Open access Journal International Journal of Emerging Trends in Science and Technology

Experimental Study of use of Solar Energy for the Effluent Treatment by Using Flat Plate Collector

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Abstract
The survey has made an attempt to find the impact of effluent in the environment. It is observed that the evaporation on black body flat plate more effectively during summer with very high evaporation rate and moderate evaporation in other seasons. And also found that during the normal operation, the color of the effluent varies and becomes clear after treatment with alum, which favors the penetration of solar thermal energy easily. Hence the efficiency of the black body flat plate solar evaporation increases than the normal cement slab tank and natural ponds. Because of the pollution created by the effluents from the industries, it is essential to treat the effluent by proper treatment process. This work recommends to all industries to use black coated sheet for constructing the solar evaporation system in order to recover the salts which causes pollution in water resources. The continuous use of the flat plate solar evaporation system can certainly reduce the volume of effluent discharged from the processing industries. The advantage of utilizing the black body flat plate for evaporation is very faster and it can absorb very high degree of solar radiation which is converted into thermal energy and it is directly converted into heat energy. Heat energy is utilized for the evaporation of effluent. It is observed that the flat plate solar evaporation system made of black body works more effectively during summer with very high evaporation rate and moderately in other seasons. It is observed that the effluent treatment by black coated flat plate solar evaporation system will be eco friendly, economical, simple and easy for adoption in process industry. The effluent from industries can cause harmful effects to the environment. Thermal energy is directly used for the evaporation of the high volume of effluent which causes pollution of ground water and surface water. The solar evaporation tank is blessed with the principle of black body surface which can absorb more solar radiation and more effective than ordinary cement slab tank and natural ponds. Hence the use of black body flat plates can prevent the water pollution to the maximum level than the cement tanks and natural ponds.
Key Words: *solar evaporation, effluent, flat plate collector*

Introduction

The development of solar technologies and an increased understanding of the use of black body flat plate collector for the effluent evaporation process are providing both economical and environmental benefits. All countries in the world receive solar energy. The amount varies from a few hundred hours per year as in the northern countries and the lower part of South America to four thousands hours per year. When the radiation strikes a solid or liquid it is absorbed and transformed into heat energy. The materials become warmer and stores the heat conducts it to surroundings materials. The absorber plate is usually made of copper, aluminum, steel or another suitable material and is usually coated with black paint. Applications of Solar Energy included, heating of building, cooling of buildings, Solar Water heating and solar heating industrial process and solar drying of agricultural products. Solar water heater system can meet the low and medium temperature process. Heat requirement like hot water up to 90°c, hot air up to 110°c and low-

pressure steam up to 140°c. These are especially useful in engineering, textile, chemicals, pharmaceutical, food processing, sugar and distilleries, diary, dye and other Industries. Solar energy could be used for preheating water up to 50-60°c with further heating of process steam to 90°c and above being done in boiler. Solar evaporation is historical and traditional.

Scope and Need of the work

It is very clear that the environmental pollution is considered as the unfavorable change of water, air, soil, and land. The principal pathway by which chemical pollutants enter in to environment in process industries is through water discharged from the sugar and distilleries industrial sources. The effluent in sugar and distilleries industry contains large amount of chemicals which is used for manufacture of sugar and alcohol. The effluent from sugar and distilleries industry having high TDS created a new problem of surface and ground water pollution. The pollution level of the water resources proved to be a threat to the human environmental conditions and damage the environment. One fine morning people will not be able to get good quality drinking water from the river, wells and water resources due to continuous discharge of process industries effluent in to the river. Therefore the disposal of effluent from process industries is becoming a universal problem now. Although the different effluent evaporation treatments are, Natural /forced circulation evaporator, falling film evaporator, rising film evaporator, climbing and falling-film plate evaporator, multiple effect evaporators, etc are available but none found to be suitable due to non-availability of man power, cost factor, working difficulty, efficiency and skilled person required for handling the toxic effluents. To overcome the inconvenience, the flat plate solar evaporation system employed for the evaporation and recovery of dissolved substance and suspended matter from the processing industries effluent. Most of the energy received from the sun comes in the form of light, a short wave radiation, not all of which is visible to human eye. When this radiation strikes a black surface it is absorbed better rather than reflect and thus become more heat and conducts heat energy to effluent at low temperature. This increase the temperature of effluent from 40°c to 60°c which can improve the evaporation of the effluent having very high TDS. In this work the solar energy shows promise of becoming a dependable heat energy source without new requirement of a highly technical and specialized nature for its wide spread utilization. In addition, there appear to be no significant polluting effects from its use.

Objective of the Present work

To construct a suitable black coated flat plate collector for the evaporation of total dissolved salts, from the process industries effluents during the treatment process.

To study the thermal performance of black coated flat plate surface for the evaporation of industrial effluents.

To study the evaporation potential of the flat plate collector for the evaporation process of industrial effluents.

