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BRACKISH WATER DISTILLATION SYSTEM FOR GOREWADAWATER TREATMENT PLANT, NAGPUR BY USING SOLAR ENERGY -A CASE STUDY

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ABSTRACT

The supply of clean water that can be used to meet human demands is very limited, where only less than one percent is available. Water shortage faced by India has become worse each year due to the impacts of global warming thus limiting the clean water supply for their domestic use. The use of oil/diesel generators to purify the recycle used water or brackish water is very exclusive and non-environment friendly; hence a need of developing a renewable energy water recycling method is to be addressed, as such provided by this case study. This paper presents development of brackish water distillation system by using solar energy for Gorewada water purification plant, Nagpur. It also presents thermal and CFD analysis of proposed single basin double slope solar still. The simulated results depicted that solar disitillation system is very applicable and essentially useful for Gorewada Water Purification plant, Nagpur.

KEYWORD: Solar still, Distillation, Gorewada NMC Plant, CFD, Water.

INTRODUCTION

Water is one of the essential requirements for life. although water covers more than 70% of earth surface, less than 1% of that resource is available as fresh water- and this is not evenly distributed throughout the world. The quantity of water available to all people should be 50-

100 liters per person per day, or an absolute minimum of 20 liters per person per day. Drinking water must be free from pathogenic (disease causing) micro-organisms and free from chemical and physical contaminants that constitute a danger to a person's health. In Nagpur, there are two main source of water supplying system which is namely, Kanhan (Nagpur) and Pench River (Madhya Pradesh). Also in Nagpur, this water is treated in two destinations one is Kanhan Water Treatment Plant (KWTP) and Pench water treatment plant. From total requirement of water 35% is handled by KWTP and 65% is satisfied by Pench Water treatment plant. In average Nagpur's total water requirement is 765 MLD.

1.1 Purification Processes:-The purification process divided into given stages: Aeration, Coagulation, Flocculation, Sedimentation, and Filtration.

1.1.1 Aeration:-Water freshening is often required in water bodies that suffer from hypoxic or anoxic conditions, often caused by upstream human activities such as sewage discharges, agricultural run-off, or over-baiting a fishing lake. For directing this process, the aerators that may are, commonly, used are gravity aerators; spray aerators, diffusers and mechanical aerators (2). As shown in fig-03, Aeration can be achieved through the fusion of air into the bottom of the lake or by surface agitation from a fountain or spray-like device to allow for oxygen exchange at the surface and the release of gasses such as carbon dioxide, methaneor hydrogen sulfide (2). Dissolved oxygen (DO) is a major contributor to water quality. Fish, as well as most other aquatic animals, need it, but aerobic bacteria help decompose organic matter. When oxygen congregation becomes low, anoxic conditions may develop which can decrease the ability of the water body to support life. In this plant, the Cascade Aerators is used for absorption of oxygen in the water. A cascade aerator consists of a number of steps in a particular manner that the water flows over. In all cascade aerators, aeration is finished in the splash zones. Cascade aerators can be used to oxidize iron and to partially reduce dissolved gases.

Figure i: - Aeration process.

1.1.2 Coagulation:-The process of coagulation and flocculation may be broadly described as a chemical/physical process of blending or mixing a coagulating chemical into a stream and then gently stirring the blended mixture (2). Coagulation is a chemical process that involves neutralization of charge whereas flocculation is a physical process and does not involve neutralization of charge. The process of adding a chemical to cause the suspended material to "clump" into larger particles is called flocculation or coagulation (1). The coagulation-flocculation process can be used as a preliminary or intermediary step between other water or wastewater treatment processes like filtration and sedimentation. Iron and aluminum salts are the most widely used coagulants but salts of other metals such as titanium and zirconium have been found to be highly effective as well. Solids are removed by sedimentation (settling) followed by filtration. Small particles are not removed efficiently by sedimentation because they settle too slowly; they may also pass through filters. They would be easier to remove if they clumped together (coagulated) to form larger particles, but they don't because they have a negative charge and repel each other (like two north poles of a magnet).

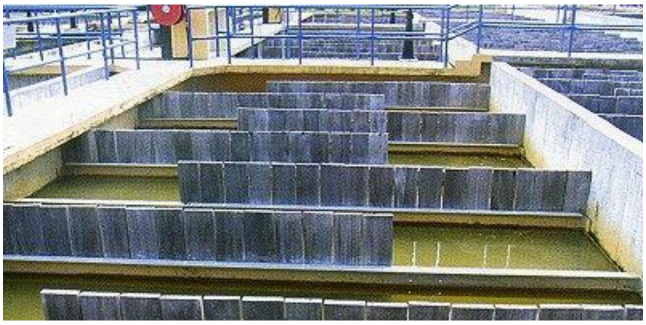

Figure ii: Coagulation.

