NEGATIVE PRESSURE SOLAR DESALINATION

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ABSTRACT

The growth of the population and industrial development ends up in demand of water resources. Water resources cover one third of the planet, rapid growth of population and industrial development ends up in deforestation and declination of water, that results indeficiency of water. In order to over come the crisis the alternate method is rain water harvesting and desalination. Desalination is best answer in order to overcome the water crisis as there is a decrease in the rain fall due to Pollution, Green House Effect, Deforestation etc. it has been calculable that 22million m^3 of freshwater being created per day by Desalination process worldwide, however only 1% of fresh water is obtained by Solar Energy. Generally Direct and Indirect methods are used for desalinating the saline water. The main objective of the projected paper is that, by utilization free energy the saline water can be converted to the potable water by using thermal energy of the solar radiation and negative pressure. Possible outcome is to provide suitable combination to get better yield of drinking water from saline water.

KEY WORDS: *Vacuum, Solar Irradiance, Weather Forecasting, Saline Water, Desalination.*

1. INTRODUCTION

Water is the major element for the life to sustain. Earth's composition consists of 97.5% of saline water (brackish water) and also the 1-2% is offered for domestic's usage. According to the World Health Organization (WHO), it is necessary for a person to consume 15-20 Litres of water per day for a better health conditions, but with the present situation of water scarcity and water pollution it has become very difficult to obtain the amount of a good quality water which is safe to be consumed.

Water resources that typically accessible are rivers, lakes and underground water reservoirs. Concerning 71% of the world is roofed in water, where 96.5% of the Earth's water is found in oceans, 1.7% in Groundwater, 1.7% in Glaciers and also the ice caps and 0.001% within the air as vapour and clouds, only 2.5% of the Earth's water is fresh and 98.8% of that water is in ice and groundwater.[6]

1.1 Need for Desalination:

Due to urbanization, growth in population, consistent raise in the rate of pollution, Green House Affect the number of water resources are being depleted, which has lead to the scarcity of water. Hence an alternative method has to be followed in order face the water crisis in the near future. The saline water of sea, ocean which are available in vast content can be converted to potable water by various methods, which can be used for daily use, can save a large number of lives.

The water quality monitoring results obtained during 1995 to 2006 indicate that the organic and bacterial contamination are continued to be critical in water bodies. This is mainly due to discharge of domestic waste, water mostly in untreated form from the urban centers of the country. The municipal corporations at large are not able to treat increasing the load of municipal sewage flowing into water bodies without treatment. Secondly the receiving water bodies also do not have adequate water for dilution. Therefore, the oxygen demand and bacterial pollution is increasing day by day. This is mainly responsible for water borne diseases. [12]

Analysing the distillation systems, two parameters are very essential to estimate the performance:

The performance magnitude relation (PR), which is the magnitude relation between water physical property of phase transition (2330 kJ/kg), hence the specific thermal energy consumption of the method itself .

The Gain Output magnitude relation (GOR), which is the magnitude relation between the obtained product (kg of condensed vapour) and therefore required energy of the method in terms of kilo of the condensed vapour of the thermal supply.[6]

