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Experimental Investigation on Solar Desalination Using Copper Oxide Nano fluid

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Abstract:
The main objective of the study is to review the various factors that play a role in increasing the desalinated water prices up and to find an alternative solution for it. Here the heat exchanger uses nano fluid as exchanging material and solar thermal power is used. Hence we are about to see whether these changes are efficient in bringing down the cost. The present study introduces an attempt for the application of flash desalination technique for small scale needs. An integrated system uses a flashing desalination technique coupled with nano-fluid-based solar collector as a heat source has been made to investigate both the effect of different operating modes and that of the variation of functioning parameters and weather conditions on the fresh water production. The thermal properties of working fluid in the solar collector have been improved by using different concentrated nano-particles. The volume fractions of nano-particle in solar collector working fluid have a significant impact on increasing the fresh water production and decreasing cost.

- *The solar thermal power is used as a heating source to bring the water to a temperature in which it produces steam.*
- *This might be an alternative energy source for the existing conventional type of desalination.*
- *The difference with this research is that the heat exchanger fluid used here contains Cuo nano particles which makes it to be a CuO nano fluid, thus enhancing the heat transfer.*

Keywords **— Solar Desalination, Copper Oxide , Nano Fluid**

Specifications Table

Subject area	• *Engineering*
More specific subject area	*The research deals in advancing the concepts used in engineering, thus providing an alternate method for producing same result in a engineering approach.*
Method name	*Solar Desalination*

I. PROCESS OF OPERATION

The process followed for the accomplishment of the project is as following:

1.1 PART I

- Research work for the desalination technique using solar thermal energy
- Design of Components as per requirement
- Purchase of products necessary for the system

1.2 PART II

- Assembling of the system as per design
- Testing the working of the plant to check and find out flaws
- Use of Nano fluid as the heat exchanger fluid to enhance heat transfer

1.3 PART III

- Running the plant at different conditions and testing the performance

- Calculating the capacity of the plant and the efficiency
- Comparing the cost of production of desalinated water with conventional type

1.3 Complete Structure

Figure 1.1Complete structure of the desallination plant

Flate plate collector is attached to flashing chamber stand and tubes has been connectd to the flashing chamber for passing the nano fluid. The flate plate solar collector is kept inside the glass frame this is to restrict the heat passing out and the ventillation to the collector. Beneath the collector cosist of a alumunium sheet this is also to restrict the loss of heat. A barrel is kept near to drain valve so that the hot water flows to the barrel, the barrel consist of three holes one for the inlet and one for the passage of steam and one for the hand pump. Here the hand pump is used to circulate the water to chamber again.

When the flashing chamber reaches the highest temperature the drain valve will be opened and the water inside the chamber will flow to the barrel so that the steam will be passed to the radiator via insulated tube this is to condense the the steam coming from the barrel.The condensed water is the desallinated water and it will be collected in a container.

The water in the barrel will be pumped agin to the flashing chamber by hand pump and it can be desallinated again.

1.4 Two step method

For oxide type nano fluid is prepared in two step method this method is most suitable as it does not allow particles to agglomerate.

