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Water Purification And Distillation System By Using Hybrid Energy Source

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ABSTRACT

This system has designed a water purification system to augment the village's water distribution system. The system utilizes sediment filtration supplemented with ultraviolet light to effectively filter and sterilize contaminated well water as it is pumped to the village reservoir. The goal of the project was to meet the needs of the village and provide a long-term water treatment solution. The purpose of this report is to present an overview of the entire project including: the design solution, project cost, construction, and maintenance information, testing and evaluation result and future field-testing plan

Freshwater availability is a crucial component of society. In India, ground water and rainfall are not always sufficient sources of fresh water; hence alternate sources are now becoming more important. India, a tropical nation, has 300 sunny days and solar radiation of 4–7 kW/hr, which may be used to give an alternative source for distillation technology. Traditional sun desalination techniques including reverse osmosis (RO), multistage flash (MSF), multifaceted distillation (MED), and electro dialysis (ED) have advanced to a greater extent in recent decades. This study examines several research initiatives on active and passive solar distillation/desalination that have been created in India.

1. INTRODUCTION

All we know that solar energy is universal energy which is renewable source of energy. The sun creates its energy through a thermonuclear process that converts about 650,000,000[1] tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation (including visible light, infra-red light, and ultraviolet radiation) streams out into space in all directions. Methods of collecting and storing solar energy vary depending on the uses planned for the solar generator.

The three types of collectors:

1. flat-plate collectors
2. focusing collectors
3. passive collectors

Flat-plate collectors are the more commonly used type of collector today.

In this project also I am going to use flat plate collectors to produce electricity through solar energy. Most of our tools are designed to be driven by electricity, so if you can create electricity through solar power, you can run almost anything with solar power. The solar collector converts radiation into electricity.

In this project I am going to run water RO-UV water purification and distillation system by using solar energy. Among the renewable resources, only in solar power do we find the potential for an energy source capable of supplying more energy than is used.

Unpredictable negative environmental effects: If all the solar collectors were placed in one or just a few areas, they would probably have large effects on the local environment, and possibly have large effects on the world environment. The problem lies in the change of temperature and humidity near a solar panel; if the energy producing panels are kept non-centralized, they should not create the same local, mass temperature change that could have such bad effects on the environment. Water is essential for life. The amount of fresh water on earth is limited, and with the rapid industrialization, its quality is under constant pressure. Preserving the quality of raw water is important not only for the drinking-water supply, but also for food production and other water uses. Water quality can be compromised by the presence of infectious agents, toxic chemicals, and radiological hazards. Water quality deterioration in distribution systems is mainly caused by inappropriate planning, design and construction or inadequate operation and maintenance and water quality control. This has been linked to a significant proportion of the burden of waterborne and water-related illness. Stresses on these systems caused by rapid urbanization, population growth and aging infrastructure further exacerbates the problems. The integrity of well managed distribution systems is one of the most important barriers that protect drinking-water from contamination. However, management of distribution systems often receives little attention. Distribution systems can incorrectly be viewed as passive systems with the only requirement being to transport drinking-water from the outlets of treatment plants to Society.

1.1 Objective

The aim of my project is to purify water by using solar energy. Same for the purification I have selected two methods; those are UV & RO Processes.

This project will be more beneficial in the rural areas where amount of energy is not sufficient. And purified water certainly neglected in such areas. Because of that many old people children are affected by water borne diseases.

- Analysis the effect of various factor on performance of solar still with desalination.
- To determine heat of absorption and condensation in particular instant by using glass.
- Determine water discharge in each phase.
- To get maximum amount of purified water and increase the efficiency of solar distillation.

To determine thermal efficiency of solar still

The main objectives of the project are to produce filters that:

1. Can effectively remove bacteria and other contaminants from drinking water.
2. Are easy for people to use.
3. Are easy for local potters to produce.
4. Have an acceptable flow rate (one that will not make people too impatient to use).
5. Are of little or no cost to users.
6. Can be easily implemented with an effective educational system.
7. Inspire users to practice good hygiene.
8. Inspire economic growth by promoting health and creation of jobs.

1.2 Problem Statement

- Electricity consumption for RO water purifier
- Low distilled output per unit area.
- Productivity decreases with time for variety of reasons like weather, seasons etc.