2. WATER RESOURCES

2.1 AVAILABILITY OF WATER ON EARTH:

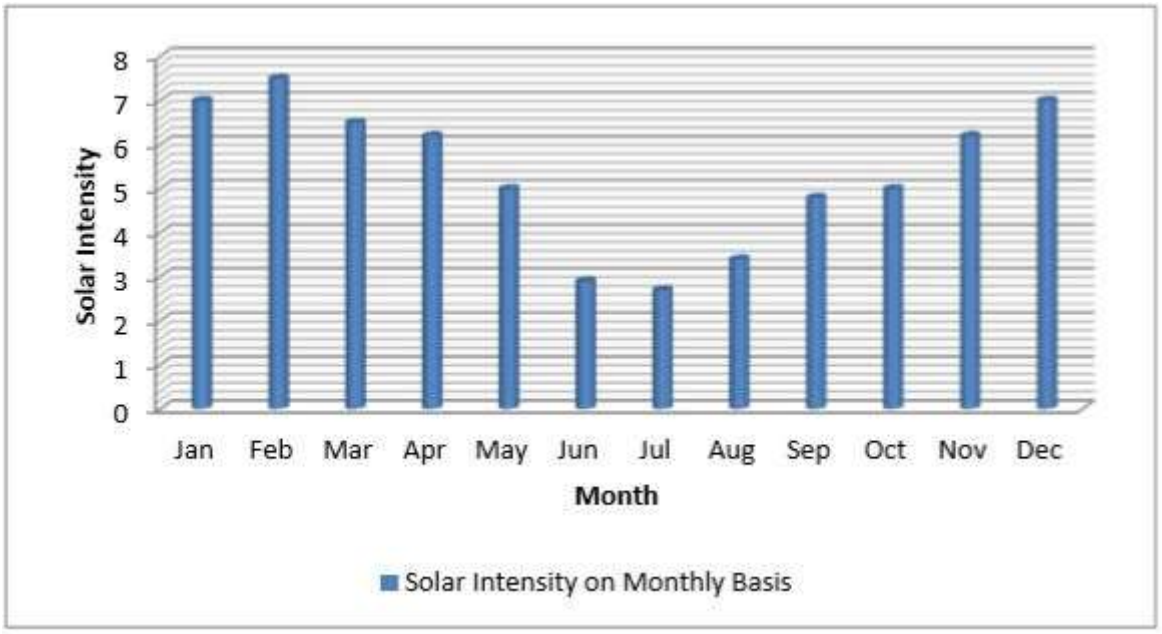
The total volume of water on Earth is estimated as 1.386 billion km³ (333 million cubic miles), with 97.5% being salt water and 2.5% being fresh water of which only 0.3% is in liquid form on the surface and the rest being frozen in to ice.

2.2 AVAILABILITY OF WATER IN INDIA

the annual per capita water availability was 5,177 cubic metres in 1951 but this has declined to 1,545 cubic metres in 2011. However, National Institute of Hydrology pegs India's utilisable per capita water availability at just 938 cubic metres in 2010 and expects this to drop to 814 cubic metres by 2025. [13]

2.3 AVAILABILITY OF WATER IN KARNATAKA

Karnataka Government admits availability of water per person for a day will be 88 liters by 2031, when Bengaluru's population will touch 20 million. Central Public Health and Environmental Engineering organisation says each person needs 135 liters per day. IISC research says Bengaluru gets enough rainfall, but the problem is in harvesting it. The lakes in Bengaluru used to have a storage capacity of 35 tmcft pf water in the year 1800 which has been reduced to 2 tmcft. These results clearly predicts that Karnataka state will have to face a huge water crisis for which the people have to be ready for.[14]



2.4 WATER SCARCITY:

Water deficiency involves water stress, shortage or deficits and water crisis, which could affect the life of all living organisms and nature accordingly. The factors that contribute to the current issue are poor maintenance of resources, lack of attention to the resources and semi synthetic waste being dumped in the water resources.[1] Official knowledge within the past decade depicts annual per capita handiness of water in the country has plummeted considerably with 163 million Indians lacking access to the safe potable water. [2][3]

3. Desalination:

Desalination refers to the removal of salts and minerals from a saline water. Saline water that has been desalinated will be inappropriate for human consumption or irrigation. One by-product of desalination is salt. Heat is critical for distillation of water, electrical or mechanical driven systems will use reverse diffusion to desalinate the water.[4]

3.1 Types of Desalination.

There are 2 methods of desalination technologies which are Direct and Indirect method i.e membrane (RO) and thermal (Multi Effect Desalination, Multi Stage Flash and Mechanical Vapour Compression) desalination respectively. Reverse Osmosis (RO) desalination uses the principle of osmosis to remove the salt and impurities by passing the water through a series of semi-permeable membranes where as thermal desalination involves evaporating the saline water and condensing the vapours in order to obtain the water that is free from salinity.[4]

3.11 Direct solar desalination:

The method of direct solar desalinization is principally to minimum production system like solar stills in the region where the fresh water demand is at least rate this low production rate is explain by the low in operation and pressure of steam. Various attempts have been made by the investigaters to provide fresh water by utilization of solar power. [4]

3.12 Indirect solar desalination:

Indirect solar desalinization strategies involve two separate systems, the gathering of solar power, by astandard solar changing system, coupled to a standard desalination technique. Desalination victimization thermal processes (phase change) are often accomplished using time period flash distillation (MSF), multi result evaporation (MEE), vapour compression (VC), and freeze separation (FS). [4]