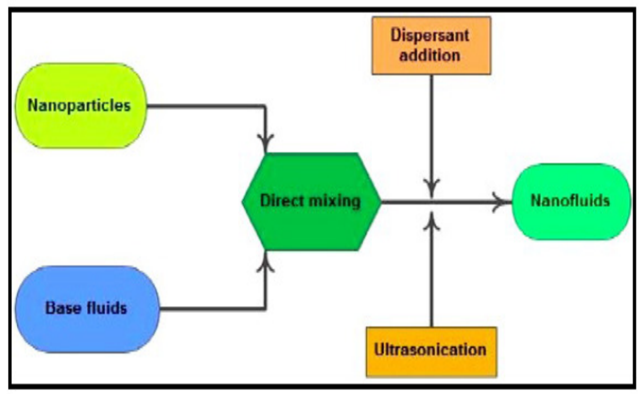

Figure 1.2 Two step method

II. PREPARATION OF NANO FLUID

Figure 2.1 Ultrasonicator bath top view

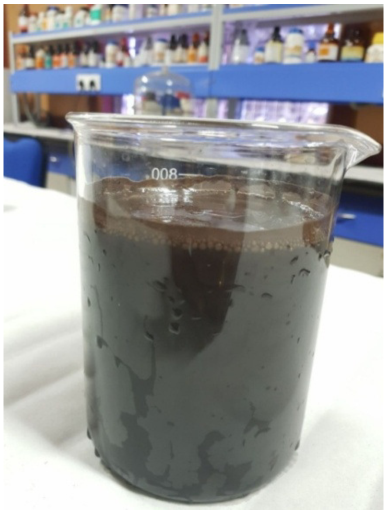

Figure 2.2 Prepared nano fluid

- The copper oxide is mixed in 3000 ml of water which is equally divided in 6 beakers of 500 ml each.
- In one iteration two beakers are kept in the ultrasonicator bath and iterated for 40 minutes.
- Thus total iteration happened in 120 minutes to complete the preparation of nano fluid.

2.1 Desalination Plant Assessment

Table 2.1 Thermo-physical properties of CuO Nanofluids at different volume concentrations

S.No	Volume Fraction in %	Thermal Conductivity W/mK	Density Kg/m^3	Specific Heat J/KgK
1	0.025	0.3118	1023.87	3860.85
2	0.1	0.3158	1027.78	3858.1
3	0.4	0.3271	1044.32	3846.92
4	0.8	0.343	1065.18	3832.19
5	1.2	0.3591	1065.93	3832.89

We have taken the 0.025% of volume fraction since the higher volume fraction may leads to sediment formation. From the table 2.1 the thermal conductivity of 0.025 % of volume fraction fluid is 0.3118W/mK , density is 1023.87 Kg/m^3 and the specific heat is 3860 J/KgK.

Table 2.2 Temperature reading without nano fluid and with nano fluid

TIME	WITHOUT NANO FLUID	WITH NANO FLUID(COPPER OXIDE)	PERCENTAGE OF INCREASE %
7:00:00 AM	38.33	38.33	0
8:00:00 AM	42	42	0
9:00:00 AM	44.33	46.33	4.32
10:00:00 AM	47	49.33	4.73
11:00:00 AM	55	59	6.78
12:00:00 PM	60.33	65.67	8.12
1:00:00 PM	63.67	70	9.05
2:00:00 PM	65	70.67	8.02
3:00:00 PM	64.67	70.33	8.06
4:00:00 PM	64.33	70	8.1
5:00:00 PM	64.33	70	8.1
6:00:00 PM	64.33	69.33	7.21
7:00:00 PM	64.33	69.33	6.25
		AVERAGE	6.06

The table contains the temperature reading of without and with nano fluid, average percentage of increase in temperature after using of nano fluid is 6.06 %. Water is filled in the heat exchanger instead of nano fluid and the temperature is reading is taken for each hour the same process is repeated for three days. Similar process is done for with nano fluid, here the nano fluid will be poured in the heat exchanger instead of water and the temperature reading is taken every hour for three days.

2.3 Heat Input for Solar Collector

Table 2.3 Heat input to solar collector for different months

MONTH	I (SOLAR INTENSITY)	TRANSMISSION COEFFICIENT	ABSORPTION COEFFICIENT	A (AREA OF COLLECTOR)	Qi (HEAT INPUT)
JAN	5.39				9.01
FEB	6.27				10.48
MAR	6.74				11.27
APR	6.88				11.50
MAY	6.58				11.00
JUN	6.01	0.88	0.95	2	10.05
JUL	5.74				9.60
AUG	5.7				9.53
SEP	5.78				9.66
OCT	4.85				8.11
NOV	4.58				7.66
DEC	4.77				7.98
AVG	5.77	0.88	0.95	2	9.65

$$Q_i = I\ (\tau\ \alpha) \qquad \text{……eqn(1)}$$

where

Qi is Heat Input (KW)
I is Solar intensity
α is absorption coefficient
τ is transmission coefficient
A is area of the collector

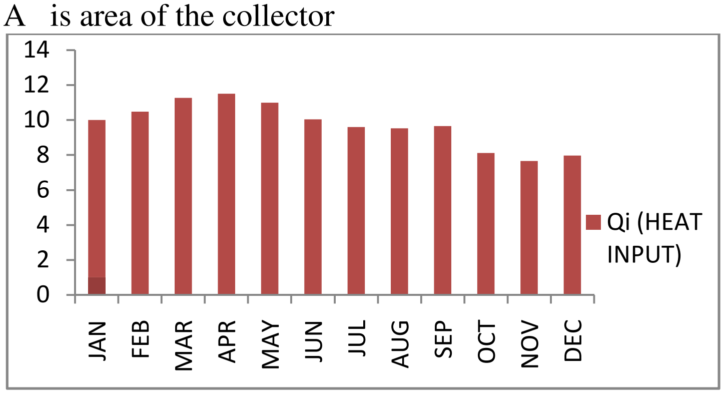

Figure 2.3 Heat input for different solar intensities

The above graph shows that the March, April, May will be having highest heat input of the year.

