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Desalination by Droplet Evaporation

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Abstract: Distillation by droplet evaporation is a multi-stage technique to improve fresh water production from salty water by using conventional evaporation and condensation. Like a conventional type of evaporating and condensing impure water to get potable water, this method also involves the same technique. But here, Instead of boiling a still water for evaporation, Droplets of Impure water will be allowed to fall on a hot plate having high thermal conductivity. Water was preheated by solar heater to increase thermal efficiency of the system. Sample plant was built to know the minimum yield of fresh water quantity. And analysed for required results.

I. INTRODUCTION

Water seems to be a superabundant natural resource on the planet earth. However, only 0.3 per cent of the world's total amount of water can be used as clean drinking water. Man requires huge amounts of drinking water every day and extracts it from nature for innumerable purposes. As natural fresh water resources are limited, sea water plays an important part as a source for drinking water as well. In order to use this water, it has to be desalinated. So, sea water desalination is a real challenge for western civilization. The base method for sea water desalination is distillation. Approximately 620 kWh of evaporation enthalpy is necessary to obtain 1 t of drinking water. The best known thermal processes for the desalination of seawater, namely MED (multi-effect desalination) and MSF (multistage flash), make an efficient use of energy because the heat released in each stage or effect was used in the next one, making multiple use of energy. However, these processes require a very precise control of temperature and pressure in each stage, which must be constant in time in order to keep the conditions needed for the boiling process. But, in this process, only small amount of surface will be used as the heating surface, so fuel requirement can be reduced predominantly. Solar preheater can be used to Increase the efficiency of overall system and to increase productivity

II. SCOPE OF THE PROJECT

In response to increasing water scarcity, over the last 30 years desalination has evolved into a viable alternative water supply. It allows us to tap non-traditional water resources with great potential to provide a sustainable, drought-proof water supply. Desalination provides only around 1 percent of the world's drinking water, but this percentage is growing year-on-year.

III. COMPONENTS

A. Conical surface Boiler
B. Insulated Boiler wall
C. Solar preheater
D. Thermocompresssor
E. Diffuser
F. Pressure Regulator
G. Droplet tube
H. Condenser
I. Passage tubes
J. Storage tank
K. Pre filter and Post filter layers
L. Transferring pumps
M. Valves, Pipes and regulators, etc.

1) *Pressure Regulator:* When the water from tank was directly fed into droplet tube, there will be uniform distribution of water among all the tube holes. In this project, the pressure regulator cannot increase the pressure but only deceases the pressure from the external tank. This is because the pressure should be low enough to convert the continuous flow of water to the droplets. If

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we want the pressure of more than 1 bar (Atmospheric pressure), the height of the tank should be increased. By this way, the pressure regulator works. A pressure regulator is a control valve that reduces the input pressure of a fluid to a desired value at its output. Regulators are used for gases and liquids, and can be an integral device with an output pressure setting, a restrictor and a sensor all in the one body, or consist of a separate pressure sensor, controller and flow valve.

2) *Droplet Tube:* Droplet tube means a tube made up of plastic, used to convert the still water or continuous flow of water into water droplets. By varying pressure of incoming water using pressure regulator, we can able to vary the speed and size of the droplets. By thus way, Droplet tube works. To improve accuracy of the system, these holes are made accurate and précised in size. Pre-filter before this setup can be involved to eliminate minute impurities which can reduce the affect the heating surface.

3) *Conical Boiler Surface:* In this system, conical surface was used as the heating surface. When the Droplet of particular size was fall on conical surface heater, due to heat on surface of boiler, there will be a convection process between the surface and drop occurs, which readily evaporates the drop and makes the size of drop as half of its original size. It should be noted that the surface of the boiler is inclined by 30˚-45˚ (Based on yield requirement). By this way, conical surface heater works. They can be heated by either Electrical heater or Conventional heater. Corrugated galvanized iron or steel (colloquially corrugated iron (near universal), wriggly tin (taken from UK military slang), piling (in Caribbean English), corrugated sheet metal (in North America) and occasionally abbreviated CGI) is a building material composed of sheets of hot-dip mild steel, cold-rolled to produce a linear corrugated pattern in them. Although it is still popularly called “iron” in the UK, the material used is actually steel (which is iron alloyed with carbon for strength, commonly 0.3% carbon), and only the surviving vintage sheets may actually be made up of 100% iron.

