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"SOLAR/THERMAL ENERGY STORAGE-POWERED PROJECT TO EXTRACT WATER FROM AIR"

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Abstract: Fresh water supply is one of the most limiting conditions for the population of arid regions. The present paper covers the working principle of systems and processes for extracting water from atmospheric air. Moreover, a summary of the experimental and analytical studies which investigate system performance has been made. Some new designs that greatly expand the solar desiccant technique for absorption with subsequent regeneration are also introduced. The research activities in this sector are still increasing to solve the crucial points that make these systems not yet ready to compete with other systems as water distillation.

Index Terms - Solar Energy, Extraction, Regeneration, Air, Absorption, Liquid, Desiccant, Dew Collection.

1. INTRODUCTION

Earth's water is finite, which means the amount of water on our planet doesn't increase or decrease. Roughly 70 percent of Earth's surface is covered by water. Water from lakes, rivers, and oceans evaporates into the air, and forms clouds to rain down again. Of all the water that exists, 97 percent is saltwater. Less than one percent of freshwater is liquid, with seven billion people and many plants and animals relying on this precious resource Surface water is water in a river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapotranspiration and groundwater recharge.

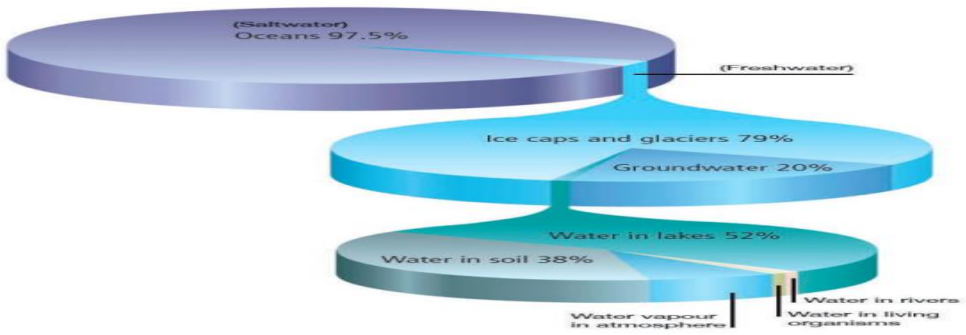


Fig.1 Water in different forms

The extraction of water from atmospheric air can be accomplished by different methods, the most common of these methods are cooling moist air to a temperature lower than the air dew point, and absorbing water vapour from moist air using a solid or a liquid desiccant, with subsequent recovery of the extracted water by heating the desiccant and condensing the evaporated water. The objective of the present work is to try the method of extraction of water from atmospheric air using desiccants and solar energy in the climatic condition of Southern India with low initial and operating costs.

2. LITERATURE REVIEW

One of the first works dealing with water extraction from atmospheric air published in Russia. An apparatus consisting of a system of vertical and inclined channels in the earth to collect water from atmospheric air by cooling moist air to a temperature lower than its dew point has been proposed. The earth-water collector was proposed by Kobayashi.

While researching project work topic we were looking to add something new in green building which is environment friendly, futuristic with less maintenance we get this idea from one of the most developing towns Masdar city in UAE.

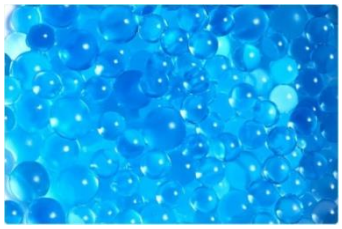
1. New technology will extract clean water from the atmosphere in commercial volumes and operate 24/7 using clean energy with high efficiency.
2. The project is running at Masdar City, Abu Dhabi's hub for technology innovation and sustainability-focused R&D.
3. The project will be a key development for hot climates such as the Middle East.

The world's first project to produce commercial volumes of an uninterrupted water supply from a sustainable source, making it carbon free in Masdar City, Abu Dhabi.

3. MATERIAL FOR ABSORPTION OF WATER MOLECULE

Hydrogel:

The hydrogel is a form of zinc oxide, a compound found in sunscreen, can absorb water from the surrounding environment more than 2.5 times its weight and performs at least eight times better than commercial drying agents. Scientists say it is suitable for both indoor and outdoor applications, and is also cheap and easy to produce. "Singapore, like many tropical countries, experience high levels of relative humidity between 70 to 80 percent".



