International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 09 | Sep 2023 www.irjet.net p-ISSN: 2395-0072

Study of Solar Distillation on Domestic Wastewater Treatment

Mr. Shubham Bhagwan Wadekar[1], Dr. Sonal G. Chonde[2], Mr. Shrikant M. Bhosale[3]

[1] PG. Student Department of Technology, Shivaji University Kolhapur-416004, Maharashtra India.
[2] Assistant Prof. Krishna Institute of Allied Sciences, Krishna Vishwa Vidyapeeth Karad, Maharashtra, India.
[3] Assistant Prof. Department of Technology, Shivaji University Kolhapur-416004, Maharashtra India.

Abstract - *In situations where the quality of the local water is poor, particularly in isolated locations where alternative treatment methods are not accessible, solar distillation has been used for decades to provide potable water. This research report examines the findings and observational viewpoint. Alkalinity, acidity, alkalinity, COD, BOD, TDS, TSS, hardness, and chlorides are some of the physio-chemical parameters. Checks were done both before and after applying these parameters to the solar distillation apparatus. The main building of the Department of Technology SUK, which is situated at 16.6703° N and 74.2604° E, is where this entire research was conducted.*

The final results for every single parameter were within tolerance; during the distillation process, up to 88% of the COD value was removed. All other parameters, including BOD, pH, TDS, Hardness, Chloride, Alkalinity, and Acidity, are only set within the permitted range.

Key Words: *solar distillation, Two Roof Solar Distillation, Domestic waste*.

1. INTRODUCTION

India is a developing country, and like many other developing countries, it has difficulties carrying out wastewater treatment. In developing nations, rapid urbanization is a trend that threatens aquatic life and human health by dumping a lot of household waste into bodies of surface water. Additionally, untreated sewage produces several illnesses that directly endanger individuals (Kolev, 2017).

Domestic wastewater has a large proportion of suspended particles and is low in strength. Sewage typically has a chemical oxygen demand (COD) of less than 1000 mg/L, but it also includes poisonous or dangerous heavy metals and other inorganic chemicals. In terms of garbage management, urban India has become a big and sometimes terrifying reality. Studies focusing on the treatment of wastewater with low strength are multiplying quickly. In recent years, there has been an effort to survey a region, define its baseline environmental state, and assess the contribution of various agencies to the subject of environmental protection and improvement. The nature of the wastewater and its source are the main factors that determine how the different elements are established in stable relationships. It is projected that these phrases will be used more frequently in the future because of how quickly the associated tests may be completed. Therefore, it is important to identify the physicochemical properties of these waste kinds. Therefore, it has been thought wise to look into the state of residential sewage produced by any community. The analysis aids in the quick assessment of water quality and the control of effluent (Venkatesh et al., 2009).

Domestic sewage is created when liquid waste is flushed down toilets, latrines, kitchen sinks, washbasins, and other plumbing fixtures in residences, companies, and other buildings. This sewage often has a very nasty smell since it contains human bodily waste. sewage as well 99.9% of the trash in this sewage is water, and 0.1% of it is organic or inorganic garbage. We gather household garbage for the study project from a nearby gutter in the Kolhapur neighbourhood of Nagala Park, as illustrated in Fig. 1

Construction of a conventional sewage treatment plant calls for a sizable surface area, specialized routine inspection, various units and personnel, but most importantly, significant ongoing financial and power allocations. Not all nations can achieve these requirements. Solar distillation is one of the most practical and effective solutions to these issues (Katekar & Deshmukh, 2020).

For many years, solar distillation has been employed. In the 18th century, the first substantial solar distillation facility was constructed at Las Salinas, Chile, and equipment was created there. In remote, arid, and semi-arid areas where drinking water is scarce, solar radiation is strong, and wastewater treatment is required, solar distillation makes sense (Velmurugan & Srithar, 2011). Because they are generally small facilities, solar distillation units can be employed in areas that lack fresh water but have a sufficient supply of brackish or saltwater water (Alsaad, 1987). The goal of the planned study is to use solar distillation to treat this residential sewage.

Figure 1 Domestic waste Nagala park, Kolhapur.

2. Material and Method

Geographical and meteorological conditions:

The research work was performed in the Department of Technology's environmental science lab at Shivaji University, Kolhapur. The two-roof solar distillation system, which is situated above the main building of the Kolhapur Department of Technology at 16.6703° N and 74.2604° E, is used for the distillation process. According to meteorological data of kolhapur city, it denotes an average high temperature of 38.3°C and an average low temperature of 22.8°C, April is the hottest month in Kolhapur. We cited the historical temperature data from the weather atlas website.

