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Development of a Novel Water Treatment Technique Using Solar Still Cum Sand Filter

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Abstract

Water is a basic need for human being for physiological processes. The supply of pure drinking water is a serious problem for most parts of the world .In coastal areas, there is a much scarcity of pure water because of high salinity in water. Develop a tubular solar still (TSS) by using ceramic media along with a sand filter (SF) for water purification. In the raw water salinity was found to be around 1550mg/L. In the treated water from TSS and TSS-SF, salinity was found to be around 0 mg/L and 400 mg/L respectively, though the influent raw water salinity was 1550 mg/L. In the influent raw water the total dissolved solids (TDS) and total coliform (TC) was 2880 mg/L and 220 no/L respectively. The salinity, total dissolved solids (TDS) and total coliform (TC) of the treated water from TSS-SF was within the permissible limit. So, the treated water is safe for drinking purposes.

Keywords: Solar desalination, water purification, salinity, Water treatment, potable water.

1. Introduction

Water treatment technologies have evolved over the past few centuries to protect public health from pathogens and chemicals. As more than a billion people on this earth have no access to potable water that is free of pathogens, technologies that are cost effective and suitable for developing countries must be considered [6]. Sustainable operation of these treatment processes taking into consideration locally available materials and ease of maintenance need to be considered. Now-a-days water desalination is an essential process in those areas where ground water is fully contaminated by salinity and surface water is highly polluted. So, this study has been introduced to develop the water treatment technique by installing tubular solar still using ceramic media along with sand filter to provide enough, pure and safe water supply specially in coastal regions. Water is one of the abundant resources on earth but only about 3 % of it is potable and remaining 97% is saline water which is lying in the sea. According to [4] 60-90% and according to Food and Agriculture Organization (2006), 69% of all freshwater sources are used for agricultural irrigation. Desalination (also spelled desalinization) is the process of creating fresh water by removing saline (salt) from bodies of salt water. There are varying degrees of salinity in water, which affects the difficulty and expense of treatment, and the level of saline is typically measured in parts per million (ppm). The U.S. Geological Survey provides an outline of what constitutes saline water: 1,000 ppm – 3,000 ppm is low salinity, 3,000 ppm – 10,000 ppm is moderate salinity, and 10,000 ppm – 35,000 ppm is high salinity [7]. Water that contains saline levels less than 1,000 ppm is generally considered fresh water, and is safe to drink and use for household and agricultural purposes. Groundwater has been used for various purposes such as drinking, domestic purposes, irrigation, and industrialization and so on. So, water level is lowering day by day. In coastal areas, there is a much scarcity of pure water because of high salinity in water. Again, surface water is being contaminated by various kinds of organisms and compounds. By using ceramic filter we can get a better quality and quantity of water. Generally, groundwater is clear, colorless with very little or no suspended solids and it is free from disease producing micro-organisms which normally present in surface water [1]. For these reasons groundwater is the main source of water supply in urban and rural areas of many developing countries but in some areas groundwater is contaminated with arsenic, and excessive dissolved iron. Besides, in coastal areas groundwater contains high level of salinity. Solar desalination is the process that removes excess salts and other organic compounds from the water. It is the process for water purification where solar energy is used as input energy, raw water is evaporated from the storage channel of solar still and finally accumulated into the outlet. Nevertheless, sand filtration reduces the number of micro-organisms and other physicochemical compounds present in the water. The main objective of this study is to develop a novel water treatment technique using solar still cum sand filter which would increase the production of treated water and retain the salinity within a permissible level.