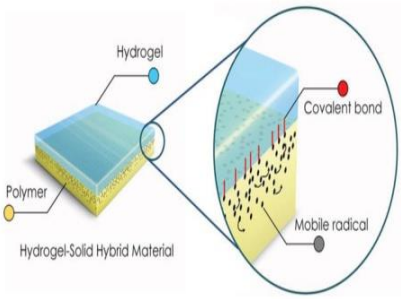
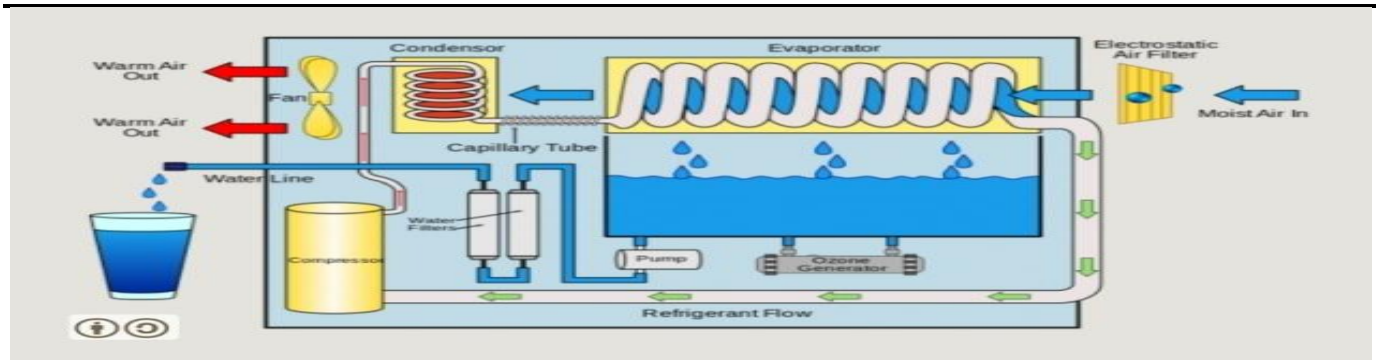


Fig. 2.1 Hydrogel

- In a humid environment, the air is saturated with water and as a result, sweat on our body evaporates more slowly. This causes us to feel hotter than the actual ambient temperature, leading to great discomfort. Our novel hydrogel aims to achieve a cooling effect by removing moisture from ambient air very efficiently.
- The material is suitable for reducing relative humidity in both indoor and outdoor environments, such as in hospital wards and classrooms without air conditioning, as well as in parks and bus stops.
- Hydrogels are materials which contain large amounts of water and are commonly used in contact lenses, wound dressing, and personal care products. Recently, hydrogels have been used for biomedical applications, such as tissue engineering and drug delivery. However, the ability of hydrogels to absorb water from surrounding air has not been well explored.
- This novel hydrogel performs at least eight times better than existing drying agents, such as silica gel and calcium chloride, in removing moisture from the air it can absorb more water, works faster, and uses less material.
- Building or home owners could enjoy savings in energy cost when using the gel together with air conditioners, as the cooler ambient air will require less electricity to chill buildings to the desired temperature.

4. WORKING MODEL

- Harvesting water from the atmosphere is not a new process, but previous methods have until now been extremely energy dependent. Traditionally, modern methods utilize atmospheric water generators which operate in a similar way to dehumidifiers, in which air is passed over a cooled coil, reducing its temperature until it is no longer able to hold the water within.



Working model-1

Parts of model:

3.1 Electrostatic air filter.

3.2 Compressor, Condenser and Evaporator.

3.3 Ozone generator.

3.4 Pump.

3.5 Water filter.

3.6 Exhaust fan.

3.1 Electrostatic air filter:

An electrostatic filter is made with electrically charged media. This type of air-filtering system uses two plates. One has a positive charge, and the other has a negative charge. The plate with the positive charge attracts particles with a negative charge. The positively charged particles are attracted to the negatively charged plate.