In coagulation, from fig-04 we add a chemical such as alum or poly aluminum chloride (PAC) which produces positive charges to neutralize the negative charges on the particles. Then the particles can stick together, forming larger particles which are more easily removed. The coagulation process involves the addition of the chemical (e.g. alum) and then a rapid mixing to dissolve the chemical and distribute it evenly throughout the water.

1.1.3 Flocculation:-Following the first step of coagulation, a second process called flocculation occurs. Flocculation, a gentle mixing stage, increases the particle size from submicroscopic microfloc to visible suspended particles it is shown in fig-05 given below. The microflocs are brought into contact with each other through the process of slow mixing. Collisions of the microfloc particles cause them to bond to produce larger, visible flocs called pinflocs (2).

Figure iii- Flocculation.

Now that the particles have a neutral charge and can stick together. The water flows into a tank with paddles that provide slow mixing and bring the small particles together to form larger particles called flocs. Mixing is done quite slowly and gently in the flocculation step. If the mixing is too fast, the flocs will break apart into small particles that are difficult to remove by sedimentation or filtration.

1.1.4 Sedimentation:-Sedimentation is a common way of treating water. It is a process that removes solids that float and settle in the water. The process relies on the use of sedimentation tanks that remove larger solids. Subsequent treatment processes may be used after sedimentation. It is important to understand how sedimentation is used in the treatment of drinking water and waste water. Sedimentation is the process of allowing particles in suspension in water to settle out of the suspension under the effect of gravity. The particles that settle out from the suspension become sediment, and in water treatment is known as sludge (2). When a thick layer of sediment continues to settle, this is known as consolidation. When consolidation of sediment, or sludge, is assisted by mechanical means then this is known as thickening. This process can be seen in above fig-06. In water treatment sedimentation might be used to reduce the concentration of particles in suspension before the application of coagulation, to reduce the amount of coagulating chemicals needed, or after coagulation and, possibly, flocculation. When sedimentation is applied after coagulation, its purpose is usually to reduce the concentration of solids in suspension so that the subsequent filtration can function most effectively. Sedimentation is one of several methods for application prior to filtration: other options include dissolved air flotation and some methods of filtration.

Figure iv- Sedimentation.

1.1.5 Filtration:-Water flows through a filter designed to remove particles in the water. The filters are made of layers of sand and gravel, and in some cases, crushed anthracite (2). Filtration collects the suspended impurities in water and enhances the effectiveness of disinfection. The filters are routinely cleaned by backwashing. The most common being sand and gravel (3). The particles are lighter than the sand, so they rise up and are flushed from the system. When backwashing is complete, the sand settles down onto the gravel, flow is reversed and the process begins again.

Figure v- Filtration.

Problem Identified

In the company, the problem we noticed that during the filtration process, 0.25% of water is removed from the purified water as a waste. This water contains the maximum amount of chemicals and impurities, as this water before coming with the purification process and it is removed out because it is not able to purify in the purification process. This wasted water is again recycled by feed into the raw water. Due to these contaminants and harmful chemicals present in this wasted water, this increases impurities in the raw water again. And this process repeats again and again. Hence, this the adeptness results in the time required for the purification process increases. Also, it is noticed that Water is a second necessary substance after the air for the survival of mankind on this planet. People get infected due to a supply of muddy water. infectious diseases caused by pathogenic bacteria, viruses, and parasites are the most common and widespread health risk associated with drinking water and it is challengeable water pollution problem faced by people. Shortage of water is also one of the main problems faced in rural areas. For this problem we identified the solution given below:-