TYPE	CAUSE	DISEASES
Chemical	Lead	Infants and Children: Delays in Physical or mental development. Adults: Kidney and High B.P
	Arsenic	High risk of getting Cancer. Skin damage or circulatory system problems
	Fluoride etc.	Bone diseases (pain and tenderness of bones). Mottled teeth in children
Microbial	Bacterial infections	Typhoid, Cholera, Bacillary dysentery
	Viral infections	Infectious Hepatitis (jaundice)
	Protozoa infections	Amoebic dysentery

Figure 1.2.1.WATER BORN DISEASE

COMMUNITY WATER	BOTTLED WATER
1. Quality at the treatment different from quality at discharge	1. Unavoidable Cost of bottling and transportation
2. Uncontrolled dosage of chemicals	2. Non-biodegradable waste
3. Common Supply for Drinking and bulk household usage	3. Not all bottled water is verified by independent agency
4. Not a cost effective supply for drinking	4. Wait for bottled water delivery or go to the market for buying

2. Methodology

2.1 Materials and its Specifications:

This project work experimental study and testing

1. Solar Panel
2. Battery
3. Solar Charge Controller
4. Booster Pump
5. Water Purification Filters
   (A) Sediment Filter (B) Pre Carbon-Filter (C) Post Carbon Filter
   (D) UF Membrane (E) Mineral Filter
6. Water TDS
7. Absorber Plate
8. Distillation Tank

3. DESIGN CALCULATION

3.1 TECHNICAL INFORMATION:

- BATTERY CAPACITY (AH): 7AH (12volt)
- SOLAR PANEL = 20 W, 12V
- VOLTAGE AT MAX POWER= 18 VOLTS
- OPEN CIRCUIT VOLTAGE = 22.40 VOLTS
- CURRENT AT MAX POWER = 1.10 amps

3.2 Parameters of Solar Panel

Solar panel of 20-watt for a 12-volt battery that is charged with the help of sunlight. Being light in weight, this portable solar panel finds many applications or uses. The panel is specially designed to charge batteries up to 10 Ah or 10,000 mAh.

Wattage (Wp)	20
Voltage at Max Power	18.20 volts
Current at Max Power	1.10 amps
Open Circuit Voltage	22.40 volts
Short Circuit Current	1.45 amps
No. of cells	36
Weight	1.7 Kg
Dimensions L x W x H	450 x 350 x 22 mm

Table 3.1 solar panel specification

3.2. Parameters of Battery

By considering desired dynamic and static load considerations and considering nominal diameter of power screw (15mm) we use bearing including following specifications [From Ref No.10]

- Exide Chloride Safe power 7AH Battery 12V is designed for UPS/Solar and other instruments for backup power. Bearing type - Extended inner race with set screws
- It has a good service life and is eco-friendly.
- Can be used for bike, lawn mowers, rechargeable tools, and more.
- Made using the latest technology to prevent spills and moisture.
- Maintenance-free nature makes it ideal for UPS/Solar and other instruments.
- Versatile and reliable battery for UPS systems and other applications.
- Performs well in solar, pumps, and other applications requiring a quality battery.
- High-performance, maintenance-free VRLA battery.
- Leak-proof design and safe operation make it suitable for UPS/Solar and all instruments.

3.3. Parameters of Solar Charge Controller

A solar charge controller is used to keep the battery from overcharging by regulating the voltage and current coming from the solar panel to the battery. It is programmed at 15-A/200-W unit and uses MPPT (maximum power point tracking) to accelerate solar charging of the battery up to 30% per day.

- This 10A Solar Regulator is only suitable for lead-acid batteries: Open, AGM, and GEL. Not suitable for Ni-MH batteries, Lithium ions or other batteries. In order to protect the service life of the battery, once the battery voltage drops below 8V, the solar controller will automatically shut down.
- The battery cable should be as short as possible to minimize loss
- Make sure your battery has enough voltage for the controller to recognize the battery type before first installation
- The charge regulator is only suitable for regulating solar modules. Never connect another charging source to the charge regulator
- The regulator is only suitable for lead acid batteries: OPEN, AGM, GEL

3.4. Booster Pump

A reverse osmosis booster pump enhances the water pressure of a reverse osmosis system. When water pressure leading into an RO system is too low, the system outputs very little water, and the water it filters is not as pure as it would be if the system was operating at peak performance levels.
Working voltage – 24 volt

3.5. Water Purification Filters

A) Sediment Filter: As the name suggests, a sediment filter acts as a barrier against different types of sediments or suspended solids. It sieves or holds back physical impurities like dust, dirt, sand, silt, clay, and other solid particles.
Sediment filters or activated carbon filters can't remove or reduce TDS levels in the water. The function of the sediment filter is to eliminate various suspended particles like dirt, sand, and rust.