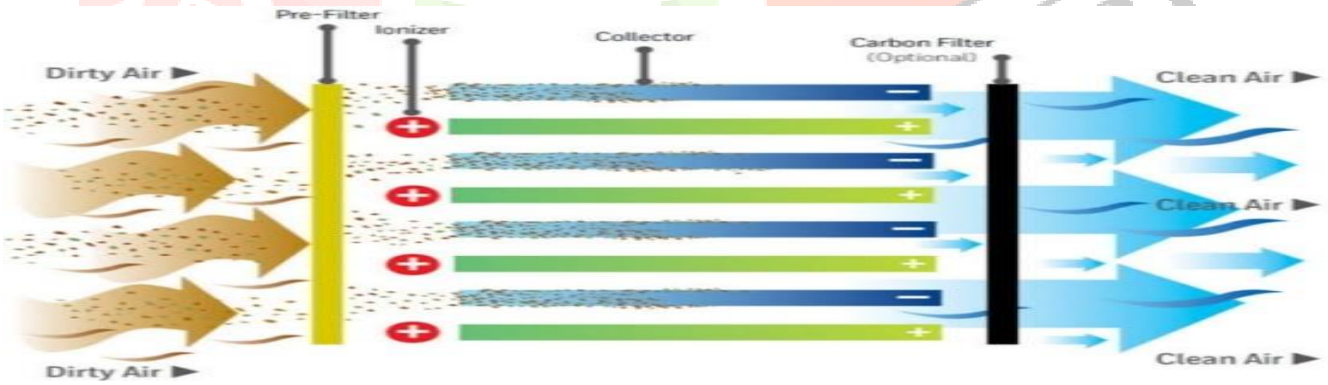


Fig: 3.2 Electrostatic Filter

3.2 Compressor, Condenser and Evaporator:

The Refrigeration Cycle

- The refrigeration cycle is a continuous process. Refrigerant moves from the compressor to the condenser, through a metering device, to an evaporator, and then the cycle repeats.

The compressor receives low pressure gas from the evaporator and converts it to high pressure gas through compression, as the name states. As the gas is compressed, the temperature rises.

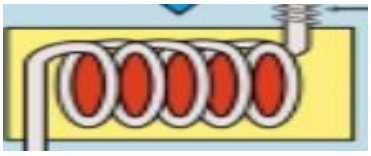


Fig 3.3 Condenser

- The metering device can be an expansion valve or a capillary tube and is used to create a pressure drop. As mentioned earlier, the temperature and boiling point of liquids decrease as the pressure decreases. Some refrigerant liquid vaporizes and the temperature of the liquid-gas mixture drops. The cool refrigerant then flows to the evaporator.

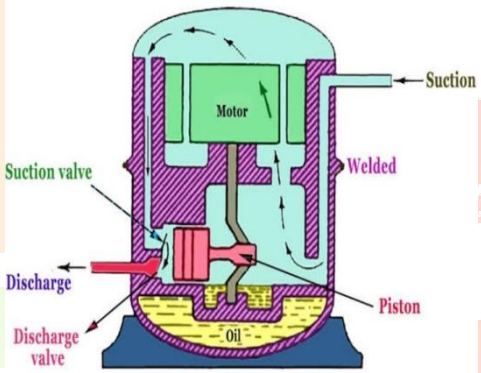


Fig 3.4 Compressor

- The evaporator is another heat exchanger that allows heat to move between the heat source and the refrigerant. In a chiller the heat source is the cooling fluid which flows into your equipment. The refrigerant enters the evaporator as a low temperature gas-liquid mixture. By design the temperature of the heat source is always higher than the refrigerant's boiling point. In the evaporator the refrigerant vaporizes as it absorbs heat from the heat source. The refrigerant's temperature remains constant as it vaporizes. The refrigerant then exits the evaporator as a gas, enters the compressor and the cycle starts again.

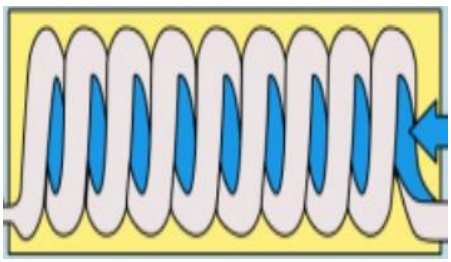


Fig 3.5 Evaporator

3.3 Ozone generator:

- Ozone generators produce ozone by breaking apart oxygen (O_2) molecules into single atoms, which then attach to other oxygen molecules in the air to form ozone (O_3).

Ozone generators work by

- Silent corona discharge: These machines use electric discharge to produce ozone by splitting the normal oxygen molecules in the air into single atoms. These atoms then attach to other O_2 molecules in the air to form ozone (O_3).
- Ultraviolet radiation: This process of ozone generation is similar to how the sun's ultraviolet radiation splits O_2 to form individual oxygen atoms. According to InterNACHI, this process is considered to be less efficient than corona discharge.
- The half-life of ozone in water is about 30 minutes, which means that every half hour the ozone concentration will be reduced to half its initial concentration.