2. Methodology

Develop a tubular solar still (TSS) by using ceramic media along with a sand filter (SF) for water purification. To monitor of the treated water quality and quantity is developed in the treatment unit. The observation of the workability of ceramic media for enhancing the capacity of TSS.To provides some Proposals for the modification of TSS-SF for its long-term sustainability. To identity the operation & maintenance problems of the developed TSS-SF.The laboratory investigation was carried out on the top roof of the Civil Engineering Department of Khulna University of Engineering and Technology (KUET) is shown in figure-1 and Structural components of a TSS-SF unit is shown in figure-2. A low cost Tubular Solar Still cum Sand Filter (TSS-SF) was designed and constructed. It was constructed of tubular frame covered with a transparent normal polythene paper and a black rectangular tray used as channel for storing saline water along with sand filter. The sand filter consists of a circular filter box and an outlet. The influent raw water quality in both TSS and SF was remained same. The effluent treated waters from these treatment operations were blended together and stored in a container. The schematic diagram of the TSS-SF unit is shown in figure below:

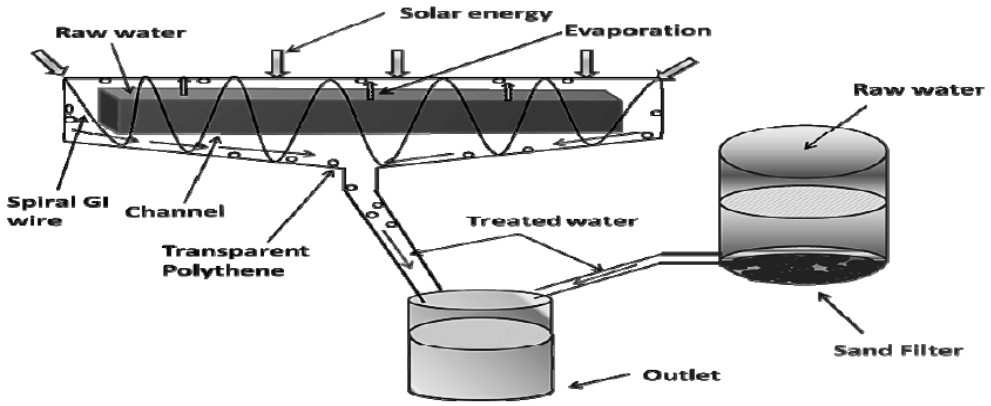

Fig.1. Schematic diagram of TSS-SF unit

Structural components of a TSS-SF unit

Black rectangular tray

Sand filter

Tubular Solar Still (TSS) Ceramic Filter

Fig.2. Structural components of a TSS-SF unit

3. Results and Discussion

A sample of 15 litres water was taken into the solar still and made its salinity artificially about 1550 mg/L for winter and summer 2100mg/L by adding sodium chloride. At the same time, the same quality of 2 litres water was taken into the sand filter in each day. When the influent raw water of TSS was finished, then it was again filled up. The output of treated water from the TSS-SF unit was collected from 19th December, 2012 to 19th January, 2013 shown in Table 1 and Table 2 respectively. Each 30 days total output from the period 19th December, 2012 to 19th January, 2013 for winter and summer 6th march to 2 April shown in Table 3 and Table 4 respectively. Graphically, Variation of value of water quality parameters between raw, TSS, SF and TSS-SF water in winter season is shown in figure-3, 4,5,6,7 and figure-8.Again, Graphically Variation of value of water quality parameters between raw, TSS, SF and TSS-SF water in Summer season is shown in figure-9,10,11,12,13 and figure-14.

Table1: The value of water quality parameters of Raw water

Water quality parameters	Value
Chloride conc.(mg/L)	1550
TS(mg/L)	3540
TDS (mg/L)	2880
TC (No./100ml)	22
FC (No./100ml)	2
DO (mg/L)	7.87
Color(Pt-Co.unit)	73
pH	6.54

Table2: The value of water quality parameters of treated water

Water quality parameters	Tubular solar still (TSS)	Sand filter (SF)	Tubular solar still cum sand filter (TSS-SF)
Chloride conc.(mg/L)	0	1481	400
TS(mg/L)	0	1850	900
TDS (mg/L)	0	1745	850
TC (No./100ml)	0	0	0
FC (No./100ml)	0	0	0
DO (mg/L)	7.82	7.95	7.6
Color(Pt-Co.unit)	0	3	0
pH	7.4	8.3	7.8

