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# Drinking Water Generator from Atmospheric Air

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**ABSTRACT:** Water scarcity is one of the burning issues of today's world. Though water covers more than two third (about 70%) of the Earth's surface but still fresh water which can be used for drinking and carrying out everyday chores remains scarce (only about 2.5%). The acute problem of water shortage, is mainly faced by the countries with long coastlines and the island nations, which do not have adequate fresh water sources like rivers and ponds. As a result most of these countries meet their water demands by desalination of sea water which is a very costly affair. Also it may so happen that these desalination plants may fail which will cause acute water shortage. This is what just recently happened in Maldives. So there is an urgent need for countries like Maldives and others, who depend solely on desalination plants to meet their water requirements, to find alternative methods to generate water in order to meet their water security needs.

Key words: Refrigeration, Evaporation, Compression

## I. INTRODUCTION

Water is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of living things. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but it often co-exists on Earth with its solid state, ice; and gaseous state, steam (water vapor). It also exists as snow, fog, dew and cloud.

Water in three states: liquid, solid (ice), and gas (invisible water vapor in the air). Clouds are accumulations of water droplets, condensed from vapor-saturated air.

Water covers 71% of the Earth's surface. It is vital for all known forms of life. On Earth, 96.5% of the planet's water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation. Only 2.5% of the Earth's water is freshwater, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products.

Water on Earth moves continually through the water cycle of evaporation and, condensation, precipitation, and runoff, usually reaching the sea.

Evaporation and transpiration contribute to the precipitation over land. Water used in the production of a good or service is known as virtual water.

Safe drinking water is essential to humans and other life forms even though it provides no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation.

There is a clear correlation between access to safe water and gross domestic product per capita. However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability. A report, issued in November 2009, suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%. Water plays an important role in the world economy, as it functions as a solvent for a wide variety of chemical substances and facilitates industrial cooling and transportation. Approximately 70% of the fresh water used by humans goes to agriculture.

The density of liquid water is 1,000 $kg/m^3$ (62.43 lb/cu ft) at 4 °C. Ice has a density of 917 $kg/m^3$ (57.25 lb/cu ft). Some specifications needed for the pure tasteless drinking water are listed below.

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# II. METHODOLOGY

## 2.1 REFRIGERATION PROCESS

Refrigeration is a process in which work is done to move heat from one location to another. The work of heat transport is traditionally driven by mechanical work, but can also be driven by heat, magnetism, electricity, laser, or other means. Refrigeration has many applications, including, but not limited to: household refrigerators, industrial freezers, cryogenics, and air conditioning. Heat pumps may use the heat output of the refrigeration process, and also may be designed to be reversible, but are otherwise similar to refrigeration units.

Refrigeration has had a large impact on industry, lifestyle, agriculture and settlement patterns. The idea of preserving food dates back to the ancient Roman and Chinese empires. However, refrigeration technology has rapidly evolved in the last century, from ice harvesting to temperature-controlled rail cars. The introduction of refrigerated rail cars contributed to the westward expansion of the United States, allowing settlement in areas that were not on main transport channels such as rivers, harbors, or valley trails. Settlements were also popping up in infertile parts of the country, filled with new natural resources. These new settlement patterns sparked the building of large cities which are able to thrive in areas that were otherwise thought to be unsustainable, such as Houston, Texas and Las Vegas, Nevada. In most developed countries, cities are heavily dependent upon refrigeration in supermarkets, in order to obtain their food for daily consumption. The increase in food sources has led to a larger concentration of agricultural sales coming from a smaller percentage of existing farms. Farms today have a much larger output per person in comparison to the late 1800s. This has resulted in new food sources available to entire populations, which has had a large impact on the nutrition of society.

In this project we can shortly say as when the air is passed over a cooled coil, causing water to condense from air. It is a process in which work is done to move heat from one location to another. The work of heat transport is traditionally driven by compressor. This cyclic process is called Refrigeration process.

## 2.2 REFRIGERATION THERMO DYNAMICS

A simplified vapor compression refrigeration cycle pressure enthalpy chart is illustrated in Figure 3.2

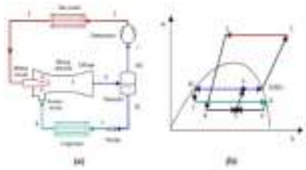

**Figure 2.2: Pressure Enthalpy Chart**

The enthalpy (energy content) of a refrigerant changes with changes to the pressure, temperature and physical state. At the left section of the curve, the refrigerant is a saturated liquid, while at the right section of the curve it is a saturated vapor. Within the curve, the refrigerant exists as a saturated mixture of liquid and vapor. Just left of the curve, the refrigerant is a sub-cooled liquid, and to the right of the curve it is a superheated vapor.

## 2.3. MATERIALS USED

### 2.3.1 CONDENSER

Condenser is a device for reducing a gas or vapor to a liquid. Condensers are employed in power plants to condense exhaust steam from turbines and in refrigeration plants to condense refrigerant vapors, such as ammonia and fluorinated hydrocarbons. The petroleum and chemical industries employ condensers for the condensation of hydrocarbons and other chemical vapors. In distilling operations, the device in which the vapor is transformed to a liquid state is called a condenser.