To create awareness about the utilizing of black body flat plate collector for the evaporation of sugar and distilleries industry effluent in order to prevent the dissolved chemicals this can cause ground water and surface water pollution.

To suggest the sugar and distilleries industries for the use of black body flat plate collector evaporation systems for the effective, evaporation of the effluent in a shorter period.

Design & Manufacturing Details

Design-The solar evaporation system consist of a metal plate of rectangular shape, a frame, an overhead tank, a bottom tank and two pumps each of 35 Watt capacity. All the components required are properly designed according to the requirement and for more & more output i.e. accurate results.

Metal Plate-A metal frame is the most important part of system. A rectangular metal plate having a beading pattern so that effluent will flow through channels covering large surface area. This metal plate is of dark color so that more and more solar radiations can be absorbed. The metal plate is fixed

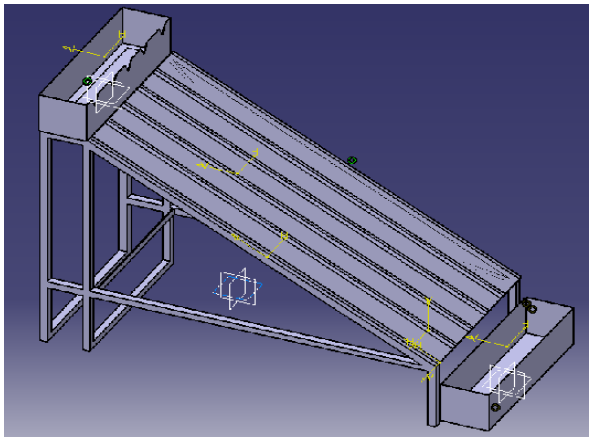
on the frame inclined to the horizontal at an angle of 30 degree.

Metal Frame-A metal frame is the important part of system. This frame holds the metal plate inclined to the horizontal. The 'L' section of 1 inch is used for making the whole frame.

Overhead and Bottom Tanks-There are two tanks required to store effluent. Both the tanks are of same dimensions, only overhead tank have five notches. Notches are provided so as to distribute equal quantity of effluent in each channel of metal plate and to measure the flow rate of effluent. The effluent is pumped from bottom tank to overhead tank. Overhead tank is placed on the frame while bottom tank is on the floor below the metal plate to collect the effluent flowing from overhead tank to metal plate and then in the bottom tank.

Pump-There are two pumps used to transfer effluent from bottom tank to overhead tank so as to get required mass flow rate of effluent. The pumps used are of 35 Watt each.

The design of solar effluent evaporation system is shown in fig.



Isometric view (CATIA model***)***

Test set up contains basically six components viz. Effluent, bottom tank, overhead tank, plate, frame, pumping system. Bottom tank and overhead tanks having same dimension of 1068×300×300 mm made of thin gauge coated steel sheet are manufactured from the " Super cooler services" . Plate is made of coated steel sheet which is bend from the nearby factory in M.I.D.C. Plate have dimension after bending 1068×2500 mm .Frame is made of 1 inch L-section. Frame is fabricated in "Essential equipment "in dhule M.I.D.C. Pump of 35Watts of discharge height of 2.4 Mt. with LDPE pipe of length approx 12feet. Test set up is assembled in the "Essential equipment" and testing procedure is under trail and we will be with some reliable observations and results.

Experimental set up

Experiment-I

Measurement of the temperature, depth and total dissolved solids

20 liters of effluent were taken for the Experimentation.

1st day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	35	44	16100
2	11 A.M	37	43	16400
3	12 A.M	39	43	17200
4	1 P.M	43	38	17600
5	2 P.M	41	37	18300
6	3 P.M	33	35	18400
7	4 P.M	32	34	18500

2nd day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	34	32	19100
2	11 A.M	37	31	19400
3	12 A.M	39	30	19600
4	1 P.M	42	29	20000
5	2 P.M	40	28	20500
6	3 P.M	35	27	20700
7	4 P.M	32	26	20800

3rd day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	33	24	21300
2	11 A.M	38	22	22500
3	12 A.M	40	21	23400
4	1 P.M	41	19	24500
5	2 P.M	39	18	25200
6	3 P.M	34	17	25900
7	4 P.M	31	16	27200

4th day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	35	15	27800
2	11 A.M	38	14	28100
3	12 A.M	40	13	28200
4	1 P.M	43	11	28400
5	2 P.M	41	10	28500
6	3 P.M	36	9	28600
7	4 P.M	31	8	28800

5th day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	35	7	29000
2	11 A.M	37	6	29100
3	12 A.M	39	5	29200
4	1 P.M	40	3	29600
5	2 P.M	41		
6	3 P.M	38		
7	4 P.M	32		