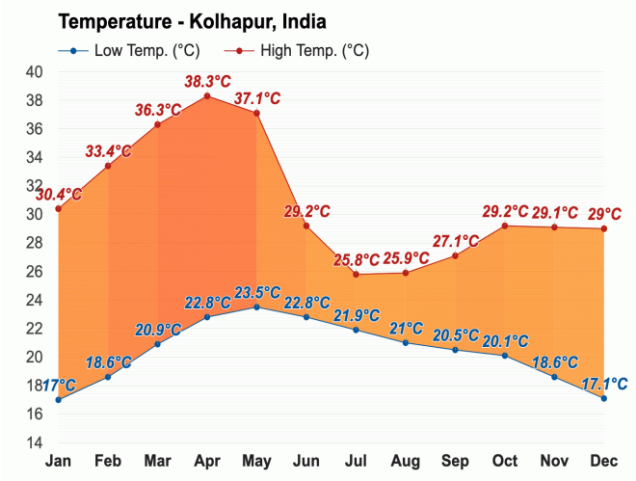


Figure 2 Ambient minimum and maximum temperature of Kolhapur City 2022

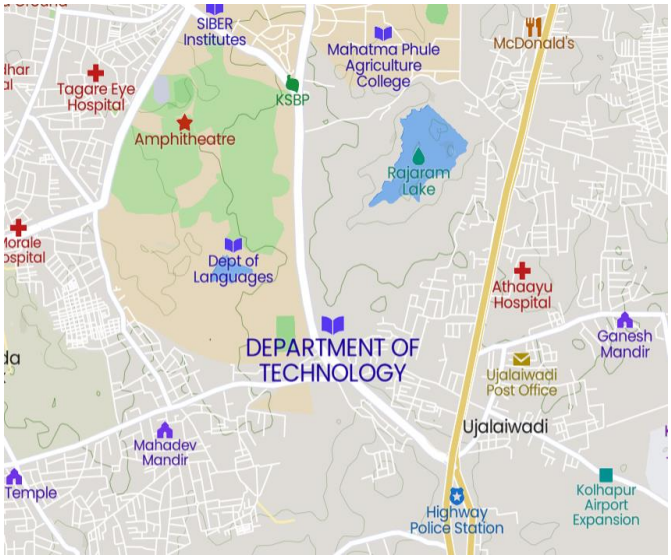


Figure 3 Department of Technology SUK

Solar Distillation module description

- ✓ Maximum water depth of 3 cm
- ✓ Glass angle 30^0
- ✓ Effective area 0.48 m^2
- ✓ Dimensions Length 0.8 m
- ✓ Width 0.6 m
- ✓ Height 0.3 m

Figure 4 Two Roof Solar Distill at SUK.

Solar Distillation process:

The still is filled with wastewater until the basin is halfway full. Solar radiation can enter the still through the glass top but is primarily absorbed by the base's blackened surface. To increase solar absorption, this inside surface is made of a substance that has been blackened. As the water warms up, the amount of moisture in the air that is trapped between

the water's surface and the glass lid rises. The glass cover's inside becomes condensed with the hot water vapour that had been evaporating from the basin. The original water's minerals and microorganisms are not removed throughout this procedure. Condensed water drips from a storage container and down the slanted glass lid to a collection trough. (*Design of Solar Distillation System*, 2017).

The sample that is classified as domestic waste consists of waste from the kitchen, bathroom, and utensil wash, except toilet water. This sample was collected from a gutter in Kolhapur's Nagala Park. After gathering this sample, we went to the Department of Technology Environmental Science Lab to conduct a preliminary physio-chemical analysis on the indicated sample. These tests assess TDS, PH, EC, Turbidity, Acidity, Alkalinity, Chloride, Hardness, DO, COD, and BOD levels.

After the test, we physically deposited this raw waste from the unit's intake section into the solar distillation container. From 10 a.m. to 4 p.m., the wastewater is kept in the distillation container for 24 hours. For a month, this procedure has persisted every day.

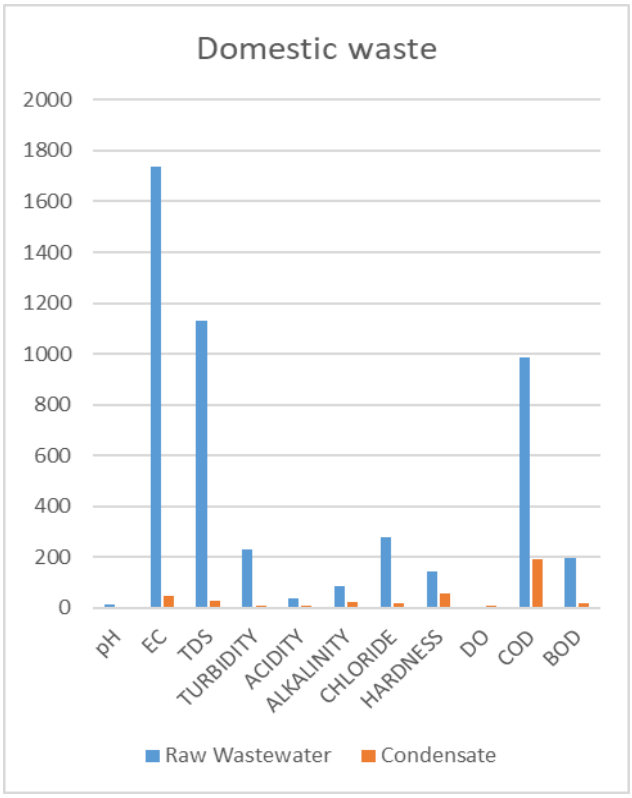
All of the specified tests were carried out according to the SK MATEY manual's instructions with extreme precision and accuracy (Analysis, n.d.).

