Performance Evaluation of Concentrating and non-concentrating Solar Energy based Water Purification Systems

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Abstract: The availability of drinking water is essential for the survival of mankind. Adequate amount of water resources are available on our planet, but few of them can be used for the purpose of drinking. A number of water purification methods are developed by the researchers. However, Solar technology offers great potential in terms of supplying the world's energy needs. The aim is to create an affordable unit, which can produce a clean drinking water from the solar energy. To achieve this goal, two types of solar water purifiers are developed and their performance is compared. One is Linear Fresnel Lens based water purifier. This lens heats the water up to boiling point. Steam is produced form the boiling process and that steam is condensed and collected in a reservoir. Other type of system is solar still which evaporate the water at its surface. Then surface droplets are collected into clean water reservoir. Water is purified by using these two systems. Performance of the both the systems is studied and compared. Adequate amount of solar radiations is necessary for the working of both the systems. So, total solar radiations received at the surface is also studied.

Keywords: Water Purification, Linear Fresnel Lens, Solar Still, Solar Radiations.

1. Introduction

Freshwater is available in a very small fraction of all water on the planet. While about 70 percent of the world is covered by water, only 2.5 percent of it is fresh. The rest is saline and ocean-based. Even then, only 1 percent of freshwater is easily accessible, rest of it is trapped in glaciers and snowfields. Only 0.007 percent of the planet's water is available to fuel and feed its 6.8 billion people [1].

More than 90% of the sewage water generated by rural municipalities and more than 50% of sewage discharged by urban municipal go untreated and discharged to the fresh water ecosystem (MEF 2005). Industries produce nearly 31,000 million cubic meters of effluent which is discharged into our fresh water bodies (MEF 2010). The estimated fecal load is 200,000 tones are generated every day [2]. Contaminants from the ground's surface include municipal, industrial and agricultural wastes. These wastes wash into rivers and also infiltrate the ground water. Therefore, waste water requires certain level of treatment before it is going to contact ground water and domestic water should also be treated before drinking.

Most of the standard Water distillation processes are extremely energy overwhelming and need fossil fuels in addition as power for their operation. Daylight has the advantage of zero fuel value however it needs extra space (for its collection) and customarily a lot of pricey instrumentation. Direct daylight has been used long back for desalinization of water. Renewable energy sources have been used directly or indirectly for the treatment of water [3]. There are different methods for water purification using solar system (a) Solar still, (b) Solar Collector (using reflector), (c) Fresnel lens.

Solar still is that the oldest technique for purification of water. Its principle of operation is that the greenhouse effect; the radiation from the sun evaporates water within a closed glass coated chamber at a temperature beyond the ambient. Water is fed on a black plate within the lower portion of the solar producer. The warmth of the sun causes the water to evaporate and vapor condenses to make strictly distilled droplets of water once it reaches the cool clear leaning surface made from glass or plastic. The droplets give on the leaning surface and square measure collected through special channels situated below the leaning surface [4].

In concentrating technologies Fresnel lens is utmost promising because of their little volume, lighter weight, additional production with low price as well as increase the energy density [5]. This lens would heat the impure water to boiling point. It can rise up to 800 degree Celsius if it is properly installed. The steam that would be produced from the process of boiling would then be distilled and collected in a reservoir. A Fresnel lens is a special type of compact lens, which was originally created for use in lighthouses but has been used in different applications [6].

2. Methodology

Methodology used for the purification and performance evaluation of both the systems is shown in figure 1.

