1. TITLE OF THE PROJECT:

Effective Utilization of Solar Energy for Purification of Water

2. NAME OF THE COLLEGE & DEPARTMENT:

Global Academy of technology

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3. NAME OF THE STUDENTS & GUIDE(S)

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4. KEYWORDS:

Water purification, Solar Energy, Water Quality Parameers, Sustainable

5. INTRODUCTION:

Water is the driving force of all nature. Water is vital to life and development in all parts of the world. The availability of a water supply adequate in terms of both quantity and quality is essential to human existence. Civilization developed around water bodies that could support agriculture and transportation as well as provide drinking water. Recognition of the importance of water quality developed more slowly. Early humans could judge water quality through physical senses of sight, taste and smell. Not until the biological, chemical and medical sciences developed were methods available to measure water quality and determine its effects on human health and well-being.

Water pollution is the presence of some inorganic, organic, biological, radiological or physical foreign substance in the water that tends to degrade its quality. The polluted water is turbid, unpleasant, bad smelling, unfit for drinking, bath and washing and incompatible in supporting life. Water pollution is also caused by the presence of undesirable and hazardous materials and pathogens beyond certain limits. Much of the pollution is due to anthropogenic activities like discharge of sewage, effluence and wastes from domestic and industrial establishments, particulate matter and metals and their compounds due to mining and metallurgy and fertilizer and pesticide runoffs from

agricultural activities.

6. OBJECTIVES:

The main objectives of this project is to design and develop a working model for purification of water, using solar energy. The source of water used in this project is polluted lake water. The water quality parameters are tested for the polluted water, before purification. The polluted water is being treated by the model, and the water quality parameters are tested after purification by the model. The results must satisfy and meet the desired water quality parameters specified by IS 10500 (2012).

7. METHODOLOGY

7.1 COLLECTION OF SAMPLES

Water Sample was collected at Herohalli Lake, Andrahalli, Bengaluru.

Fig. 7.1. Water sample collected from Herohalli Lake, Bangalore

7.2 WATER SAMPLE TESTS: BEFORE PURIFICATION

Table 7.1. Water quality tests before purification

Water Quality Parameters	**Results**
pH	7.5
Turbidity	44 NTU
Total Solids	2200 mg/l
Total Suspended Solids	1480 mg/l
Total Dissolved Solids	720 mg/l
Dissolved oxygen	5 mg/l

BOD	8.65 ppm
Total Hardness	92 mg/l
Calcium	9.72 mg/l
Magnesium	16 mg/l
Chloride	47.91 mg/l
Total Alkalinity	80 mg/l as $CaCO_3$

7.3 PURIFICATION PROCESS

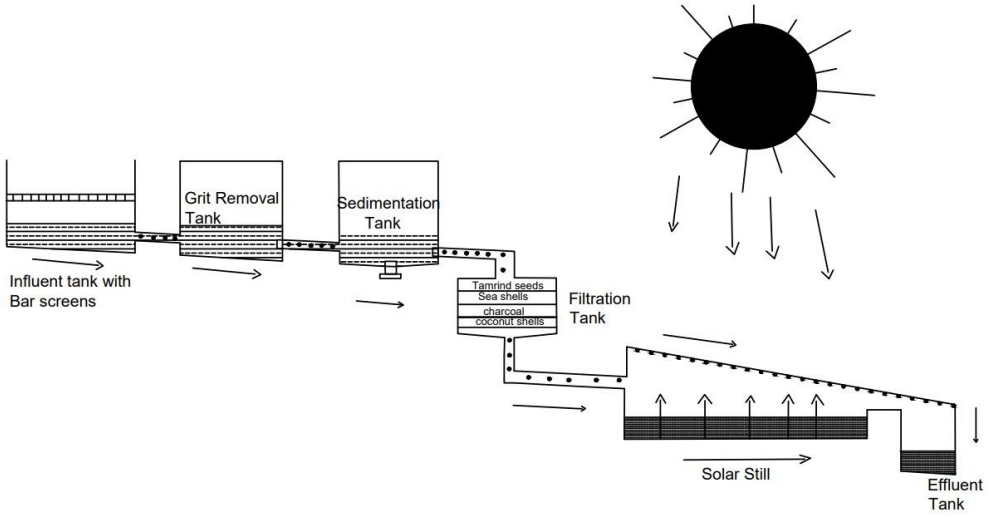

Fig. 7.2 Design methodology

7.3.1 Influent Tank: Water sample is poured to influent tank. This tank consists of bar screens. Solids present in the sample are removed through bar screens

