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Intelligent Solar Desalination System on Sea Water

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Abstract. The Paper "**DRINKABLE SEA WATER"** is to Applicable See water. The technology Desalination is one of the most traditional processes to generate potable water. With the rise in demand for potable water and scarcity of fresh water resources, this process has gained special importance. Conventional desalination system use coal as a fuel for water heating purpose. Although coal is depleting with time and it is harmful to human. In addition, conventional thermal desalination processes involve evaporative methods such as multi-stage flash and solar distils, which are found to be energy intensive, whereas reverse osmosis-based systems have high operating and maintenance costs. My Paper is describing the **Try bed Adsorption Desalination (3- BAD)** system, which is an emerging process of thermal desalination cum refrigeration capable of utilizing low-grade heat easily obtainable from even non-concentrating type solar collectors. The system employs a combination of flash evaporation and thermal compression to generate cooling and desalinated water. Parabolic trough collector used for heating of water. To design, construct and test the solar desalination system with try and more adsorbed bed. It also has the ability to cool the water along with potable water. The cycle produces 7.598 liters /day in a span of 7.30 hours with a COP of 0.697 which is maximum, comes at noon. This technology produces single products drinkable water.

Keywords: Adsorption **D**esalination, Desalination, 3-BAD.

1 Introduction

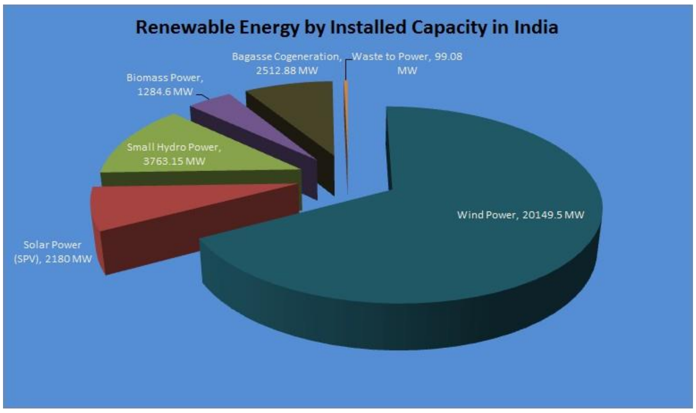
The search for fresh or potable water remains a pressing concern throughout many regions of the world, even though most of the Earth's surface is covered by oceans. The World Health Organization (WHO) reported that about 41% of the Earth's population lives in water-stressed areas and the number of people in the water scarce regions may climb to more than 3.5 billion by the year 2025+. Hence, there is a great motivation to explore a more efficient and environmental-friendly desalination method. The methods for desalination available hitherto are categorized into two groups, namely, the thermally and the electric power-driven methods. The thermal activated process includes multistage flash (MSF) and multi-effect desalination (MED) whereas the second method includes membrane-based reverse osmosis (RO), freezing, mechanical vapor compression and electro dialysis. The hybrid plants are a combination of the RO and the MSF processes and they can recover higher water yields of water with lesser dissolved solids (<500 mg/l) for human consumption, as stipulated by the World Health Organization (WHO) standards. Ion exchangeis another hybrid method whereby ions of dissolved inorganic salts are replaced with the more desirable ions, and such as a process have been used to minimize the fouling and carry-over to the water. The aforesaid types of desalination suffer from three fundamental drawbacks:

(i) The high thermal energy consumption as the processes are maintained at higher driving source temperatures,

(ii) the high electric energy consumption due to the poor recovery ratios and

(iii) the high maintenance cost arising from salt deposition, fouling in the evaporating unit or the frequent replacement of membranes.

The objective of this work is to design, construct and test the solar desalination system with dual and more adsorbed bed to increase the potable water production to determine coefficient of performance (COP) to test and compare the effect of temperature on the performance parameters of adsorption desalination system to ability to cool the water along with natural process for mineral water potable water and to collect high density of salt water.



2 Methodology

Your In a first aspect, the Paper provides a water desalination system comprising: at least one pair of evaporators, said pair comprising a high pressure and a low pressure evaporator, each for evaporating saline water to produce water vapour; at least three adsorption beds in selective vapour communication with each evaporator, said adsorption beds arranged to reversibly adsorb the water vapour from the corresponding evaporator; said adsorption beds in selective vapour communication with a condenser, and in heat transfer communication with a heat source for selectively desorbing the adsorbed water vapour; said condenser arranged to condense the water vapour to desalinated water; wherein said system is arranged to sequentially connect, for a pre-determined period, each evaporator to a corresponding adsorption bed, and the heat source to the third bed.

