Transforming Brackish Water into Ingestion Liquid Using Solar Still, Physico-Chemical Analysis

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Abstract: In this work, an endeavor has been made to purify waste water by using solar still and the purity of water has been examined using physico-chemical properties such as taste, odour, pH, electrical conductivity, TDS, total alkalinity, total hardness, magnesium, magnesium hardness, calcium, calcium hardness, sulphate, nitrate, iron, chloride, silica were shows the purity of water. Standard methods were used for determination of physical and chemical characteristics of the waste water and distilled water. The outcomes were equaled with standards prescribed by IS:(10500-1991). As a result, the physico-chemical parameters exceeded the water quality standards and the waste water (Brackish water) is unfit for drinking purpose as it was contaminated and the quality of water is very bad. It needs some degree of treatment before consumption. Hence the waste water is cleansed by means of solar still and found that the physicochemical parameters are underneath permissible limit of IS:(10500-1991). From these results it is clear that, purification of waste water by using solar still is an optimistic approach for the production of drinking water and also can be used as a purifier in brackish area.

Keywords: Water Purification, Water Quality, Solar Still, Physico-chemical parameters

Introduction

Fresh/Clean water is essential for human beings and life is impossible without water. The accessibility of drinking/clean water is unattainable currently owing to rapid growth of population and development of industries. Only 1% of available water in Earth is fresh and in liquid state, and among this availability of water, it is polluted by both diseases and toxic chemicals. For this reason purification of water is necessary and in many countries the solar still working by utilizing solar energy which is renewable and sustainable has been used to produce drinking water [1-2]. Solar radiation is the source of energy for the
solar still and in the process; water is evaporated and water vapor is separated from dissolved matter and condensed as pure water [3-4]. Drinking water quality management is a key pillar in the prevention and control of water born diseases [5]. Many researchers have analyzed the quality of drinking water using physico-chemical and microbial parameters. The drinking, borewell and sewage water from three different places of Sivakasi has been analyzed by Radha Krishnan et al., [6]. Pavan Kumar et al., [7] have determined the quality of the Raman Padu balancing reservoir and Koilsagar reservoir by using bacteriological and physicochemical parameters. The outcome displayed the physico-compound parameters are inside as far as possible. The quality of 24 bore well water samples from Madyal and Vadgaon Villages of Kagal Tahsil MS, India has been investigated by Ashvinet al., [8]. It has been recommended for drinking and domestic purposes, only after pretreatments like filtering, boiling, reverse osmosis and electrodialysis. Chemical characteristics of different sources of drinking water have been studied by Yousaf et al., [9] in Nowshera district, Khyber Pakhtunkhwa. It has been inferred that the quality of water in Nowshera district is badly deteriorated and contaminated as a result of the flood of 2010. Sanjay et al., [10] have studied the quality of Bansagar dam and nearby area, Madhya Pradesh, India using physico-chemical parameters and concluded that the quality of Bansagar dam and nearby area is better. The physico-chemical parameters of ground water of 15 stations in Bhandara district has been studied by Asia et al., [11] and found that the treatment of ground water is needed to minimize the contamination. The quality of different water samples from different sources in Coimbatore district has been analyzed by various researchers [12-15] using physico-chemical and microbiological parameters and found that it is fit for drinking and domestic purposes.

Aim of this work is to purify the waste water by using solar still and quality of the water before and after distillation has been analyzed using physico-chemical parameters such as pH, electrical conductance, total hardness, total alkalinity, magnesium hardness, total dissolved solids, chloride etc.

Materials and Method

Design of the solar still
A schematic diagram of the proposed passive distillation system is shown in Fig. 1. It consists of a single basin type solar still. The still has an area of 1 m². The bottom and sides are insulated against heat loss to surroundings by means of glass wool insulation. The surface of the basin facing the sun is painted black for maximum absorption of solar radiation. The still cover is made of 0.004 m thick ordinary glass and has an inclination of 11°. The yield is collected by an Aluminium channel attached to the lower end of the glass cover and measured directly by a measured jar.