LITERATURE REVIEW

Pixyish Pal et al.[9] after the Experimental Study of double slope single basin solar distiller has found the following results, Heat input has increased due to transparent east,west and south walls and hence there was a significant increase in the yield and efficiency. Water was collected from the south wall also as it is made transparent, hence, the yield of the still has improved. The maximum measured solar radiation was 876 W/m2 at 12:00 h and maximum measured ambient temperature was 32.2 °C at 14:00 h. The maximum measured yield obtained was 526 ml at 13:00 h. The cumulative yield was 2744 ml/day at 1 cm water depth. The maximum (instantaneous) thermal efficiency and overall thermal efficiency of proposed solar still were 26.74% and 12.35%, respectively. RahulDev et al[10] has done the experimental study on double slope single basin solar still has found that The amount of distillate found to 3624 ml/day. And it can be used in areas where water contains lot of impurities and can be useful in the slum areas. S. N. Husainy[11] has observed that, solar still continues to produce the fresh water by converting mud water. The distillate production is said to be increased to 10-25% with PCM. The energy storage materials in the still store considerable amount of heat during noon hours and release the stored heat to the basin water in the late afternoon hours when radiation is low, and are found to influence the temperature of the solar still components considerably. Output of the conventional still is higher in the morning whereas the output of the energy storage material still is higher in the evening hours. The energy storage materials which are used in this investigation system are economically suitable for solar still to improve the output and efficiency. In this study, physical and chemical tests are performed on the water distilled from the solar stills. The distilled water from the solar stills was collected in a plastic bottle. Kalidasa Murugavel et al[5,6] performed an experiment and In this work, a single basin double slope solar still is fabricated and tested. Theoretical and thermal models were used to predict the year round performance for the year 2008. ASHRAE[20] radiation model and meteorological data for the local place are used to estimate the irradiances received at the covers in different months. The production rate variations for different months have been studied as a function of local time. In November and March the variations are steeper. Similarly the time for maximum production rate is also different for different months. This is due to variations in irradiance incidence on the covers, atmospheric temperature and wind velocity. The overall production is higher in March, April, August, November and December and it is around 4 L/day. The average production of the still is 2.1 L/day/m2. MD. IrfanAli ET an l[12] after analyzing has found that,the performance of solar-still with two different photo-catalysts, granular activated carbon (GAC) and PbO2 was in-vest gated. The output from the solar-still with 0.5 kg GAC was recorded to be 1.44 kg, and the output with 1 kg GAC and 0.5 kg PbO2wasrecorded to be 2.45 kg. By increasing the con-centration of GAC to 1 kg and by adding 0.5 kgPbO2the efficiency of the still increased to 40 %. It was found that the out-put from the still in the night hours is 30-40 % of the output obtained in the day hours. The pH of desalinated water decreased to 6.5 from 7.42. The total dissolved solids concentration in desalinated water de-creased from 698 mg/lit to 44 mg/lit resulting in 93.6 % de-crease. Total hardness as CaCO3in the desalinated water de-creased from 618 mg/lit to 40 mg/lit, resulting in 93.5 % de-crease. Chlorides in the desalinated water decreased from 238 5 mg/l to 8.4 mg/lit resulting in 96.4 % decrease. Hence the use by increasing the evaporation rate in the solar-still. Omar Butt et al[13] after comparing both temperatures and condensate production fields between passive and active solar stills have been performed and also graphically illustrated. Results show that the proposed enhancement conception of the passive solar still by combination with the present preheating system (Cylindrical solar water heater) has relevantly improved its capacities namely the temperature and mass rate distillate production. In the passive situation it was found 66.12 °C of heating water temperature, on the other hand it is increased reaching 75.06 °C which represents a important augmentation difference by 8.94 °C. The second investigated parameter regarding the distillated water amount for the two devices was also taken into account. The uncoupled design (passive still) has the ability to produce a condensate amount which can reach 2.33 kg/m2/day at the end of the distillation process, while for the second system active still was considerably higher and it can achieve its maximum value of 3 kg/m2/day which it can be evidently seen a difference of 0.67 kg/m2/day of produced distillate. Tatak K. Kaseem[14] his study mainly deals with the effect of corrugated work by wick surface on the performance of the still and to optimize the performance. From the analyses of data collected over the span of three days, the following conclusions can be drawn: - The system has the advantages of using a low cost, cheap material wick surface to enhance the still yield and its efficiency. - Still daily yield with the jute cloth is 4.20 kgm-2 per day while the conventional solar still is 3.30 Kg m-2 per day. - Maximum efficiency of the still with the wick surface is found as 42% and the internal efficiency for this still is 0.589 for = 0.8 and = 0.89 while the efficiency of the conventional solar still is 33% and its internal efficiency is 0.46. w α g τ . Uma Mahehwari et al[17] using a single basin double slope solar still was modelled by using solid works and CFD analysis is carried out using ANSYS. Theoretical models were used to predict the year round performance of the solar still. ASHRAE radiation model and meteorological data for the local place are used to estimate the irradiances received at the covers in different months. The production rate variations for different months have been studied as a function of local time. In November and March the variations are steeper. RegilBadusha et al[4] has found that two phase three dimensional model ismade for evaporation and condensation process in solar still by using CFD techniques.There is good agreement between simulation result and experimental result with certain errors. The results predicted by ANSYS CFX show that, it is very powerful tool for design, parameter analysis and difficulty removal in solar still construction. Amrik Singh et al[18] observed that Simulation work is done on ANSYS CFX 13. Simulation of evaporation process is done on a single slope solar still. Different sets of simulation are done by varying the temperature of top and bottom according to experimental data. The behavior of phase change and temperature distribution is observed due to evaporation. The temperature of water obtained by CFX and mass yield is compared with the available experimental data. Two inclination of condensing cover at 150 and 300 are taken for simulation. By plotting the curves of mass of water produced, convective and evaporative heat transfer coefficient it is determined that condensing cover at 300 inclination gives higher yield as compared to condensing cover at 150 inclination.) Curves for convective and evaporative heat transfer coefficient are plotted. It is observed that condensing cover at inclination 300 obtain the high convective and evaporative heat transfer coefficient. The 6 condensing cover at 300 inclinations gives about 29.4% higher yield than 150 inclination. Hence CFD is powerful tool in design of solar still and studying effective parameters on the performance. Hitesh N Panchal et al[16] observed that evaporation and condensation processes are occurring in solar stills were simulated by ANSYS CFX. A two phase, three dimensional model were developed and simulation continue up to 8 hours continuously as 8 steps of 1 hour period. There are good correlations or agreements between simulated results as well as experimental results of Distilled water rate, Water temperature, glass cover temperature, convective heat transfer coefficient and evaporative heat transfer coefficient. Predicted results by ANSYS CFX show that, it is very powerful tool for design, parameter analysis and difficulty removal in solar still construction

