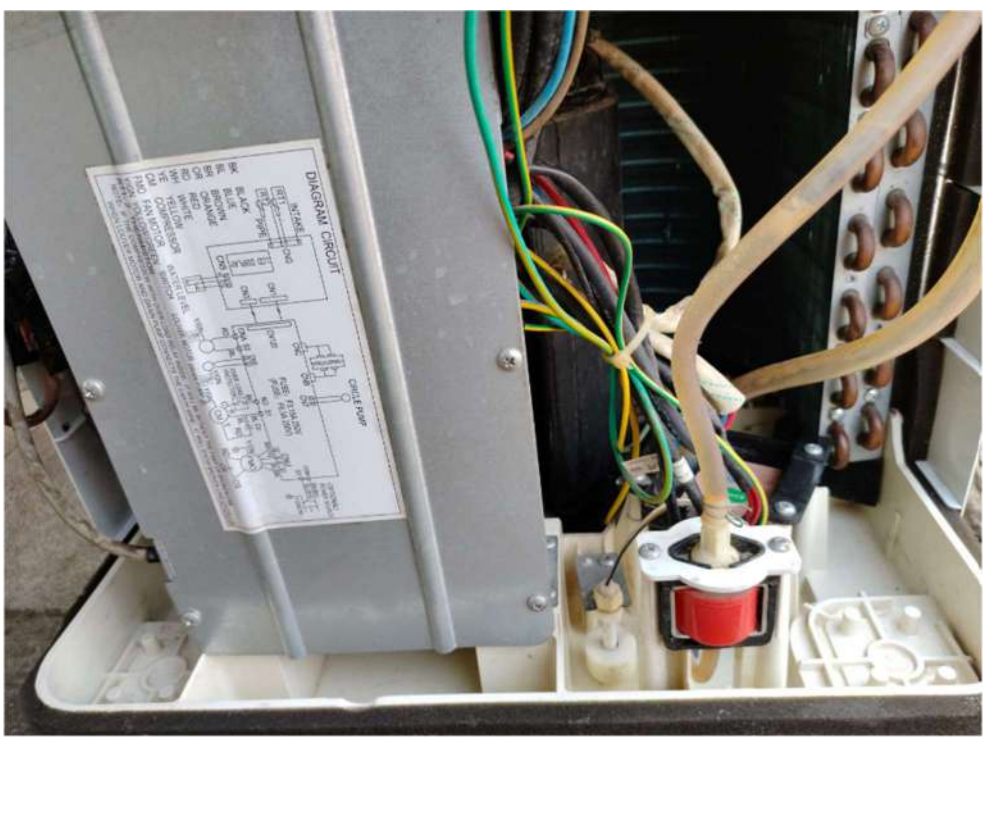
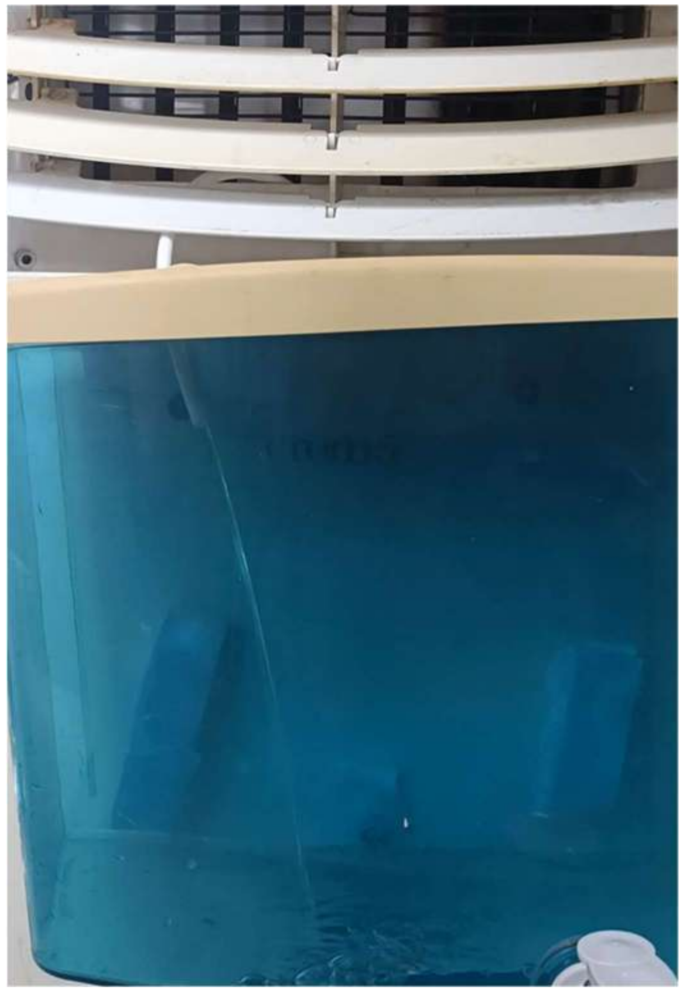