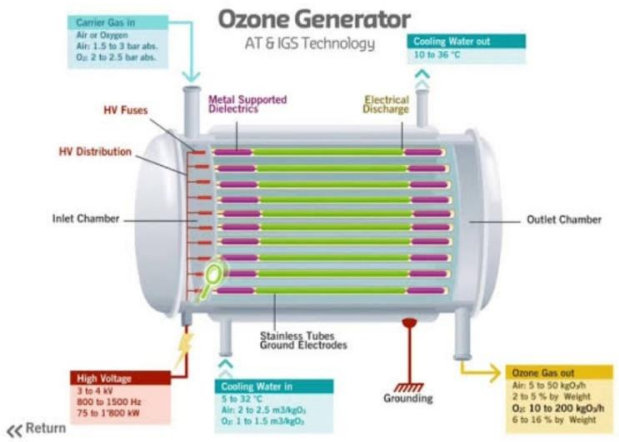


Fig 3.6 Ozone Generator

3.4 Pump:

- Water pump is a machine used to increase the pressure of water in order to move it from one point to another

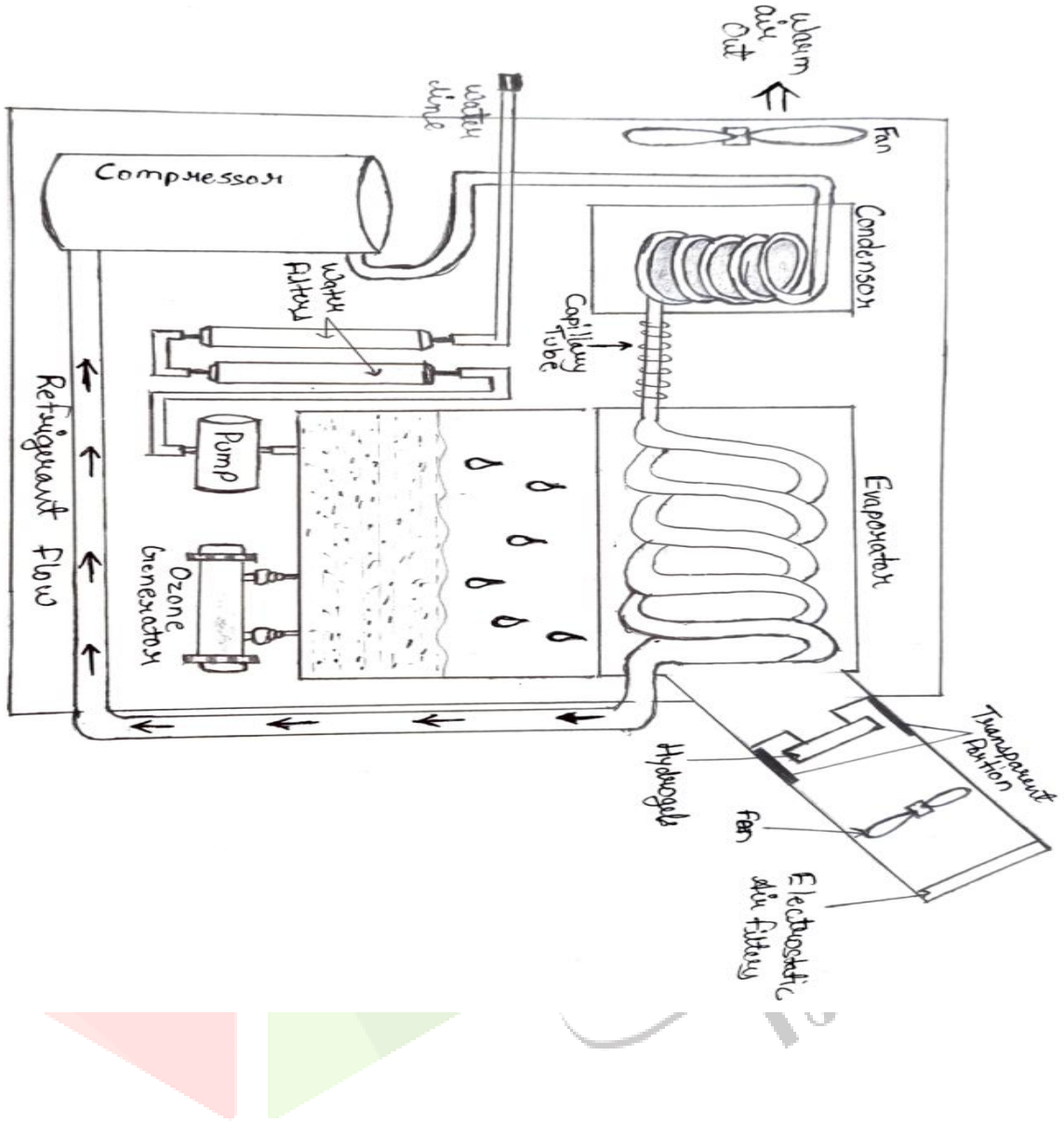
3.5 Water filter

- First, the large internal surface area physically traps sediments and contaminants.
- Then, activated carbon acts like a magnet for compounds

  like lead and volatile organic compounds as water passes through.
- Finally, chemical reactions inside the filter reduce chemicals like chlorine on contact.