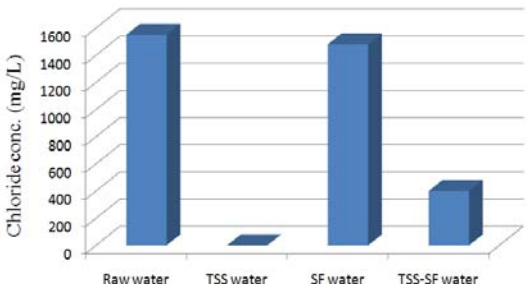

Fig.3. Variation of salinity

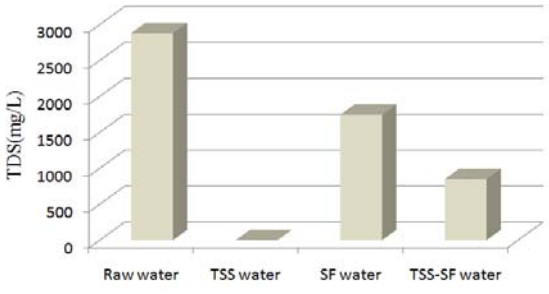

Fig.4. Variation of total dissolved solids(TDS)

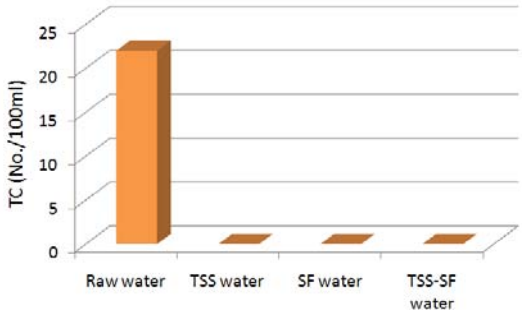

Fig.5. Variation of total coliform(TC)

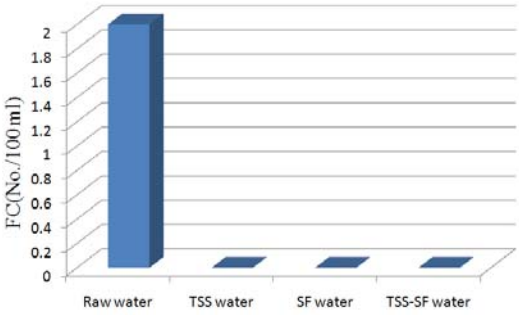

Fig.6. Variation of faecal coliform(FC)

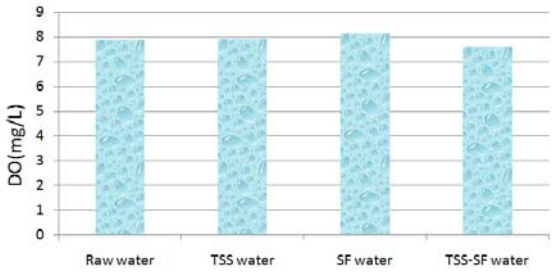

Fig.7. Variation of dissolve oxygen(DO)

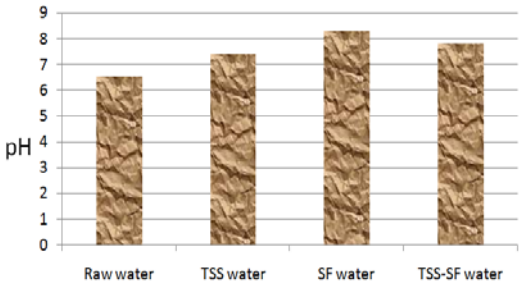

Fig.8. Variation of pH

Table3: The value of water quality parameters of Raw water

Water quality parameters	Value
Chloride conc.(mg/L)	2100
TS(mg/L)	3540
TDS (mg/L)	3500
TC (No./100ml)	21
FC (No./100ml)	2
DO (mg/L)	8.77
Color(Pt-Co.unit)	60
pH	7.94

Table4: The value of water quality parameters of treated water

Water quality parameters	Tubular solar still (TSS)	Sand filter (SF)	Tubular solar still cum sand filter (TSS-SF)
Chloride conc.(mg/L)	0	1983	400
TS(mg/L)	0	1813.2	868
TDS (mg/L)	0	1813	868
TC (No./100ml)	0	0	0
FC (No./100ml)	0	0	0
DO (mg/L)	7.96	8.16	7.98
Color(Pt-Co.unit)	0	0	0
pH	7.6	7.82	7.73