DIAGRAM CIRCUIT
CIRCLE PUMP


ROTEK
PP SEDIMENT FILTER



Chapter 12 – Future Scope

Air conditioning and refrigeration are used around the world for temperature comfort and food preservation. As the air is being cooled, it is dehumidified, causing water to be removed as condensate. With proper treatment to address biological contaminants, this water can be constructively used.

A typical air conditioning system in a commercial building consists of an air-handling unit that circulates air to the occupied spaces to maintain comfort. As the air returns from space, it is mixed with outside air, which is necessaryto maintain a healthy environment. As the air passes through the air-handlingunit, it goes through a cooling coil. The temperature of the air drops, and thehumidity, from the added outside air and moisture from the space, is removedas condensate.

Condensate is essentially distilled water, low in mineral content, but may contain bacteria. Air conditioning condensate can amplify Legionella and other airborne bacteria, and it has been shown to be the source of outbreaks inhospitals, motels, and cruise ships. Contamination of air conditioning condensate by Legionella is so common that there are commercially availablekits for inhibiting microbial growth in the condensate.

High levels of Legionella are cause for concern. Most natural sources of waterare not contaminated, but can become problematic when an amplifyingdevice, such as an air conditioner, is present.

If it is to be used for potable water or for washing, proper disinfection of the water is required. Ultraviolet light, chlorine tablets, ozone injection, and/or raising water temperature to at least 140 degrees Fahrenheit reduce the potential hazard of biological contamination. Reclaimed air conditioning condensate is high-quality water with low mineral and chemical content and has many potential uses, but care must be taken with its use.

Hybrid systems are being developed that route the condensate into the rainwater catchment cistern.

Chapter 13 – Conclusion

Air conditioning units generate significant amounts of chemically and microbiologically pure water during their normal operations. This study shows the feasibility of collecting and using this water at source for both domestic andindustrial purposes. Large industrial AC systems, trains and cars can also potentiallybottle the condensate and convert a waste stream into a revenue source. Current ACunit designs include a drainage tube to remove the condensate. A simple water collection system can be designed and included in the unit at the time of manufacturein order to facilitate its use. There are roughly about 6 million air conditioner units active in Indian houses and establishments and the number is rising exponentially. The high purity water condensate collected from all these units will be between 50 and 100 million liters a day for most of the year. We can no longer ignore this issueand allow this precious resource to get drained. An aesthetically good-looking storage tank near the air conditioner unit inside the hall would maintain the purity ofthis condensate and high value applications like battery or drinking water. It would certainly encourage the people to collect this condensate.

As the dual challenges of population growth and climate change stress the planet's resources and threaten livelihoods, simple, decentralized technologies will form a major part of the solution to the problem of water scarcity. Even as we collectively focus scientific and engineering resources on big, revolutionary technologies to mitigate our challenges, it is valuable to invest in easily executable technologies that can have a meaningful impact on the way the general public gets involved in solving these problems. In addition to the obvious impact on reducing water waste, the sociological impact of this technology will also be significant, as it will encourage more people to focus on the ideals of conservation and minimizing our environmental footprint. Ultimately, simple technologies with widespread adaptation will have the most impact on our collective efforts to survive on a crowded and climatically changing planet.

It is high time that leading manufacturers of air conditioners like Voltas, BPL, LG, Hitachi, Godrej and many others take cognizance of this study not only in Indiabut worldwide and help in developing a good collection system for water condensate. This would also offer good business opportunities.

CHAPTER 14

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