4.0 Salinity-gradient solar ponds:

This is a shallow pond with a vertical saltwater gradient, so that the denser saltier water stays at the bottom of the pond and does not mix with the upper layer of fresher water. Consequently, the lower salty layer gets very hot (70–85°C). [4]

5.0 Measuring instruments:

Various types of measurement were used such as: (1) Pyranometer: To measure the total radiation. (2) Glass beaker: To collect the distillate water. (3) Temperature thermometer: to measure temperature at various points in the still by thermocouples (type-k). The accuracy of this device is in the range of 0.3°C for the temperature measurements between 1 and 99°C. [5]

6.0 Main parts of the Negative Pressure Solar Desalination Process:

Basin liner: This is the major part of the solar still. It absorbs the incident radiation that is transmitted through the glass cover. The basin liner should be resistant to hot saline water, have a high absorbance to solar radiation and to resistance to accidental puncturing and in the case of damage, (the shape of drawer, for maintenance and cleaning purposes); it should be easily repaired. A very large part of the solar radiation, direct and diffused, falling in the still is absorbed in the black base. Small reflection losses occur at the glass surface, the water surface and to a very small extent at the base. The energy absorbed at the base is largely transferred to the water in the still and a small fraction of it lost to the ambient by conduction through the base. The water enters the basin through an inlet hose. A trough is fixed inside the still, and is tilted so that condensed water can be accumulated in the glass beaker outside the still through a plastic pipe.[5]

Transparent cover: The cover of the solar still must transmit solar radiation with minimum amount of absorption and reflection in the solar spectrum. It should also act as resistant to thermal radiation heat transfer from the basin to the atmosphere. The cover will be placed at 32 degree with respect to the horizontal axis. [5]

Insulating material: The insulating material is used to reduce the heat losses from the bottom and the sides of the solar still. In this work, the insulating material is Aluminium foil of 0.2 mm thickness and 0.03 W/m2 °C thermal conductivity.[5]

7.0 Methedology

Solar desalination is a conventional process of converting saline water in to potable water. It uses solar energy in order to remove the salt content from the saline water by converting the water to steam and then condensing the same inorder to obtain water which is free from salinity.

The boiling point of saline water will be comparatively more than that of the potable water, hence it will be difficult to obtain boiling point of the saline water just by using the solar intensity also the yield quantity of the fresh water obtained will be less and will consume more time. Hence in order to increase the yield point the boiling point of saline water should be reduced.

When the pressure in a confined chamber is reduced than the atmospheric pressure the boiling temperature also reduces (i.e., p α t) which will be very usefull in converting the saline water in to steam with the help of solar radiation.in order to do so, the chamber which would withstand the negative pressure should be built according to the design.

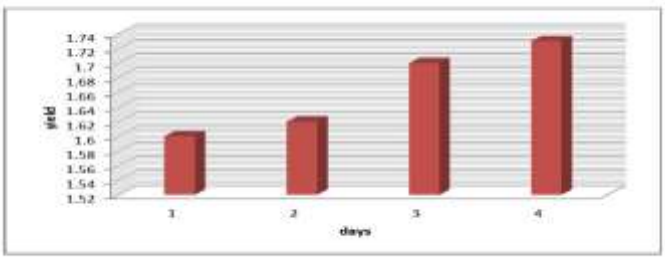
A vacuum pump is used to reduce the pressure in the chamber, when the pressure gets reduced to a desired range the saline water gets converted in to steam at a temperature of 50 to $60^{O}C$. Once the vapours are formed it travels upwards and gets collected at the inclined glass. Here the condensation process takes place and due to the inclination of the glass the water droplets formed from the vapour unite together and flow downwards in to the collector tank.

The yield obtained in this process is comparatively better than the old conventional method and the time period required for an unit quantity of saline water to get converted in to a potable water is also very less than the conventional method as the boiling point will be lesser due to the pressure reduction in the chamber.

Hence negative pressure solar desalination is very useful in a process of obtaining a better output than the conventional method at a faster rate.