Fig 7.3 Influent tank with bar screens

7.3.2 Oil and Grease Removal Tank: The oil and grease is skimmed off the water in this tank.

Fig. 7.4 Oil and Grease removal tank

7.3.3 Sedimentation Tank: The suspended solids settle down in this tank and the pure water flows to the next unit. The sediments are later scoured off.

Fig. 7.5 Sedimentation tank

7.3.4 Filtration Unit: Materials used in filtration unit are tamarind seeds, sea shells, coconut shells and charcoal.

Fig. 7.6 Filtration tank

7.3.5 Solar Still with Parabolic Reflector: The solar still wroks on evaporation-condensation process. The clean water is collected on the right-most part of the solar still, which is separated by a baffle wall.
The parabolic refletor is used to capture and reflect more solar energy onto the solar still.

Fig. 7.7 Solar still with parabolic reflector

Fig. 7.8 Water Purification Unit

8. RESULTS AND CONCLUSIONS

8.1 WATER SAMPLE TESTS – AFTER PURIFICATION

Table 8.1. Water quality tests after purification

Water Quality Parameters	**Results**
pH	8.1
Turbidity	3.6 NTU
Total Solids	1600 mg/l
Total Suspended Solids	1200 mg/l
Total Dissolved Solids	400 mg/l
Dissolved oxygen	6.7 mg/l
BOD	1.34 ppm
Total Hardness	176 mg/l
Calcium	67 mg/l
Magnesium	7.77 mg/l
Chloride	214.05 mg/l
Total Alkalinity	160 mg/l as $CaCO_3$

For accurate results, the water samples were taken on three days from the same lake. The samples were collected on 8th May 2023 at 8:00 a.m, 9th May 2023 at 12:00 p.m and 10th May 2023 at 4:00 p.m. The test results before and after purification are tabulated below.

Table 8.2. Sample 1 collected on 8th May 2023 at 8:00 a.m

Water Quality Parameters	**Results Before Purification**	**Results After Purification**
pH	9.6	7.9
Turbidity	35 NTU	3.2 NTU
Total Solids	2150 mg/l	1470 mg/l
Total Suspended Solids	1360 mg/l	1150 mg/l

Total Dissolved Solids	790 mg/l	320 mg/l
Dissolved oxygen	3 mg/l	6.7 mg/l
BOD	10.35 ppm	1.45 ppm
Total Hardness	102 mg/l	167 mg/l
Calcium	10.34 mg/l	67 mg/l
Magnesium	24 mg/l	9.97 mg/l
Chloride	37.85 mg/l	114.05 mg/l
Total Alkalinity	170 mg/l as $CaCO_3$	140 mg/l as $CaCO_3$

Table 8.3. Sample 2 collected on 9th May 2023 at 12:00 p.m

Water Quality Parameters	**Before Purification**	**After Purification**
pH	10.3	8.0
Turbidity	65 NTU	4.5 NTU
Total Solids	2090 mg/l	1200 mg/l
Total Suspended Solids	1240 mg/l	960 mg/l
Total Dissolved Solids	850 mg/l	240 mg/l
Dissolved oxygen	4.6 mg/l	6.7 mg/l
BOD	11.23 ppm	1.34 ppm
Total Hardness	94 mg/l	105 mg/l
Calcium	11.35 mg/l	63 mg/l
Magnesium	42.26 mg/l	12.65 mg/l
Chloride	25.87 mg/l	168 mg/l
Total Alkalinity	185 mg/l as $CaCO_3$	145 mg/l as $CaCO_3$