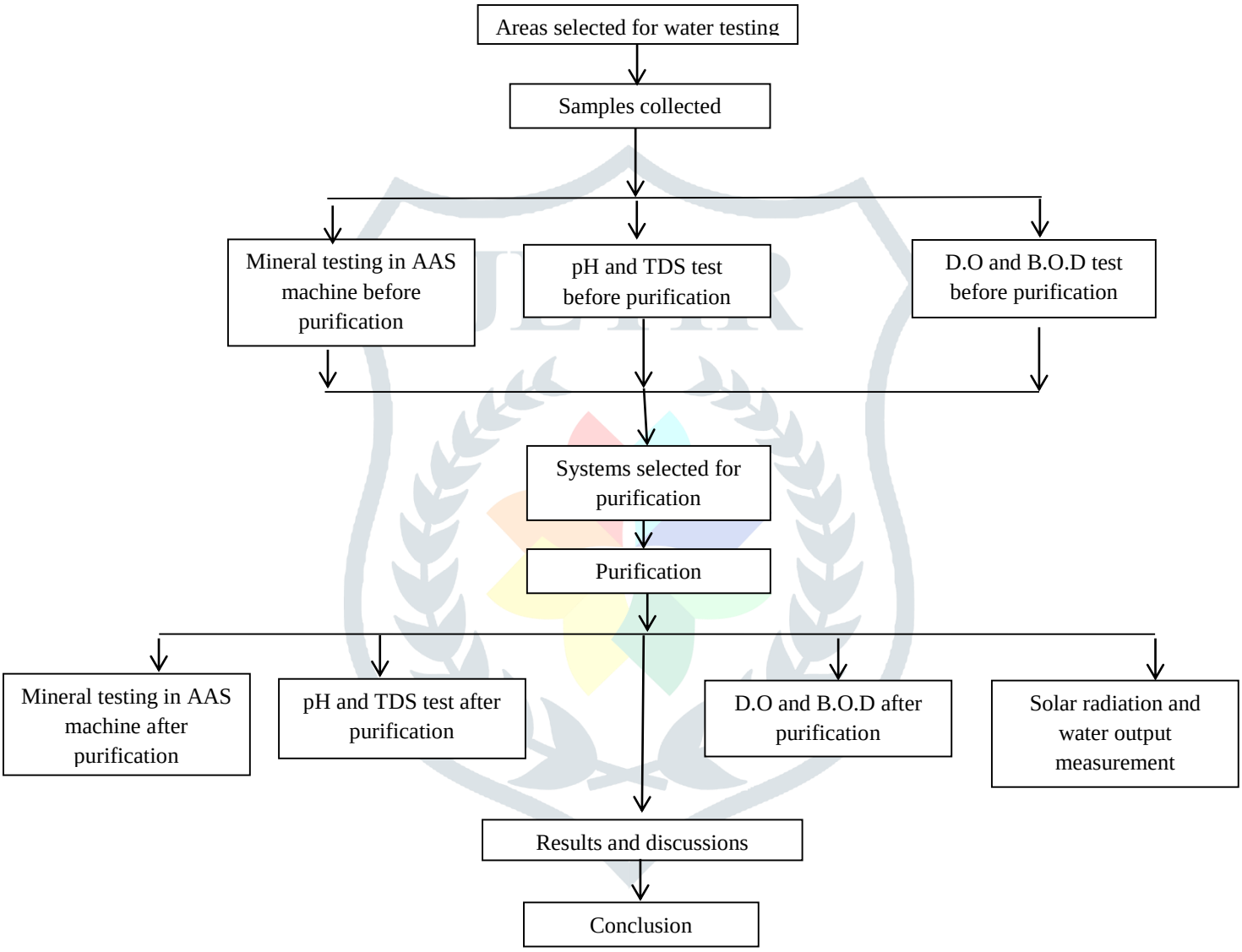

Figure 1: Methodology flow chart

3. Results

Different waste water samples are collected from the identified areas. Based on survey Physico-chemical analysis of all the collected waste water samples as per their sources (APHA 2008) is done. The characteristics of the tested water samples is shown in table 1. The different samples of waste water will be purified using LFR water purifier prototype and solar still. The characteristics of the purified water samples using LFR and solar still are shown in table 2 and table 3 respectively. All the purified samples will be analyzed for their physic-chemical characteristics as per (APHA 2008). The out present characteristics are be compared with recommended guidelines for further use of purified water. Performance of both the systems is also compared.

Water is collected from different locations in Baru Sahib. Collected water is tested in AAS. Then harmful effects of excess minerals are studied.

Table 1. Water Sample Testing of Nearby Area Brau Sahib.