In a second aspect, the Paper provides a method for desalinating water, the method comprising the steps of: evaporating saline water in a high pressure and a low pressure evaporator to produce water vapour; directing the water vapour from the high pressure evaporator to a first adsorption bed, and adsorbing water vapour until an adsorption medium within said first bed is saturated; directing the water vapour from the low pressure evaporator to a second adsorption bed and adsorbing the water vapour by an adsorption medium within said second bed; heating a saturated adsorption medium within a third adsorption bed to desorbs watervapour from said medium; directing the desorbed water vapour to a condenser, and condensing said water vapour to desalinated water.In a third aspect, the Paper provides a cooling system comprising: at least one pair of evaporators, said pair comprising a high pressure and a low pressure evaporator, each for evaporating saline water to produce water vapour during an evaporative cycle; a first and second water circulation system in heat transfer communication with said respective high and low pressure evaporators; wherein following an evaporative cycle, the system is arranged to collect cooled water from the first water circulation system and chilled water from the second water circulation system.

In a fourth aspect, the Paper provides a method of cooling comprising the steps of: providing at least one pair of evaporators, said pair comprising a high pressure and a low pressure evaporator; evaporating saline water in each evaporator to produce water vapour during an evaporative cycle; providing a first and second water circulation system in heat transfer communication with said respective high and low pressure evaporators; following an evaporative cycle, collecting cooled water from the first water circulation system and chilled water from the second water circulation system. An adsorption process refers to the vapor communication or uptake between a bed (containing unsaturated adsorbent) with either the low or the high pressure evaporator; the high pressure evaporator produces a cooling stream at temperatures near to the ambient temperatures, typically from 20 to 30° C. which can be directly for sensible or process cooling. The said low pressure evaporator, on the other hand, generates a stream of coolant at 5 to 10° C. which is useful for air conditioning or dehumidification. Owing to these external thermal loads, the vapor pressures in the evaporators are maintained. A desorption process refers to the removal of adsorbed water vapor from the adsorbent by the application of heat, supplied from a coolant heat source or any other means. The desorbed vapor is collected in the condenser; said condenser is adapted to condense the water vapor as desalinated water. In one embodiment, the Paper may include an adsorption-desalination cycle comprising three-adsorption bed and two-evaporator assembled to operate as an adsorption device in which a two-temperature level type of cooling (both sensible and dehumidification) is generated at the evaporators whilst concomitantly, fresh or potable water may be produced at the condenser. The embodiment may include arrangements of the high and low-pressure evaporators in thermal and mass communication with the adsorbent beds, operating in tandem and yet in a pre-determined˜manner with an externally supplied heat source. In a further embodiment, the system may include an AD cycle which produces cooling and desalination, with a heat source for desorbing an adsorption bed at a low temperature heat input varying from 65 to 75° C. The proposed Paper may be directed to two key parameters, namely the specific daily water production (SDWP) and the cooling capacity. In a further embodiment, chilled water at 4° C. to 10° C. may be produced from the low-pressure evaporator, which may be used for residential air-conditioning while the high-pressure evaporator may produce chilled water at 18° C. to 27° C. which may be utilized for district process cooling, or industrial cooling systems In one embodiment, the water vapour from the evaporators and heat source may be respectively directed to the corresponding adsorption bed for the pre-determined period. This pre-determined period may be a function of the desorption rate of a saturated adsorption bed. Alternatively the pre-determined period may be a function of the rate of saturation of an adsorption bed. Further, the pre-determined period may be the greater of the period to adsorb a saturated adsorption bed and the period to saturate unsaturated adsorption bed. In a preferred embodiment, two heat exchanger chambers may be used for the evaporation of saline, brackish or waste water where the energy for evaporation is extracted from the cool water and chilled water circuits, the said cool and chilled water circuits may be used for dehumidification purposes. External cooling for condensation may be required and the heat of condensation may be recovered for the evaporation process of saline water at the higher pressure evaporator. According to a further embodiment, each adsorption bed comprises finned tube heat exchanger with the adsorbent material placed in spaces between finned tubes. Said material may be silica gel, synthetic Zeolite, or any other hydrophilic porousadsorbent having a specific surface pore area not less than 500 m2/g. In a more preferred embodiment, at least one array of adsorbent beds may be arranged vertically within at least one adsorption bed tower, each of said beds may include a mesh adapted to encapsulate the heat exchanger so as to retain the adsorbent material. According to a further embodiment of the Paper, the temperature range within the low pressure evaporator may be in the range 5° C. to 10° C., whereas the temperature of the higher pressure evaporator ranges from 20 to 30° C. In a further embodiment, there may be the use of a cool water recirculation system to enhance the boiling in the evaporator at relatively high pressure, and the amount of water vapor uptakes in the adsorbent bed, there may also be the use of chill-water recirculating system. According to a further aspect of the Paper there is provided further consequence of using low and moderate temperature evaporation rather than direct heating of the saline water to produce water vapor is that at these low temperatures, fouling is reduced significantly and thus lowers the maintenance cost of plant operation. In a preferred embodiment, conventional carbon steel may be used for many of the key components of the proposed AD plant such as theadsorbed and desorbed beds, as well as the condenser unit due to low fouling rates at sub atmospheric pressures. Only the evaporator unit may require alloy steel to prevent excessive corrosion. In a further embodiment, chilled water from the evaporators may be used to cool the designated disrober bed for the first quarter of the cycle and then re-directed to the adsorption beds for the second quarter of the cycle. During these periods, low and high pressure evaporators are connected to the designated adsorption bed. By increasing the evaporator pressure (with the cooler water), the amount of water vapor uptake is further increased for the second quarter of the cycle. The lowering of the adsorbent temperature (when chilled water is channeled into the absorber towers) may enhance the vapor-uptake by the adsorbent. In general, the Paper may include a process for desalinating water comprising the steps of lower and higher pressure evaporating saline water within two evaporators, alternatively to produce water vapor; adsorbing the water vapor from the evaporator using an adsorption means in the adsorption beds for low and high pressurized (sub-atmospheric) water vapor communications; desorbing the adsorbed water vapor from the adsorption means using desorbing means and delivering the water vapor to a condenser; condensing the water vapor to form desalinated water. In a further embodiment, the first and second stages of evaporating and adsorbing steps may be performed until saturation of the adsorption means, and the desorbing and condensing steps commenced until a substantial quantity of the adsorbed water vapor has been desorbed from the adsorption means. In one embodiment, the adsorbing step may be performed until saturation of the adsorbent means. In a further embodiment, the desorbing step may be performed until the adsorbed water vapor is substantially removed from the desorption bed. In a preferred embodiment, the process may switch the adsorbing step and the desorbing step between the adsorption beds, either at saturation or at substantial removal of adsorbed water vapor or when both processes are complete. According to a third aspect of the Paper, there is provided a process for effective and sensible cooling comprising the steps of low and high pressure (sub-atmospheric) evaporation of saline water in the two evaporators to produce water vapor; adsorbing the water vapor from the evaporator using an adsorption means in the adsorption beds for low and high pressurized water vapor communications. Due to the adsorption-triggered-evaporation processes, sensible cooling is at the high pressure evaporator, and the effective cooling occurs at the low pressure evaporator.