Solution

It is essential to develop a distillation system which will be efficient and affordable to common people of both urban and remote area. The WHO guidelines for drinking water quality indicate that the water can be made safe by boiling. This procedure is effective at all altitudes and with turbid water. Conventional fuels are not at all suitable for boiling the water as they are the expensive, not easily available and polluting environment. During the case study, we got the solution that solar energy can be an important part of India's plan not only to add new capacity but also to increase energy security, address environmental concerns. Hence the solar distillation system will be emerging renewable energy technologies. It can be developed as a future potential option for potable water generation in India. Hence we are giving the solution of solar still to this identified problem. explanation about solar steel is given below.

4.1 Solar Still:-A solar still evaporates the water with substances dissolved in it causing the heat of the sun to evaporate the water so that it may be cooled and collected, 11 thereby purifying it. Solar still is one of the cost effective method of producing pure water using solar distillation techniques (4). They are used in areas where drinking water is unavailable, so that clean water is obtained from dirty water or from plants from exposing them to sunlight.

4.2 Double Slope Single Basin Solar Still:-Drinking water is still a big problem in most arid and remote areas. Single basin solar still is a valuable solution to this problem. This type of still is capable of producing clean potable water from available brackish or waste water throughout the year. Single slope still is suitable at higher latitude place, while at lower places double slope still is preferred. For theoretical analysis, the transmittance of the cover plate is assumed as constant and the irradiance on the horizontal basin area is taken as the energy input. However, the transmittance of the cover depends on many parameters like incidence angle, cover plate material, and its thickness. Only a few authors have considered this effect during the analysis. Experiments have been conducted by considering the still with different thicknesses of commercially available window glasses at a different inclination, orientation and radiation conditions. Correlation has been obtained to estimate the transmittance of the given glass at any place, time, inclination, and orientation (5).

4.3 Methodology:-A single basin double slope solar still was fabricated with mild steel plate. The overall size of the basin is 2.3 m × 1 m × 0.25 m (6). The bottom of the still was leveled with 5 cm thick concrete to minimize heat loss through the basin and to spread the water uniformly. The concrete surface was black painted to improve the irradiance absorption capacity. The top is covered with two glasses of thickness 4 mm inclined at 30o on both sides supported by a wooden frame. The outer surfaces are covered with insulating glass wool layers. The temperature of the glass cover, basin water, and outlet water was measured after every hour starting from 9:00 am to 18:00 pm. The most favorable evaporation condensation was attained at noon from 12:00 pm to 15:00 pm. The properties of the distilled water, obtained with the double slope solar still design, were tested to check its quality. The water will start evaporating and it is collected in a tank where it is condensed.

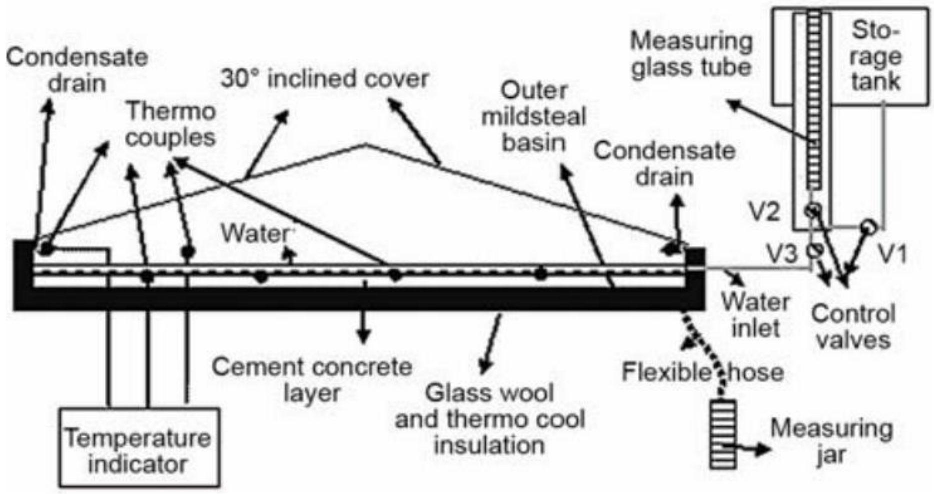

Figure vi: Double slope solar still.