3.6 Exhaust fan

- Exhaust fans are used to pull excess moisture and unwanted odors out of a particular room or area. Here we are using exhaust fan, so that moisture present in the air gets absorbed by the material and to remove out warm air.



Working Model-2

4. PROCEDURE

1. Energy generated by solar system is used in providing electricity to all the electrical and mechanical equipment.
2. With the help of solar panel exhaust fan gets started, start taking water molecules from environment.
3. When exhaust fan starts, the electrostatic air filter, filters out almost all the dust particles and other foreign particles. The remaining water molecules present in air gets attracted by hydrogel material.
4. Hydrogel material stores water molecules in it pores.

5. In day time, water gets evaporated from the material with the help of sun rays and enters into the evaporator.

6. In evaporator, the water molecules get condensed in liquid form due to refrigerant of temperature lower than the water molecules present in the evaporator.

7. The liquefied water molecules then stored in a container and get continuously disinfected by Ozone generator.

8. Then, the stored ozonated water is moved forward with the help of a water pump to the water filters for complete purification.

9. The purified water can be used directly for any purpose.

10. For long life of working equipment the warm air generated inside mechanism is removed with the help of exhaust fan.

SOLAR PANELS

- A solar cell panel, solar electric panel, photo-voltaic (PV) module or just solar panel is an assembly of photo-voltaic cells mounted in a framework for installation. Solar panels use sunlight as a source of energy to generate direct current electricity.
- A collection of PV modules is called a PV panel, and a system of PV panels is called an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

Fig.4.1 Solar cells

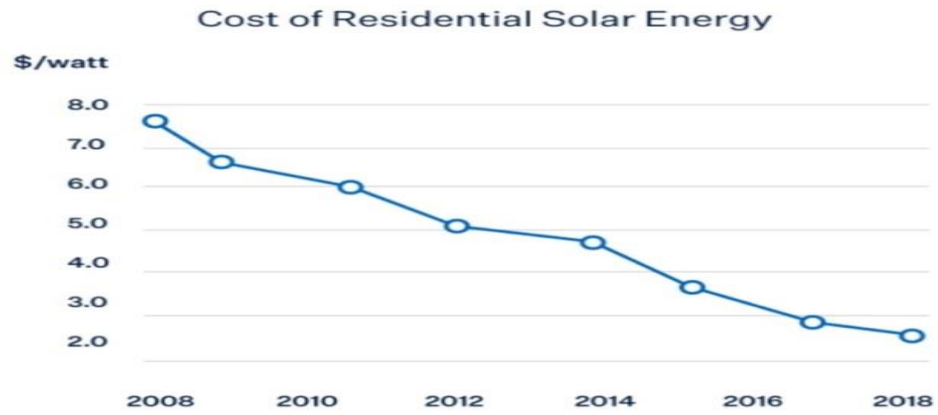


Fig. 4.2 Cost of Residential Solar Energy

5. CONCLUSION

- By applying this system, we have concluded that from highly humid region we can extract more amount of drinking water from atmospheric air.
- The use of this system may result in solution for drinking water problems in many situations without high infrastructures setup cost and time needed.
- It could create additional portable drinking water with the help of compressor, condenser, evaporator and refrigerant flow in it, without any external power sources and only using solar energy.
- The mechanism can be used at different places in different nature with varying humidity in the environment. It can decrease the need of water/drinking water to some extent in water scarce places.

6. FUTURE SCOPE

The AWH technology is promising to be widely used for decentralized water supply in the future freshwater production market. Current water production techniques, such as multi-stage flash and multi-effect distillation, highly depend on complex infrastructure and need high energy consumption, leading to relatively high cost, and hence hindering their generalization in developing countries and remote regions. The materials enabled AWH is capable of producing water regardless of geographical and hydrologic conditions, and renewable energy can be utilized to avoid energy consumption by combusting traditional fossil fuel. Therefore, benefiting from the development of AWH materials, the cost of freshwater production will be reduced to an appealing level in the near future. In reflection of all aforementioned research efforts and promising prospects, moisture harvesters are able to expand the limits of current technologies and will significantly contribute to the alleviation of water scarcity.