**Figure 2.3.1: Condenser**

All condensers operate by removing heat from the gas or vapour; once sufficient heat is eliminated, liquefaction occurs. For some applications, all that is necessary is to pass the gas through a long tube (usually arranged in a coil or other compact shape) to permit heat to escape into the surrounding air. A heat-conductive metal, such as copper, is commonly used to transport the vapor. A condenser's efficiency is often enhanced by attaching fins (i.e., flat sheets of conductive metal) to the tubing to accelerate heat removal.

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Commonly, such condensers employ fans to force air through the fins and carry the heat away. In many cases, large condensers for industrial applications use water or some other liquid in place of air to achieve heat removal.

**2.3.2 EVAPORATOR**

The evaporator works the opposite of the condenser, here refrigerant liquid is converted to gas, absorbing heat from the air in the compartment.

**Figure 2.3.2: Evaporator**

When the liquid refrigerant reaches the evaporator its pressure has been reduced, dissipating its heat content and making it much cooler than the fan air flowing around it. This causes the refrigerant to absorb heat from the warm air and reach its low boiling point rapidly. The refrigerant then vaporizes, absorbing the maximum amount of heat.

This heat is then carried by the refrigerant from the evaporator as a low-pressure gas through a hose or line to the low side of the compressor, where the whole refrigeration cycle is repeated.

The evaporator removes heat from the area that is to be cooled. The desired temperature of cooling of the area will determine if refrigeration or air conditioning is desired. For example, food preservation generally requires low refrigeration temperatures, ranging from 40°F (4°C) to below 0°F (-18°C).

A higher temperature is required for human comfort. A larger area is cooled, which requires that large volumes of air be passed through the evaporator coil for heat exchange. A blower becomes a necessary part of the evaporator in the air conditioning system. The blower fans must not only draw heat-laden air into the evaporator, but must also force this air over the evaporator fins and coils where it surrenders its heat to the refrigerant and then forces the cooled air out of the evaporator into the space being cooled.

**2.3.3 CAPILLARY TUBE**

Capillary tube is one of the most commonly used throttling devices in the refrigeration and the air conditioning systems. The capillary tube is a copper tube of very small internal diameter. It is of very long length and it is coiled to several turns so that it would occupy less space. The internal diameter of the capillary tube used for the refrigeration and air conditioning applications varies from 0.5 to 2.28 mm (0.020 to 0.09 inches). Capillary tube used as the throttling device in the domestic refrigerators, deep freezers, water coolers and air conditioners.

**Figure : 2.3.3 Capillary Tube**

**2.3.4 CARBON ACTIVATED FILTER**

It is a form of carbon processed membrane to have a small low-volume pores that increase the surface area available for chemical reactions. Due to high micro porosity, just one gram of activated carbon has a surface area in 500 square meters. It removes the all impurities of condensed water and change the Ph 6.7to7.02 form pure drinking water.

**Figure 2.3.4: Filter**

**2.3.5 COMPRESSOR**

The purpose of the compressor is to circulate the refrigerant in the system under pressure; this concentrates the heat it contains. At the compressor, the low pressure gas is changed to high pressure gas. This pressure buildup can only be accomplished by having a restriction in the high pressure side of the system. This is a small valve located in the expansion valve. The compressor has reed valves to control the entrance and exit of refrigerant gas during the pumping operation. An improperly seated intake reed valve can result in gas leaking back into the low side during the compression stroke, raising the low side pressure and impairing the cooling effect. Two service valves are located near the compressor as an aid in servicing the system.

1. One services the high side; it is quickly identified by the smaller discharge hose routed to the condenser.
2. One is used for the low side; the low side comes from the evaporator, and is larger than the discharge hose

**Figure 2.3.5: Compressor**

The screw compressor sweeps a volume through two rotors that are meshed together. As the rotors turn inside the closely fitted casing, the space becomes sealed and the gas is compressed. Maintenance, adequate lubrication, cooling and sealing between the working parts is very important. Screw compressors do not have clearance volume, and there is no loss of volumetric efficiency from re-expansion, as in a piston machine. Leakage of refrigerant back to the suction via in-built clearances is a main cause of reduced volumetric efficiency.

## III. CALCULATION OF WATER GENERATION

**Power consumption calculation**

Amount of refrigerant used = 10psi

Units of electricity consumed by the machine for 1 year = 264units/year

Units of electricity consumed by the machine per day = 264/365

= 0.72units

Cost of unit current = Rs.7.50

Cost of current used by the machine per day = 0.72 x 7.50

=

Rs.5.42

**Water production calculation:**

Relative humidity of air = 70%

Average temperature = 26°C

ACC temperature = 9°C

Water production = 2.7litres

## IV. CONCLUSION

### 4.1. Conclusion

When considering the advantages, it provides more useful in water production. Also the cost of the device is less and simple in construction. Also the maintenance of the compressor and filter equipments are very less.

It is evident from above investigation that the machine called as "Drinking Water Generator" performs the best result and it can able to collect water as much about 3 to 8 liters a day. We investigated and found that the variation in water production is due to the variation humidity content in the atmosphere. We can even solve the power consumptions by fitting solar panels. It can able to produce pure drinking water any place at any time. We strongly believe that it will be the only future water source during water scarcity periods.

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