4.4 Nomenclature

T_w -Water temperature

T_g -Glass Temprature

T_{a-} atmospheric temperature

H_{cw}-convective heat transfer coefficient (W/m2 –K)

H_{ew}- Evaporative heat transfer coefficient (W/m2 –k)

H_{rn}- Radiative heat transfer coefficient (W/m2 –k)

Q_{ew}- rate of evaporation of water (W/m2)

P_w -saturated pressure at water temperature (Kpa)

P_a- saturated pressure at glass temperature (Kpa)

E_g- Emissivity of glass plate=0.90

E_w-Emissivity of water =0.90

E_{FF}- total emissivity

4.5 Numerical Analysis

As the evaporation occurs on water so the rate of evaporation of water is given by the equation -

q_{ew}=hew(Tw-Tg) (1)

and the evaporative heat transfer coefficient is given by the equation-

$h_{ew}=0.016273(h_{cw})\left(\frac{Pw-Pg}{Tw-Tg}\right)$ (2)

Also Convective heat transfer coefficient is given by:-

$hcw = 0.884\left[Tw - Tg + \frac{(Pw+Pg)(Tw+273)}{268900-Pw}\right]^{\frac{1}{3}}$ (3)

Partialvapour pressure of water, P_w and glass cover Pg is found by relation,

$P_w=exp^{\left(25.317-\frac{5144}{Tw+273}\right)}$ (4)

$P_g=exp^{\left(25.317-\frac{5144}{Tg+273}\right)}$ (5)

As the radiation occurs in basin and top glass, so the Radiative Heat Transfer Coefficient is given by,

$h_r=\varepsilon_{ff}\sigma[(Tw+273)+(Tg+273)^2](Tw+Tg+546)$ (6)

where,

$\varepsilon_{ff}=\frac{1}{\varepsilon g}+\frac{1}{\varepsilon w}-1$ and (7)

Stefan Boltzmann Constant is

$\sigma = 5.67 * 10^{-8} W/m^2k^4$

4.6 Design Calculation

Dimensions for solar distillation is given as

Distilled water output per day=17578.6 kg/day

Distilled water output in kg/sec=0.610 kg/sec

Period of incident solar energy =8hours

Base area signifies the base design where the impure water has been stored and kept for the distillation process. The base is of square shaped. In the top view the square shape is the base area. Amount of solar energy required

Q_{req}=m x h_{fg} (8)

Evaporation occur when the temperature reaches to 100^0c assume mass of water as 5 kg .from steam table @100^0c.

h_{fg}=2257KJ/Kg

Q_{req}= 17578.59 x 2257

Q_{req}=39674880 W/m^2

The sun is considered to produce a constant amount of energy. As the sun's rays spread out into the space, the radiation becomes less intense and by the time the rays reach the edge of the Earth's atmosphere, the intensity decreases. The solar energy incident on the Nagpur city is about the incident solar energy is 480W/m^2 (7)

Period of 8 hours-

Q_{inc}= 480 x 8 x 60 x 60

Q_{inc}=13824000W/m^2

Now, the Area of the base required=$\frac{Qred}{Qinc}$ (9)

A=$\frac{39674880}{13824000}$

Therefore, A=2.78 m2

Hence, L=2.78m, W=1m

4.6 Theoretical Result:-

Table 1: Theoretical result.

Time	T_w	T_g	T_a	P_w	P_g	H_{cw}	H_{cw}	H_{rw}
Hrs	^{0}C	^{0}C	^{0}C	Mpa	Mpa	W/m^2k	W/m^2k	W/m^2k
9	19	18	17	2.2	2.1	1.6	3.33	6.85
10	19	18	20	2.2	2.1	1.6	3.33	6.85
11	24	19	22	2.9	2.2	1.9	4.85	7.07
12	27	26	24	3.5	3.3	1.8	5.84	7.43
13	32	27	25	4.7	3.5	2.2	8.05	7.66
14	35	27	26	5.5	3.5	2.3	9.45	7.77
15	37	28	26	6.1	3.7	2.4	10.54	7.89
16	34	27	26	5.2	3.5	2.3	8.97	7.74
17	32	27	25	4.7	3.5	2.2	8.05	7.66
18	29	26	23	3.9.	3.3	1.9	6.7	7.51

4.7 Result Analysis

The performance of solar still depends upon the glass cover angle, depth of water, fabrication materials, temperature of water in the basin and insulation thickness which could be modified for improving the performance (8). Hence, Thermal analysis simulation approach is adopted to analyze the effect of different temperature 15 distributions for air and water on the rate of evaporation to obtain the maximum yield. In evaporation water phase change takes pace which is very difficult to model mathematically. The complicated thermal relationship involved in the phase change of water from liquid to gas phase is accurately solved by using ANSYS analysis software.