Result:

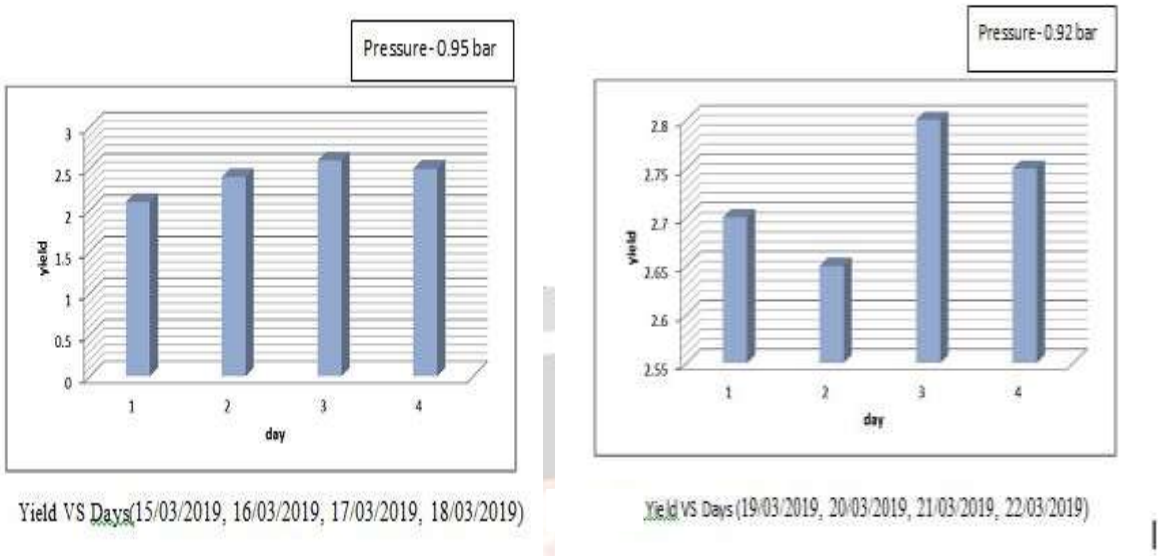
Desalination Without Vacuum.



The variation of Yield obtained per day as the experiment was conducted for 4 Days from 11/03/2019, 12/03/2019, 13/03/2019, 14/03/2019 and the average yield per day is 1.68lts.
As explained before the Yield obtained is lesser in the conventional process as solar intensity reduces after the mid-day i.e from 12:00 pm to 2:00 pm. Also at this time interval the water takes more time to evaporate hence at

the peak hour of solar intensity the process of desalination without vacuum fails to produce more yield. As the water fails to get the heat from the solar radiation after 2:00 pm the water stops evaporating which will be a major constraint for producing more yield

Desalination with Vacuum



Yield VS Days(15/03/2019, 16/03/2019, 17/03/2019, 18/03/2019)

Yield VS Days (19/03/2019, 20/03/2019, 21/03/2019, 22/03/2019)

The yield obtained every different day of conduction of the experiment from 15/03/2019, 16/03/2019, 17/03/2019, 18/03/2019, for a pressure of 0.95 bar
and 19/03/2019, 20/03/2019, 21/03/2019, 22/03/2019 for a pressure of 0.92 bar and the average yield per day is of 2.73ltrs. The more yield is obtained during the time interval of 12:00 pm to 2:00 pm when the solar intensity is very high. At this point of time when the vacuum is created, the water tends to evaporate vigorously as the surface area of the water molecules will be increased with the help of negative pressure and at this point of time when the solar radiation falls on it the water evaporates faster in turn producing more yield at a short span time.
Hence compared to the conventional method of solar desalination method the yield obtained is of about 1ltr more in the Negative Pressure Solar Desalination Process

Conclusion:

By survey we conclude that the water plays a very essential part in sustaining the life source on earth. With the increase in population the rate of pollution increases every day. As on today on the basis of the review we know that water pollution has reached the critical zone. Urbanisation, global warming, and growth in population has resulted in water scarcity. The alternate method in order to overcome the crisis is Negative Pressure Solar Desalination, this process utilizes minimum amount of energy to produce potable water and is completely eco friendly it also utilizes minimum area for installation. The negative pressure helps in reducing the boiling point of saline water, in turn increases the yield point of potable water, i.e more the pressure is reduced more the yield will be obtained.

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