Table 8.4. Sample 3 collected on 10th May 2023 at 4:00 p.m

Water Quality Parameters	**Before Purification**	**After Purification**
pH	9.8	7.8
Turbidity	48 NTU	3.6 NTU
Total Solids	1800 mg/l	1100 mg/l
Total Suspended Solids	1160 mg/l	940 mg/l
Total Dissolved Solids	640 mg/l	160 mg/l
Dissolved oxygen	4.4 mg/l	6.7 mg/l
BOD	10.12 ppm	1.49 ppm
Total Hardness	106 mg/l	157 mg/l
Calcium	15.36 mg/l	46 mg/l
Magnesium	26.59 mg/l	15.55 mg/l
Chloride	25.87 mg/l	269 mg/l
Total Alkalinity	174 mg/l as $CaCO_3$	125 mg/l as $CaCO_3$

The pH has considerably met the desired water quality parameters for drinking water, the Dissolved Oxygen in water has been increased and the turbidity has decreased completely.

The increase in Total Hardness, Calcium, Chloride and Total Alkalinity is due to use of seashells in filtration unit. Seashells are made of Calcium Carbonate ($CaCO_3$), the same substance as limestone. They tend to dissolve in water, and the dissolved calcium and carbonate increase the calcium content, the hardness, the alkalinity and chloride content of water.

The exception to this is, if the water is already hard, in those cases, the water may have no capacity to dissolve much, or any, calcium carbonate. By the same token, water that is soft will dissolve much more calcium carbonate, and much faster, than

water that is not soft, up to the point that the water is no longer soft because of its dissolved mineral content.

Seashells, limestone, and other forms of calcium carbonate tend to dissolve in fresh water, and raise the water's pH, up until the water has a pH of 8.5 or thereabouts. At that point, little or no additional shell or limestone will dissolve, but the already-dissolved mineral will buffer the water, that is, it will react with any acids to resist a drop in pH (This is why it's very difficult to reduce the pH of hard water). So if the pH is already, say, 9.0, adding seashells won't make much difference in the water chemistry.

8.2 CONCLUSION

The purpose of this project was to develop solar water purification system. This project focuses on the development of systems that could purify biologically contaminated water by using the solar energy and UV system. Even though the method is new, and requires much further work to reach commercialized implementation, it has already proven to be a relatively simple and reliable method. Solar water purification is a functioning and sustainable water treatment method, suitable for implementation in rural areas despite widely varying water contaminants and to purify the water.

The water sample collected from Herohalli Lake, Bangalore was alkaline in nature, the colour was non agreeable and the water quality parameters did not meet the BIS standards. Hence the purification was required. After purification, the water met the BIS Standards. The pH, turbidity, total hardness, total alkalinity, solids, dissolved oxygen, biological oxygen demand met the desired water quality parameters as in IS 10500-2012. Though the hardness, alkalinity, chloride, calcium content has increased after purification, the results meet the desired water quality parameters.

The study also showed that the method has the potential to be implemented in much greater areas than just the ones with continuous high levels of solar energy. The solar water purification system was designed with the parameters of being sustainable, portable, cost effective ,easy to use and scalable.

9. SCOPE FOR FUTURE WORK

Modern waste water treatment process is aiming at incorporating cost effective, economic, natural and simple. In conventional water treatment, coagulation is achieved using chemical coagulants such as aluminium sulphate, ferric chloride, poly aluminium chloride, etc. While the effectiveness of these coagulants is well-recognized, nonetheless, their application in water treatment is becoming unsuitable owing to ineffectiveness in low temperature water, relatively high procurement costs, detrimental effects on human health, production of large sludge volumes and the fact that they significantly affect pH of treated water. This work does not need coagulation, if required, natural coagulants can be made use of.

This work specifies treatment of polluted lake water, nonetheless, grey water, sewage water could be also treated. The efficiency of the model must be looked and focussed upon in the future, to enhance the effciency of the water purification model.