4.8 Temperature Distribution

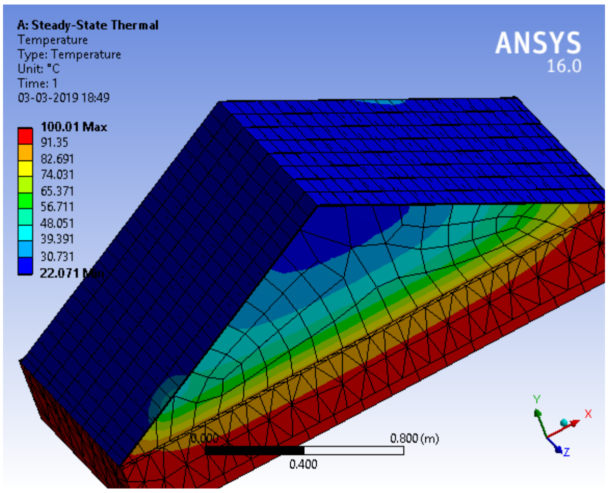

Figure vii - Temperature distribution over different section.

Figure vii. shows the Steady State Thermal Temperature distribution of water and glass in one sec. and due to temperature difference between water and glass leads to vapors condensation. The graph of total temperature distribution in 1 second of time is shown below – In the following Fig –Red line shows the minimum temperature and green line shows the maximum temperature.

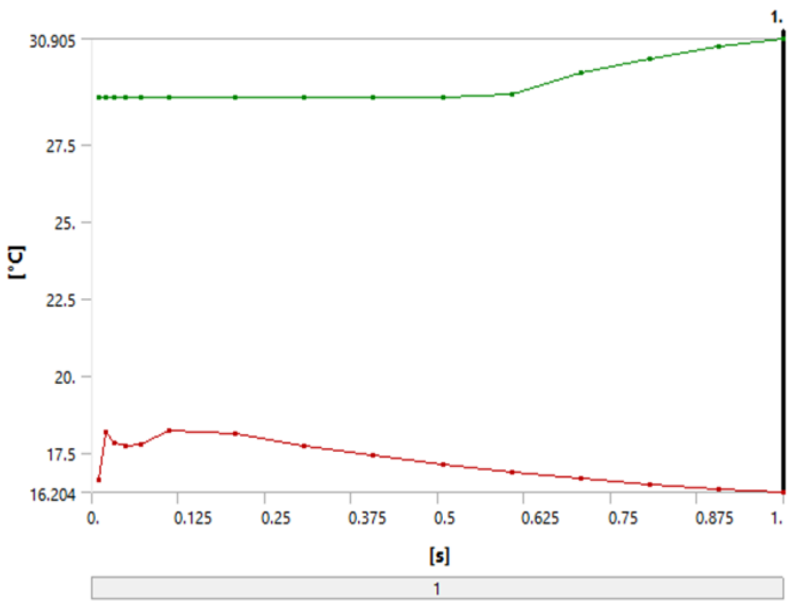

Figure viii - Temperature along the glass cover and water.

Table 2: Temperature distribution.

Time (s)	Minimum[^{0}c]	Maximum [^{0}c]
1.e-002	16.599	29
2.e-002	18.168	29
3.2977e-002	17.82	29
4.8827e-002	17.696	29
7.0974e-002	17.774	29
0.11111	18.188	29
0.20743	18.093	29
0.30743	17.707	29
0.40743	17.379	29
0.50743	17.102	29
0.60743	16.854	29.117
0.70743	16.644	29.782
0.80743	16.468	30.279
0.90743	16.32	30.648
1	16.204	30.905

The above table shows the different temperature at different nodes in 1sec. The temperature at 1.e-002sec is 16.599^{0}c.This is the minimum temperature at the beginning. As the time change the temperature also starts variie.But we observe that till 0.50743sec, the maximum temperature remains constant and the minimum temperature varies with time. As time changes from 0.60743sec the maximum temperature will increses.And at 1 sec we get the maximum temperature 30.9050 c. So as the time increases the minimum and maximum temperature varies accordingly.