Sr. No.	Khairi River sample 1	Khairi River sample 2	Bagroti	Water tank	STP water	Indian standard	W.H.O
Mn	0.47	.4	.3	.18	6.8	.1	.03
Cu	.034	.038	.03	.05	.09	.05	.02
Fe	.12	.14	.14	.16	.12	.3	.5
Zn	.74	.8	.75	.32	6.4	.5	.03
Mg	1.27	1.29	1.28	1.25	11.2	.3	.25
pH	8.04	8.05	8.03	8.2	8.8	7	7
TDS	315	344	284	286	446	<300	<300
D.O	8.6	8.6	8.3	9.1	6.4	5-9.5	5-9.5
B.O.D	5.8	5.7	1.7	1.4	13	0	0

Table 2. Water Sample Testing using Linear Fresnel Lens based water purification system.

Sr. No.	Khairi River sample 1	Khairi River sample 2	Bagroti	Water tank	STP water	Indian standard	W.H.O
Mn	0.23	.26	.24	.08	2.8	.1	.03
Cu	.020	.021	.02	.025	.05	.05	.02
Fe	.08	.09	1.1	.10	.09	.3	.5
Zn	.44	.5	.43	.20	3.3	.5	.03
Mg	.88	.99	.92	.98	5.2	.3	.25
pH	7.3	7.25	7.21	7.4	7.5	7	7
TDS	301	311	244	236	336	<300	<300
D.O	8.5	8.6	8.4	9.0	8.4	5-9.5	5-9.5
B.O.D	.4	.4	.1	.1	1.4	0	0

Table 3. Water Sample Testing using Solar Still.

Sr. No.	Khairi River sample 1	Khairi River sample 2	Bagroti	Water tank	STP water	Indian standard	W.H.O
Mn	0.13	.18	.14	.03	2.1	.1	.03
Cu	.011	.013	.01	.014	.03	.05	.02
Fe	.03	.05	.06	.06	.07	.3	.5
Zn	.24	.3	.33	.10	2.3	.5	.03
Mg	.56	.77	.72	.69	2.2	.3	.25
pH	7.06	7.05	7.04	7.03	7.05	7	7
TDS	251	241	202	204	255	<300	<300
D.O	8.8	8.9	8.8	9.1	8.9	>5	>5
B.O.D	**2.4**	**2.6**	**1.2**	**1.1**	**4.7**	**0**	**0**

Hence when the water is tested and seen that it is having lot pollution and excess minerals so there is great need for purifying the water. There is lot of technology for purifying water Drinking water, also called drinking water, is drinking water or used for food preparation. The amount of drinking water required by various Indians, on average, drinks one liter of water a day and 95% drink less than three liters a day. Due to the increase of the population, the industrialization of the water is polluted. And the polluted water is

harmful water pollution can be causes by many ways (a) Sewage And Waste Water, (b) Dumping,(c) Industrial waste,(d) Oil pollution ,(e) Acid rain,(f) Global warming. Therefore the water must be purified before drinking

4. Conclusion

The availability of drinking water is the most essential thing for the survival of human being. Lot of water resources are available on the earth but only limited can be used for drinking water. From the detailed survey of identified regions, it is concluded that water is too much contaminated and have lot of minerals in excess amount which can cause lot of diseases like stomach irritations, Brownish color, bitter taste, altered taste of water-mixed beverages, damage healthy skin cells, which can lead to wrinkles, Brackish color, rusty, Anemia, digestive disturbances, liver and kidney damage, gastrointestinal irritations, bitter or metallic taste, Blue-green stains on plumbing fixtures etc. so it is necessary to clean the water before using. To achieve this goal, two types of solar water purifiers are developed and their performance is compared. With Linear Fresnel Lens based water purification system near about 5 litter water is purified in sunny day, 3.3 litter of water in partially cloudy day and 2.5 litter water in cloudy days when the solar radiation is very less and The output of water from solar still on sunny day is near about 3 litter ,in partially cloudy day it fall on 2 litter and on partially cloudy days it is only 1 litter per day which is very less.

Although both the systems look very simple, however the main challenge is to find the angle at which systems can receive maximum radiations. For Fresnel lens system the main challenge was the designing of system.

To increase the efficiency of solar still we can place some reflecting object inside the still and for Fresnel lens system we can use the multi lens.

5. References

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