3. Observation:

Figure 5 COD test samples

Figure 6 COD digestor

	DOMESTIC WASTE	
TESTS	**Raw waste**	**Condensate**
pH	12 ± 0.50	6.58 ± 0.20
EC µS	1738 ± 20	19 ± 3
TDS mg/l	1130 ± 8	12± 2
TURBIDITY NTU	230 ± 5	8 ± 1
ACIDITY mg/l	37.5 ± 4	12 ± 1
ALKALINITY mg/l	85 ± 8	25 ± 2
CHLORIDE mg/l	281 ± 3	17 ± 2
HARDNESS mg/l	145± 12	18 ± 5
DO mg/l	2± 1	6 ± 1
COD mg/l	986 ± 40	43 ± 5
BOD mg/l	196 ± 16	21 ± 8



4. Results and Discussion:

pH:
The PH number refers to the potential of H+ ions that are present in the specified samples. After the raw waste sample is distilled, the PH = - Log (H+) value ranges from 6.5 to 7.2, within the allowable limit. (Addy et al., 2004).

Electric Conductivity [EC]:
Pure water is a poor conductor of electricity. When it is in equilibrium with ambient carbon dioxide, conventional distilled water has a conductivity of around (20 µS). Since the electrical current in a solution is carried by the ions within, conductivity increases as ion concentration does. Conductivity increases in proportion to the dissolution of ionic species in water. During distillation, the EC value was dramatically reduced by up to 95%. (Rusydi, 2018).

Total Dissolved Solids [TDS]:
The entire quantity of inorganic and organic components that have been dissolved and are suspended as molecules, ions, or small granules in a liquid is known as total dissolved solids (TDS). When distilling, it can be reduced by up to 99% (Rusydi, 2018).

Turbidity:
Turbidity is a measure used to evaluate the relative clarity of a liquid. When light passes through a water sample, the amount of light dispersed by its constituents is measured. It is a characteristic of water's optics (Niam et al., 2008) With an increase in diffused light intensity, the turbidity rises. Turbidity is reduced by 97% during the distillation process.

Acidity:
If the sample's pH is lower than 7, it usually indicates that it is acidic. After solar distillation, the value has been seen to decrease by up to 74% utilizing titration measurements.

Alkalinity:
An alkalinity is a unit of measurement for a body of water's capacity to buffer acids and bases and maintain a pH level that is generally stable (Addy et al., 2004). The waste sample's alkalinity has decreased by up to 71%.

Hardness:
The fluid parameter of "hardness" is used to compute the multivalent metallic cation in the sample. (Mukhopadhyay, 2008). During the distillation process, hardness can be reduced by up to 92% when utilising the EDTA technique in a lab.

Chlorides:
Mohr's method of titration is used to calculate chlorides. Chloride levels are excessive, which is a sign of industrial contamination (Balan et al., 2011). The findings demonstrate that the sun distillation procedure is successful in reducing chlorides by up to 90%.

DO
Dissolved Oxygen (DO), which was determined in a lab using Winkler's technique, is the maximum amount of oxygen that may dissolve in a sample at any given temperature. (Sawyer, C.N; McCarty, 1978). The results show that throughout the distillation process, the dissolved oxygen content rises in all samples to a permissible level.

COD
It is the quantity of oxygen needed for both biodegradable and non-biodegradable organic materials to degrade. (COD Chemical Oxygen Demand) The distillation process can remove up to 88% of the cod's value, which is determined using the titration technique (Zarasvand Asadi et al., 2013).

BOD
BOD (Biochemical oxygen demand) is the quantity of oxygen that degraded, biodegradable organic matter needs. By incubating for five days, the biochemical oxygen demand (BOD) value has been determined (Ghazy et al., 2013). When the solar distillation process was considered, the BOD value decreased by up to 89%.

5. Conclusion:

The usage of solar distillation technology has substantially aided in the development of sustainable environmental technology due to its major focus on improving the quality of life in underdeveloped areas. The results of this paper's

observations and analysis suggest that the sun distillation method for treating domestic wastewater successfully satisfies the objectives of the study. The solar distillation technique provides an option for conventional sewage treatment plants with huge expenditures.

The biological parameters are downsized from the observation situation to 92 +/-6%. Physical parameters like TDS were decreased up to 99% and chemical parameters were lowered to 92 +/- 6%. The clean water is simply evaporated and condensed by the sun distillation process, then it is collected in a container. This sustainability strategy will aid in the promotion of green energy.

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