4.9 Heat Transfer Per Unit Area

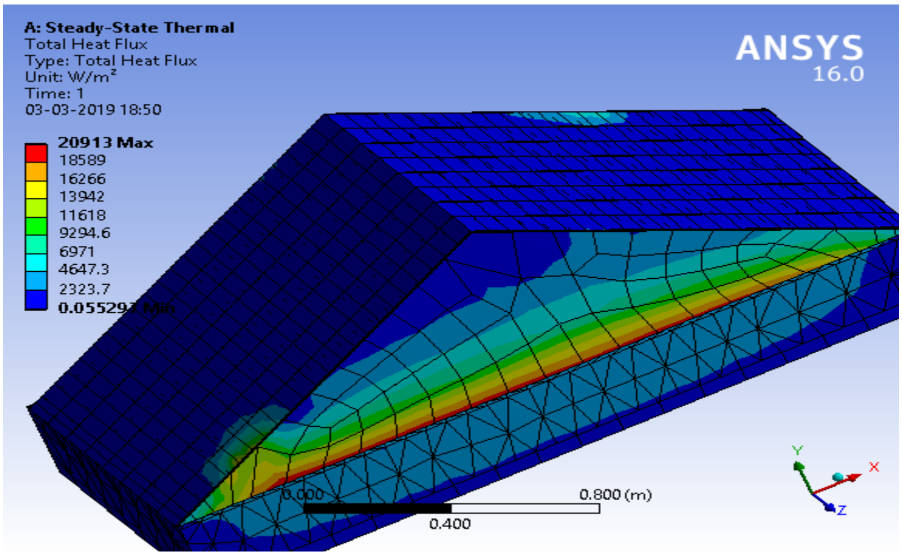

Figure ix - Total heat flux distribution.

Figure ix. gives the result that at different section how much amount of heat is transfer. The water temperature is higher than the glass cover temperature. Temperature difference between water vapour and glass leads to Evaporationand this evaporated water leads to condensation. The graph of total heat flux distribution in 1second of time is shown below –

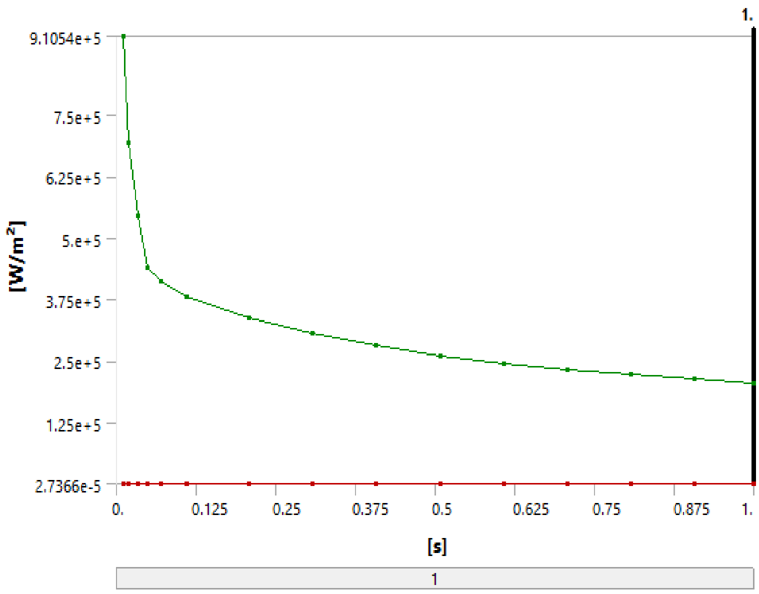

Figure x - Graph between total heat flux produced in 1 second.

Table 3: Total heat flux distribution.

Time [s]	Minimum [W/m^2]	Maximum [W/m^2]
1.e-002	6.0896e-005	9.1054e+005
2.e-002	2.7366e-005	6.9427e+005
3.2977e-002	1.0317e-004	5.4443e+005
4.8827e-002	2.6706e-004	4.4052e+005
7.0974e-002	2.4449e-004	4.1198e+005
0.11111	7.0471e-004	3.8138e+005
0.20743	5.2728e-004	3.3824e+005
0.30743	8.5842e-004	3.0589e+005
0.40743	1.1841e-003	2.8092e+005
0.50743	1.2355e-003	2.6113e+005
0.60743	1.0204e-003	2.4524e+005
0.70743	8.6622e-004	2.3229e+005
0.80743	8.0078e-004	2.2162e+005
0.90743	8.4449e-004	2.1271e+005
1	1.0377e-003	2.0565e+005

The above table shows that heat flux rate at different node. It isobserve that at time 1.e-002 sec, the minimum heat flux is 6.0896e-005W/m2 and maximumheat flux is 9.1054e+005

W/m2. And this heat flux will starts decreasing with respect to time.This shows that the heat is accumulate in the basin so that temperature of water increases andmore evaporation occurs.

4.10 Cost Estimation

For solar still with area of 2.78m^2.

Table 4: Cost estimation.