4) *Insulated Boiler Walls:* Here this system consists of boiler walls of insulated surface. They are kept insulated in order to reduce the transfer of heat from heating surface to the boiler walls and also to reduce the fuel consumption for heat transfer. Plastic walls are used in this project to reduce the prominent heat transfer between heating surface and the wall. The main purpose of refractory material that is used inside a marine boiler is to contain the heat generated by burning of the fuel in the furnace and to minimize heat losses from the furnace. It is therefore important that these materials have insulating properties and are able to withstand high temperatures. Also, the refractory to be used inside boiler furnace should not contaminate the material with which it is in contact

5) *Condenser:* Finally the vapour inside the boiler are collected and condensed using condenser made up of copper tube. Compressed vapour can give high yield but there will be an increase in cost. Here, in this project, Copper tube was used to increase thermal efficiency of the system. Copper has many desirable properties for thermally efficient and durable heat exchangers. First and foremost, copper is an excellent conductor of heat. This means that copper's high thermal conductivity allows heat to pass through it quickly. Other desirable properties of copper in heat exchangers include its corrosion resistance, befouling resistance, maximum allowable stress and internal pressure, creep rupture strength, fatigue strength, hardness, thermal expansion, specific heat, antimicrobial properties, tensile strength, yield strength, high melting point, alloy ability, ease of fabrication, and ease of joining. The combination of these properties enable copper to be specified for heat exchangers in industrial facilities, HVAC systems, vehicular coolers and radiators, and as heat sinks to cool computers, disk drives, televisions, computer monitors, and other electronic equipment.[1] Copper is also incorporated into the bottoms of high-quality cookware because the metal conducts heat quickly and distributes it evenly. Non-copper heat exchangers are also available. Some alternative materials include aluminum, carbon steel, stainless steel, nickel alloys, and titanium. This article focuses on beneficial properties and common applications of copper in heat exchangers. New copper heat exchanger technologies for specific applications are also introduced.

IV. WORKING

Storage tank is used to store the impure and salt water on top of the surface of heater to get the pressure. This tank is made up of either insulated surface or conducting surface. But insulated surface is very much preferred to maintain the temperature of the water. Because, Increase in temperature of the water increases the scale formation on their surface. This tank will consists of two holes namely inlet and outlet holes. Inlet holes are used to bring the hot vapour inside the tank through the copper tube and similarly, the outlet of the tank hole is used to let the impure water outside the tank through the pressure regulator. Pressure regulator used here is basically a passive type of regulator, because they can be only used to decrease the pressure but the cannot able to increase the pressure When the water from tank was directly fed into droplet tube, there will be uniform distribution of water among all the tube holes. In order to regulate the pressure, Pressure Regulator is used. This is made up of plastic so that there will be no additional weight will be carried out. In this project, the pressure regulator cannot increase the pressure but only deceases the pressure from the

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external tank. This is because the pressure should be low enough to convert the continuous flow of water to the droplets. If we want the pressure of more than 1 bar (Atmospheric pressure), the height of the tank should be increased. By this way, the pressure regulator work. This tube is used to carry the impure water from the tank to the Boiler surface.

Main purpose of this Tube is to convert the continuously flowing water to the regular interval and precised drops of water. Droplet tube means a tube made up of plastic, used to convert the still water or continuous flow of water into water droplets. By varying pressure of incoming water using pressure regulator, we can able to vary the speed and size of the droplets. By thus way, Droplet tube works. To improve accuracy of the system, these holes are made accurate and précised in size. Pre-filter before this setup can be involved to eliminate minute impurities which can reduce the affect the heating surface. Instead of using flat surface type of boiler surfaces, this method uses the conical surface to force the impure and half sized impure droplets to the outside edge of the surface of boiler. In this system, conical surface was used as the heating surface. When the Droplet of particular size was fall on conical surface heater, due to heat on surface of boiler, there will be a convection process between the surface and drop occurs, which readily evaporates the drop and makes the size of drop as half of its original size. It should be noted that the surface of the boiler is inclined by 30˚-45˚ (Based on yield requirement). By this way, conical surface heater works. They can be heated by either Electrical heater or Conventional heater Boiler surface is a most important factor for deciding the yield of system. Because the metal surface will get heated and consumes more cost of fuel when the heat is conducted throughout the surface. Likewise when the surface of the boiler walls are made up of ceramics or concretes, then there will be reduced amount of yield because the surface may absorb the water vapour. Here this system consists of boiler walls of insulated surface. They are kept insulated in order to reduce the transfer of heat from heating surface to the boiler walls and also to reduce the fuel consumption for heat transfer. Plastic walls are used in this project to reduce the prominent heat transfer between heating surface and the wall. It is a electromechanical device used to compress the vapour in order to increase the yield of water content Thermo compressors boost low-pressure steam to higher pressures for reuse in multiple applications. This maximizes energy efficiency by retaining the energy in low-pressure steam while increasing its pressure by mixing in high-pressure steam. Booster applications increase the pressure of the steam for increased drying capacity.This tank is used to collect the finally condensed water for potable purpose. It should be noted that, there is always clean and sterile utensils should be used to collect those water in order to reduce human health problems. Finally the water amount was calculated for the yield point and other purposes.

V. ADVANTAGES

A. Small heating surface, so heat transfer rate is high b\w surfaces
B. Fuel consumption is lower than ME
C. No filter or Semipermeable membranes are used, so no solid wastes
D. Solar preheater is renewable and increases efficiency of the plant
E. Low energy consumption compared to other thermal processes[1]
F. Operates at low temperature (< 70 °C) and at low concentration (< 1.5) to avoid corrosion and scaling
G. Does not need pre-treatment of sea water and tolerates variations in sea water conditions
H. Highly reliable and simple to operate
I. 24-hour-a-day continuous operation with minimum supervision
J. Can be adapted to any heat source, including hot water, waste heat from power generation, industrial processes, or solar heating..