In a preferred embodiment, the stainless steel-finned tubes are arranged either horizontally or vertically in two evaporators and one condenser. The said evaporation is achieved by pool boiling process and the energy for evaporation is obtained from the external cooling water circuits. The said condensation is achieved by desorption of desorbed water vapors inside the condenser where the condensation may be either film or drop wise. In a preferred embodiment of the Paper, the evaporator and the condenser are made of anti-corrosive materials such as alloy steel to prevent excessive corrosion. The rest components ofthe plant such as absorber and disrober chamber can be made of conventional carbon steel or concrete.

3 Conclusion

As the world population increases, the requirement of water for various purposes also increases. But the water is less available as compared to the population. Only one percent of water is accessible to the population and other being locked in various reservoirs or as seawater. In addition to WHO after research came to know that, huge amount of people does not get uncontaminated water, and about 41% of Earth's population live in the semi-drought areas, and this population may rise up to 3.5 billion by the year 2025. So desalination of seawater is necessary to tackle the problem of water. But problem not stops here, because conventional desalination system uses fossil fuels for start-up of the system which is harmful to environment.

The end product is harmful as it contains carbon and other harmful products. So the desalination with non-conventional source should be used to tackle the problem environment hazard problem. In present work adsorption desalination system is introduced which tackle water problem but ultimately the environment hazard problem also.

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