Materials and components	Cost (Rs)
Glass sheet	1520/-
plywood	980/-
thermocouple	800/-
Copper sheet	1200/-
Glass wool	600/-
Iron stand	1300/-
Storage tank	500/-
fabrication	1200/-
Total cost	Rs. 8100/-

The above cost estimation is calculated on the basis of the most suitable economic model of solar still. The cost of the particular materials used in the solar still is cheaper keeping the quality parameters high. These materials can be easily available in market at economic rates. This price estimation is calculated on the basis of recent market rates and can be considered as the most sustainable and economic price range for the making of solar still.

CONCLUSION

The following conclusion can be obtained from the above analysis is that the higher the rates of evaporation of water inside the solar still, the higher the rate of fresh water production. The temperatures difference between the glass cover and the water inside the solar still will significantly affect the rate of evaporation. It can produce considerable distilled water as compared to that of single slope solar still. The water distilled at output have the good quality for drinking purpose and household purpose. From the analysis, the maximum heat flux decreases with respect to time i.e 9.1054e+005 to 2.0565e+005 in 1 sec. As the time changes the temperature also starts varies. But we observe that till 0.50743sec, the maximum temperature remains constant and the minimum temperature varies with time. As time changes from 0.60743sec the maximum temperature will increases. And at 1 sec we get the maximum temperature 30.9050 c. So as the time increases the minimum and maximum temperature varies accordingly. The maximum heat flux decreases with respect to time i.e 9.1054e+005 W/m2 to 2.0565e+005 W/m2 in 1 sec. This shows that the heat is accumulate in the basin so that temperature of water increases and more evaporation occurs. The system has the advantages that using a low cost cheap material wick surface to enhance the still yield and its efficiency. Hence it is economical. The basin Materials and components Cost (Rs) Glass sheet 1520 plywood 980 thermocouple 800 Copper sheet 1200 Glass wool 600 Iron stand 1300 Storage tank 500 fabrication 1200 Total cost Rs 8100 19 component is main part of still which can play an important role of an evaporation surface. It represents an enclosure box configuration covered in black which is able to absorb a maximum solar radiation. Due to double slope the solar energy intake is get increases. As compared to single slope solar till. And also the quantity of distilled water also increases. It is the pollution free process of purification of water. For this it does not required any external source that is electricity.

REFERENCES

1. Dinesh Rathi& Associates, NMC 24x7 Water Supply Project. nagpur.
2. The indian lawyer, "Water Treatment IN INDIA,", 18.04.2017.
3. Tymn Combest, "Municipal Water Treatment Processes".
4. Regil Badusha T.V Arjunan, "Performance Analysis of Single Slope solar still," international journal of mechanical engineering and robotics research, 2013; 2: ISSN-2278-0149.
5. Kalidasa Murugavel KULANDAIVEL and Srithar KARUPPIAHb, "SINGLE BASIN DOUBLE SLOPE SOLAR STILL," Original scientific paper, Year, 2014; S429-S438.
6. Kalidas Murugavael Kulandaivel and Srithar Karuppaih, "Single Basin Double Slope Solar Still Performance Prediction For Local Climate at Sothern India," THERMAL SCIENCE, 2014; 18: S429-S438.
7. V. P. Katekar, H. S. Bhatkulkar, Ajay Mate, "Performance Investigation of Solar Still for," International conference on Advances in Thermal Systems, Materials and Design Engineering, 2017.
8. Navyasree, Harish Kumar Verma Uma Maheshwari, "CFD analaysis of Single basin Double slope solar still,", 2016; 01-05.
9. Rahul Dev Piyush Pal, "Experimental study on Modified Double slope solar still," 2016.
10. S.N Husainy, "Experimental study of Double Slope Solar still with and without Effect of Latent Thermal Energy Storage," 2017.
11. S. MadhuAli,T. Raja Siddhartha MD Irfan Ali, "Analysis of double slope solar still Using Photo-Catalyst," ISSN 2278-7763, 2012.

12. Mhd. SI-Ameur Omar Bait, "numerical approach of double slope solar still," 227-234, 2015-2018.
13. Dr. A. A. Pawar Prof. P. W. Ingle, "CFD Analysis of Solar Flat Plate Collector," 2250-2459, 2013.
14. P. K. Shah Hitesh N Panchal, "Modelling and verification of single slope solar still using," INTERNATIONAL JOURNAL OF RENEWABLE ENERGY, 2013; 8.
15. TalalK. Kassem, "Optimization of Performance of Single Basin Solar Still With Corrugated Wick Surface At High Place," International Research Journal Of Engineering And Technolgy, JAN 2016; 3(01): e-ISSN: 2395-0056.
16. M.K Mittal, Amrik Singh, "Simulation of single slope solar still at different inclinations using CFD," international conference of advance research and innovation, 2014; ISBN 978-93-5156-328.
17. Ajayketannayak, Rahul dev, piyush pal, "a modified double slope besin type solar still distiller," Evergreen, 2018; 05(01): 51-61.