Experiment have been carried out from 9am to 5pm with the dual purpose double slope single basin solar still at Department of Physics, Karpagam University, Coimbatore-641021 (latitude 11° N, long 77° 52’ E). Fig.2. shows the photograph of a single basin double slope solar still.

**Results and discussion**

The raw water sample was collected from Coimbatore District, Tamilnadu, India and purified by using solar still for drinking and domestic purposes. The quality of before and after purification of raw water have tested by using physic-chemical parameter analysis to know the quality of water. The results of the physicochemical parameters are given in Table.1. The odor and taste has been tested for raw water and purified water and found that the before purification of raw water is objectionable but after the purification of it the results have shown that the odour and taste are agreeable. The pH values of before and after purification of raw water is shown graphically in Fig.3. It is seen that the pH value of raw water is 8.4 and after distillation or purification of this water is 7.4. From these results it is confirmed that the pH values of samples are within the permissible limit of IS:(10500-1991). The value electrical conductivity for before and after distillation of raw water is depicted graphically in Fig 4 and observed that the value of electrical conductivity of brackish water is 900μmhos/cm and after distillation it is 59. The electrical conductivity brackish water is higher than the distilled water due to high salt content is presented in brackish water. Fig.5. shows the turbidity for before and after distillation of raw water. The result shows that the turbidity of raw water is higher than the purified water and it is not exceed the prescribed limit of ISI(10500-1991). Fig.6. illustrates the values of total dissolved solid for brackish and
distilled water and compared these water samples the TDS value of raw water is higher than the distilled water. Because, high total dissolved solids might be due to the presence of large number of organic salts, such as chloride, magnesium, calcium and carbonates.

Alkalinity is the name given to the quantitative capacity of water to neutralize an acid. The value of total alkalinity of brackish water and after distillation of it is depicted graphically in Fig. 7. From these results it is confirmed that the water samples are within the permissible limit of ISI(10500-1991). Total hardness is represented by the value of CaCO₃ is present in the water. Fig. 8. shows the total hardness of water samples and it is found that the value of total hardness is 356mg/l.

The magnesium hardness of the brackish water range is 36 mg/l and after purification of it is below detective level is shown in Fig. 9. It is found that the water samples are below the permissible limit. The values of calcium hardness for water samples is shown graphically in Fig. 10 and inferred that the value of calcium hardness is 68 mg/l and below detective level for before and after distillation of brackish water and water samples are below the prescribed limit of Indian drinking water standard IS:(10500-1991).

Calcium is naturally present in water. Calcium is largely responsible for water hardness. The calcium ranges in the present water samples high before distillation of brackish water and it is shown in Fig. 11. The value of calcium content in raw water is 25.6mg/l.

Magnesium and other alkali metals are responsible for water hardness. Fig. 12. shows the magnesium content of water samples and inferred that magnesium content is not able to detect after distillation of brackish water. The value of magnesium content is found to be 11mg/l. The tolerance of magnesium is 30 mg/l.

The iron content of water samples is shown graphically in Fig. 13. The result shows that the values of iron content are below the permissible limit of Indian drinking water standard. The tolerance range of iron is 0.30 mg/l.
Sulphate is a substance that occurs naturally in drinking water. The content of sulphate for water sample is illustrated in Fig.14. It is found that the water samples are below the prescribed sulphate. The tolerance range for sulphate is 200 to 400 mg/l.

The value of phosphate is found to be 1.2 for before distillation of raw water and it is shown in Fig.15. The results revealed that the after distillation of brackish water the phosphate value is not detectable level. Most chlorides in water come from salt (NaCl). The value of chloride for brackish water is 165mg/l and after distillation by solar still it is 10.2mg/l.