Experiment-II

30 Liters of effluent were taken for the evaporations

1st day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	37	79	16600
2	11 A.M	38	77	16750
3	12 A.M	40	75	16840
4	1 P.M	41	73	17200
5	2 P.M	40	72	17400
6	3 P.M	37	71	17700
7	4 P.M	35	70	17850

2nd day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	37	67	18400
2	11 A.M	38	66	18600
3	12 A.M	42	65	19000
4	1 P.M	45	63	19400
5	2 P.M	39	62	19600
6	3 P.M	38	61	19700
7	4 P.M	34	60	20100

3rd day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	37	58	20300
2	11 A.M	40	57	20400
3	12 A.M	41	55	20500
4	1 P.M	43	54	20600
5	2 P.M	39	53	20700
6	3 P.M	38	52	20800
7	4 P.M	35	51	21000

4th day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	30	49	21100
2	11 A.M	35	48	21300
3	12 A.M	36	46	21500
4	1 P.M	38	44	21700
5	2 P.M	34	42	21800
6	3 P.M	32	40	22000
7	4 P.M	31	39	22100

5th day of the experiment

No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	40	36	22500
2	11 A.M	41	34	22600
3	12 A.M	42	31	22700
4	1 P.M	45	28	23100
5	2 P.M	38	26	23300
6	3 P.M	37	24	23450
7	4 P.M	36	23	23550

6th day of the experiment

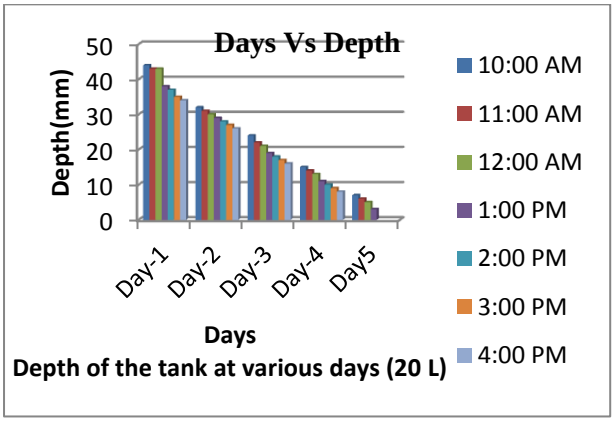
No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	38	21	23650
2	11 A.M	40	19	23800
3	12 A.M	44	17	23900
4	1 P.M	46	14	24200
5	2 P.M	37	12	24400
6	3 P.M	34	10	24500
7	4 P.M	32	8	24600

7th day of the experiment

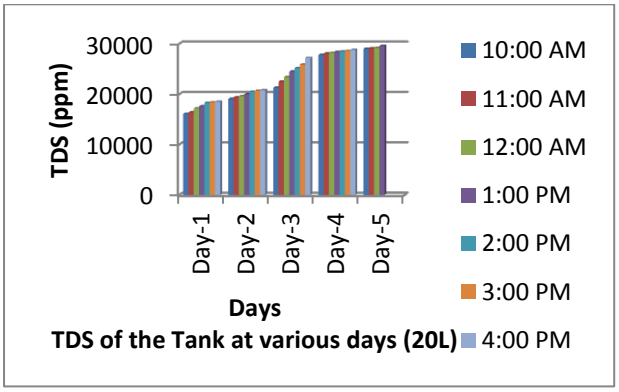
No	Time (hr)	Temp (°c)	Depth (mm)	TDS (ppm)
1	10 A.M	31.5	5	24800
2	11 A.M	32	4	24900
3	12 A.M	36	3	25100
4	1 P.M	33.6	1	25200
5	2 P.M			
6	3 P.M			
7	4 P.M			

Results and Discussion

The water quality for drinking and irrigation depends upon the total dissolved constituents. The dissolved ions are prime importance in determining the water quality for drinking and irrigation purpose. The reason may be that various chemical ions can move much faster into the ground and can seep through the sandy soil in to the ground water and surface water which causes pollution.



Depth of the tank at various days (20 L)



TDS of the Tank at various days (20L)

In general these sugar and distilleries effluent ions can cause high degree of water pollution in the water resources. Hence TDS are dominated in the effluents which enter into the water resources like ponds, lake and river. In order to control the sugar and distilleries effluent problems, the black surface flat plate collector has been fabricated here for enhancing the absorption of solar radiation for evaporation. It prevents the dissolved salts from contaminating the water resources and the soil, directly without any pre-treatment.

Conclusion

From the data in the above table's effluent depending upon the value of temperature; the evaporation of effluent varies. It certainly causes the decreases in the depth of the effluent increases the concentration of the effluent. The higher the temperature of the liquid, the grater is the evaporation rate of the molecules. The rate of Evaporation increases with the rise in temperature of the effluent. The rate of evaporation is inversely proportional to the atmospheric pressure. It has been found experimentally that low atmosphere pressure increases the rate of evaporation. The large area of the free surface of the Flat plate collector and effluent exposed to the atmosphere increases the rate of evaporation.

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