VI. APPLICATIONS

A. Main purpose of this project is to convert the impure and salty water into potable water, so this project can be applied on many countries where water scarcity is high
B. Can be applied in power plants in order to produce fresh feed water
C. Can be used in major manufacturing industries as cleaning water purpose

VII. CONCLUSION

It is assumed that, Water scarcity will get double after 10 years in gulf countries. Using Reverse Osmosis technique for desalination of sea water and high saline water like the same cannot be used because of continuous replacement of semipermeable membrane. And also it should be noted that Multi effect vapour distillation cannot also be used because of high fuel requirements, so, our project Distillation by Droplet Evaporation can be used instead for above two because of having high advantages than others. The 3

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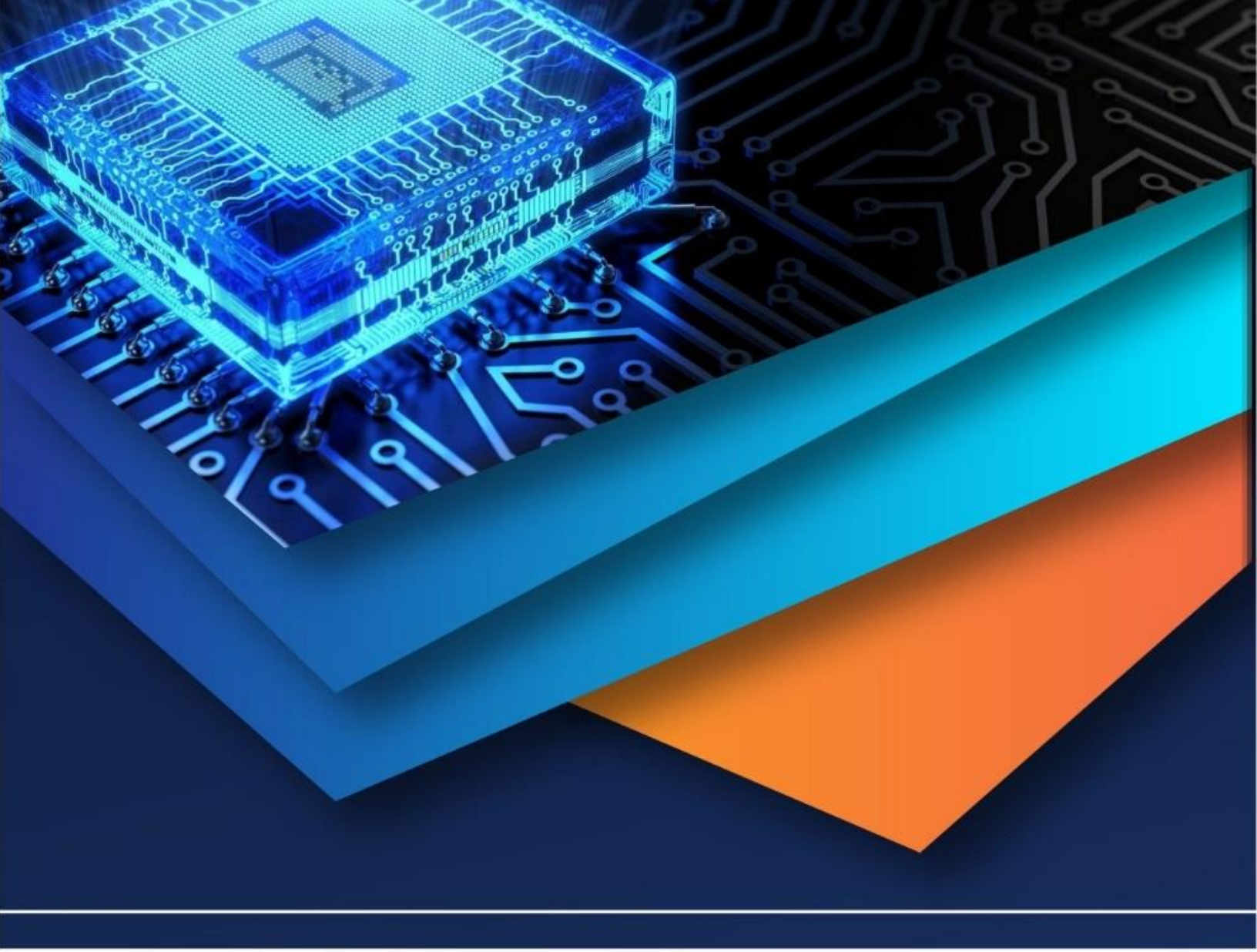
Samples of impure water was collected from locality and tested for the salinity using Digital Salinity tester before and after this method and the results were tabulated below as:

Sl. No	ppm before process	ppm after process
1	300 ppm	35 ppm
2	260 ppm	40 ppm
3	315 ppm	20 ppm

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