Fig.16. shows the chloride content of water samples and confirmed that the water samples are within the permissible limit of IS:(10500-1991). The tolerance range of the chloride is 200 to 1000 mg/l.

In Figs. 17 and 18 expresses the presence of nitrate and silica for the water samples. Fig.17. illustrates the values of nitrate content for before and after distillation of raw water and found that the value of nitrate for brackish water is 1.2mg/l and in distilled water is below detectable level. From these results it is confirmed that the water samples are below the permissible limit. Fig.16. shows the value of silica for raw and distilled water. The result indicates that the value of silica is 2mg/l which is higher than the distilled water 0.4 mg/l.

**Conclusion**

In light of these outcomes following conclusion has been drawn. The waste water (Brackish water) is polluted and the physico-chemical parameters surpass the water quality guidelines and the nature of water is exceptionally terrible and it is unfit for drinking reason. In this way the waste water is filtered by utilizing solar still and found that the physico-chemical parameters are inside the reasonable furthest reaches of ISI(10500-1991). From these outcomes plainly, sanitization of waste water quality by utilizing sunlight based still is great and fit for drinking reason and prescribed that the sun based still can be utilized as purifier in brackish area.
Table 1. Results of the Physico-Chemical parameters and comparison between Indian drinking water standards of IS: (10500-1991)

| Parameters          | Before distillation (Raw Water) | After distillation  | Indian Standard IS: (10500-1991) |
|---------------------|---------------------------------|---------------------|----------------------------------|
| Odour               | Objectionable                   | Unobjectionable     | Agreeable                        |
| Taste               | Not agreed                      | Agreeable           | Agreeable                        |
| pH                  | 8.4                             | 7.4                 | 6.5-8.5                          |
| Electrical conductivity(μmhos/cm) | 900                            | 59                  | -                                |
| Turbidity( NTU)    | 0.9                             | 0.1                 | 5                                |
| Total dissolved solids(mg/l) | 501                            | 45                  | 500                              |
| Total alkalinity(mg/l) | 350                            | 10                  | 300                              |
| Total hardness(mg/l) | 356                            | BDL                 | 300                              |
| Magnesium hardness(mg/l) | 36                             | BDL                 | 50-100                           |
| Calcium hardness(mg/l) | 68                             | BDL                 | 75-200                           |
| Calcium as Ca (mg/l) | 25.6                           | BDL                 | 75                               |
| Magnesium Mg (mg/l)  | 11                             | BDL                 | 30                               |
| Iron Fe (mg/l)      | 0.13                           | BDL                 | 0.30                             |
| Sulphate SO₄(mg/l)  | 26                             | BDL                 | 200                              |
| Phosphate(mg/l)     | 1.2                            | BDL                 |                                  |
| Chloride Cl₂(mg/l)  | 165                            | 10.2                | 200                              |
| Nitrate(mg/l)       | 1.2                            | BDL                 | 200                              |
| Silica SiO₂(mg/l)   | 2                              | 0.4                 | 100                              |

Note: BDL-Blow Detective Level
Figures

Fig 1. A schematic diagram of the single basin double slope solar still

Fig 2. Photograph of the single basin double slope solar still
Graphs

Fig.3. the pH value of water samples. Fig.4. Electrical conductivity for waters samples

Fig.5. the turbidity of water samples Fig.6. Total dissolved solid of water samples
Fig. 7. Total alkalinity of water samples
Fig. 8. The total hardness for water samples
Fig. 9. Magnesium hardness for the water samples
Fig. 10. Calcium hardness of water samples
Fig. 11. Calcium content of water samples
Fig. 12. Magnesium content of water samples
Fig. 13. Iron content of water samples

Fig. 14. The values of sulphate for the water samples

Fig. 15. The value of Phosphate for water samples

Fig. 16. The chloride content of water samples

Fig. 17. The value of Nitrate for water samples

Fig. 18. The content of silica for water samples
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