2.4 Heat loss and Net heat gained

Heat loss from solar collector

$$Q_o = U_L A\ (T_c - T_a) \qquad \text{…..eqn(2)}$$

where
Qo is Heat Loss
UL is Overall heat loss coefficient
A is Area of the collector
Tcis Collector average temperature
Ta is ambient temperature

2.5 Net heat gained from collector

$$Q_u = Q_i - Q_o = I\ \tau\ \alpha * A - U_L A\ (T_c - T_a) \qquad \text{……eqn(3)}$$

Where,

Q_u is Heat gain W
Q_i is Heat input W
Q_o is Heat loss W
I is Solar intensity
αis absorption coefficient
τis transmission coefficient
A is area of the collector
U_L is Overall heat loss coefficient
A is Area of the collector
$T_c$is collector average temperature
Ta is ambient temperature

Table 2.4 Power required for heat different capacity of water

LITRES	AMBIENT TEMPERATURE	REQUIRED TEMPERATURE	TEMPERATURE RISE	CONSTANT	POWER REQUIRED (KW)
10	25	70	45	3600	0.525
20	25	70	45	3600	1.05
30	25	70	45	3600	1.575
40	25	70	45	3600	2.1
50	25	70	45	3600	2.625

The above mentioned table is the power required to heat different volume of water. Since the power required for 50 litres of water is 2.625 KW but heat we gained is 8 KW even though there will be some minor power loss due to reflection, but still there will be enough power to generate steam.

III.TEST RESULTS

The test done is total salt dissolved in the water for both salt content water and desalinated water.

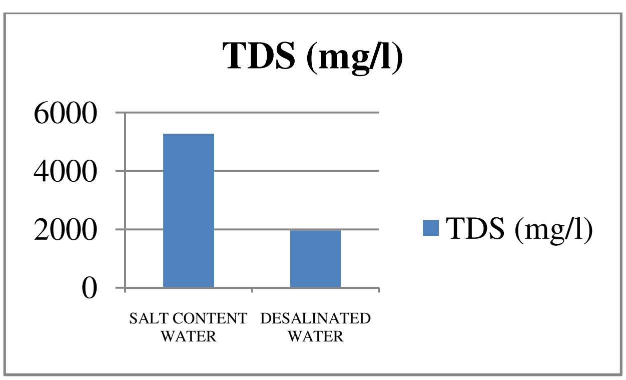

Figure 3.1 Difference of TDS in both samples

- The total dissolved salt in salt content water is 5272 mg/l.
- The salt content in desalinated water after testing was found to be 1952 mg/l.
- Hence after desalination of water the amount of reduction of salt content is 62.84 %.
- Thus the removal of salt content from the water is found to be successful.

3.1 Drawbacks

- Though the objective of the project was found to be successful, the quantity of water desalinated is very less.
- The average amount desalinated water is close to half a liter.
- Modifications to be done to achieve more productivity are,
  - Use of evacuated tube collector as it produces more temperature than flat plate collector.
  - Use of more quality products for heat exchanger and insulation might have restricted the heat loss.

IV. CONCLUSION

The present study introduces an attempt for the application of flash desalination technique for small scale needs. The flashing unit is performed by similar construction design technique of commercial flashing plant. The thermal properties of working fluid in the solar collector have been improved by using different concentrated nano-particles. Cu nano particle is used in the modeling to determine the proper nano-fluid volume fraction that gives higher fresh water productivity.

- The desalination of water is done using the solar energy by using Copper oxide nano fluid as heat exchanger.

- There is a 6.06% increase in temperature obtained in the chamber by using the nano fluid.
- The salt content in the water is reduced by 62.84 %.
- The objective was successfully accomplished though the quantity of water desalinated was less.
- Further advancement in the project may lead to more quantity conversion of desalinated water.

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