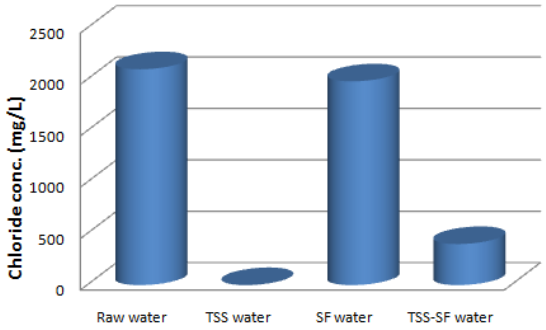

Fig.9. Variation of salinity

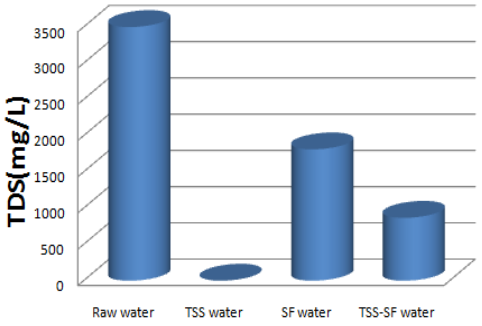

Fig.10. Variation of total dissolved solids(TDS)

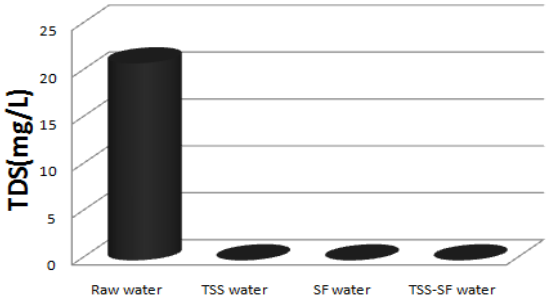

Fig.11. Variation of total coliform(TC)

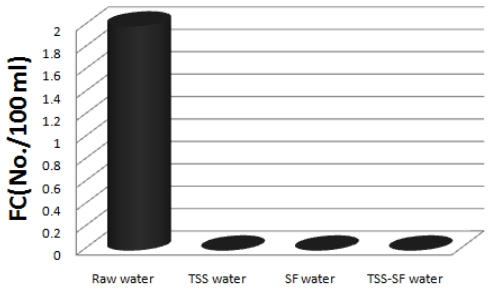

Fig.12. Variation of faecal coliform(FC)

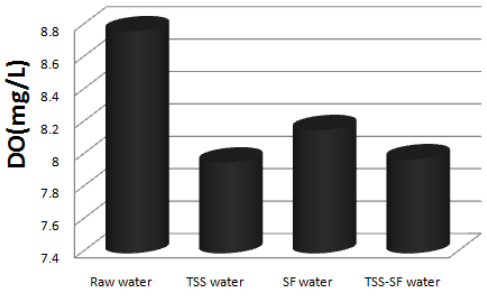

Fig.13. Variation of dissolve oxygen(DO)

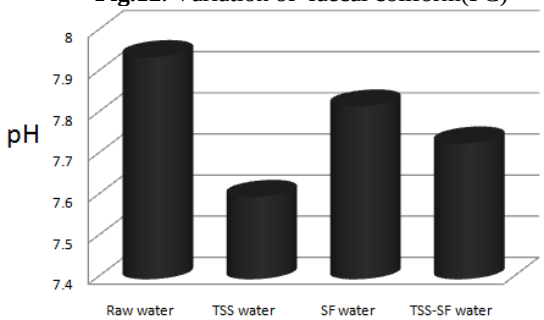

Fig.14. Variation of pH

The construction cost of TSS was 500 Tk (BDT) and including it, the cost of storage channel and tubular frame was 250 Tk (BDT) and 120 Tk (BDT) respectively. The storage channel was made of good quality cartoon paper with high durable polythene so its construction cost was semi-high relative to the TSS. The construction cost of SF was 900 Tk (BDT). By adding the operational cost, the total cost of TSS-SF unit was 1750 Tk (BDT). The TSS-SF unit was placed strongly on a safe place so that high wind velocity could not do any harm to it. The TSS-SF was operated very carefully and maintained continuously.

The raw water salinity was found to be around 1550 mg/L. In the treated water from TSS and TSS-SF, salinity was found to be around 0 mg/L and 400 mg/L respectively, though the influent raw water salinity was 1550 mg/L. In the influent raw water the total dissolved solids (TDS) and total coliform (TC) was 2880 mg/L and 22 No/100mL, respectively. The TDS value of treated water from TSS and TSS-SF was found 0 mg/L and 850 mg/L, respectively. The TC value of treated water was found to be 0 No/100mL.

4. Conclusions

Today, the world demand for potable water is increasing continuously due to industrial development, intensified agriculture, improvement of standard of life and increase of the world population. The world demand for potable water is increasing continuously due to industrial development day by day, intensified agriculture, improvement of standard of life and increase of the world population. The supply of pure drinking water is a serious problem for most parts of the world. In dry season, this problem becomes very acute. But in dry season, the productivity of TSS-SF unit is higher. The TSS-SF unit is suitable for producing potable water from mostly available saline water in the coastal belt of Bangladesh. Though desalination is a slow process, but in the TSS-SF unit the production rate is larger than desalination process and production cost of distilled water is very small. The construction of the TSS-SF unit is very simple and one can use this technology easily in the house. Water from desalination is not bound by many of the conditions that plague traditional fresh water development. The increase in the public awareness of the environmental problems associated with fresh water sources coupled with the new, more stringent drinking water quality regulations make development of new traditional water resources more difficult and costly. Unlike traditional water supplies, alternative desalted water supplies are not vulnerable to weather. So, it is concluded that the application of TSS-SF technique can fulfill the demand of potable water in coastal areas of many developing countries like Bangladesh.

5. Acknowledgement

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6. References

[1] Ahmed, M., Feroze and Rahman, Md., Mujibur (2000). Water Supply & Sanitation. ITN-Bangladesh, BUET, Dhaka, pp. 330-450.
[2] ALKAN, Pinar Ilker (2003). “Theoretical and Experimental Investigations on Solar Distillation of IYTE Gulbahçe Campus Area Seawater.” Izmir Institute of Technology, Izmir, Turkey.
[3] Bokshi, A. and Khatun, H (2010). “Desalination using low cost Tubular solar still” - Thesis report of B.Sc. Program, KUET, 2010.
[4] Buros, O.K. (2000). “The ABCs of desalting”. International Desalination Association, Topsfield, Massachusetts, USA.
[5] Cooley, Heather, Peter H. Gleick, and Wolff, Gary (2007). “Desalination, with a Grain of Salt – a California Perspective”. Pacific Institute, retrieved on 2007.
[6] Hasan, M.N. and Mondol, P. K. (2005). “Desalination and Arsenic Removal by Solar Energy” - Thesis report of B.Sc. Program, KUET, 2005.
[7] Kharabsheh, Al. S. and Goswami, D.Y. (2003). “Analysis of an Innovative Water Desalination System using Low-Grade Solar Heat”. Desalination, Vol. 156, pp. 323-332
[8] Rab, Md. Abdur (2011). “Solar Desalination using Low Cost Tubular Solar Still (TSS) with Normal Polythene Paper as Tubular Cover” - Thesis report of B.Sc. Program, KUET, 2011.
[9] Saha, A. Kumar (2011). “Solar Desalination using Low Cost Tubular Solar Still” - Thesis report of B.Sc. Program, KUET, 2011.
[10] Sobsey, M. (2002). “Managing Water in the Home: accelerated Health Gains from Improved Water Supply”. World Health Organization (WHO), North California, USA.
[11] Sultana, Shammi and Jesmine, Mansura (2009). “Monitoring Bacteriological Quality of Water from Household ,Taps and Filter” - Thesis report of B.Sc. Program, KUET, 2009
[12] Yadav, Y.P. and Yadav, B.P (1998). “Transient Analytical Solution of a Solar Still Integrated with a Tubular Solar Energy Collector”. Energy Conversion & Management, Vol. 39(9), pp. 927-930.