B) Pre Carbon-Filter: It's a filter that has been coated with carbon and it is often sold alongside the HEPA filter. It is a first-stage filter, and it is placed in front of the HEPA filter to trap bigger particles.
Carbon filters can effectively remove or reduce many contaminants from water including VOCs, chlorine, lead, fluoride, pesticides and much more. Activated carbon filtersdo not reduce Total Dissolved Solids (TDS) such as chlorides, sodium, calcium and sulfates. Carbon filters are extremely effective at reducing chlorine, improving taste and reducing odor.

C) Post Carbon Filter: Post-RO Carbon Filter. After water gets filtered through RO and UV purification stages, another layer of carbon filter is added, called as post-RO Carbon filter. Post-RO Carbon filter usually forms the last stages of water purification. This carbon filter purification stage helps in enhancing the quality of the water.
The PAC filters out major water impurities like Chlorine, Total Organic Carbon (TOC), Pharmaceuticals, Turbidity, Volatile Organic Chemicals (VOC), Industrial Solvents, and Chemicals causing bad tastes, odors, and more.
Pre Carbon filter by absorbing, eliminates Odor, Chlorine and other Organic Chemical present in the water. Post Carbon filter further removes any trace of Odor or Organic Chemical and gives colorless, odorless pure drinking water. This is suitable for all type of RO Water Purifiers.

D) UF Membrane:

- UF membranes are used for removing colloidal particles and pathogenic organisms.
- Dissolved solids can pass through the membrane without causing downstream problems.
- UF effectively removes turbidity from water.
- UF is a low-pressure membrane process for water treatment.
- It removes turbidity-causing particles, suspended solids, bacteria, colloidal matter, and proteins.
- UF uses a hollow fiber membrane to block solid debris and microscopic contaminants.
- Ultra filtration membranes have a service life of three to seven years or longer.
- UF membranes have a pore size of 0.005-0.1 μm.
- They act as a filter and separation barrier

E) Mineral Filter:

- Mineral water purifiers are essentially RO water purifiers with an additional Mineral Cartridge.
- RO water purifiers remove harmful impurities and excess TDS through multiple purification stages.
- Mineral water purifiers add minerals back into the purified water through the Mineral Cartridge.
- Mineral sanitizers in pools work by adding small amounts of ionic silver and copper to eliminate algae and bacteria.
- They also help reduce chlorine demand in the pool water.

F) Absorber Plate:

- The absorber plate is typically made from copper, stainless steel, or plastic material.
- The entire surface of the absorber plate is covered with black materials that have high absorbance.
- A selective coating can be applied to the copper absorber plate to further enhance its absorptive.
- The selective coating is typically made of copper, aluminum, or mild steel with a thickness of 0.20 mm.
- The absorber plate can be flat, corrugated, or grooved, with tubes, fins, or passages attached to it.
- Its purpose is to intercept and absorb solar energy.
- The absorber plate is typically made of copper, aluminum, or steel, with a thickness ranging from 1 to 2 mm.
- It is a critical component of the collector, working in conjunction with tubes to heat the liquid or air passing through them.
- The plate absorbs the maximum solar radiation, facilitated by glazing (cover plate), and transfers the heat with minimal losses to the atmosphere.
- The absorber plate is black painted and may have a selective material coating to enhance absorption and reduce emission.
- It has high absorption rates (80-95%) and low transmission/reflection properties.
- The base area of the absorber plate is 0.4 x 0.4 m with a thickness of 1 mm.

G) Distillation Tank:

- Insulation materials or devices, such as mild steel, have low electrical or thermal conductivity.
- They prevent heat transfer and reduce energy costs.
- Insulation also prevents moisture condensation and protects against pollutants.
- It enhances process performance, improves acoustical performance, and provides safety and personnel protection.
- Insulation contributes to fire protection and improves the appearance of equipment.
- Glass insulators have the drawback of easily condensing moisture, limiting their use in higher voltage applications.
- The base area of the water tank is 2 ft x 2 ft.
- The tank has a thickness of 1.5 mm and a height of 1 ft.
- The material used for the water basin is mild steel.
- The basin is covered with insulation, and an absorber plate is placed within it.
- The water tank has a capacity of approximately 5 liters for storing impure water.

3.6. 3D Model Design

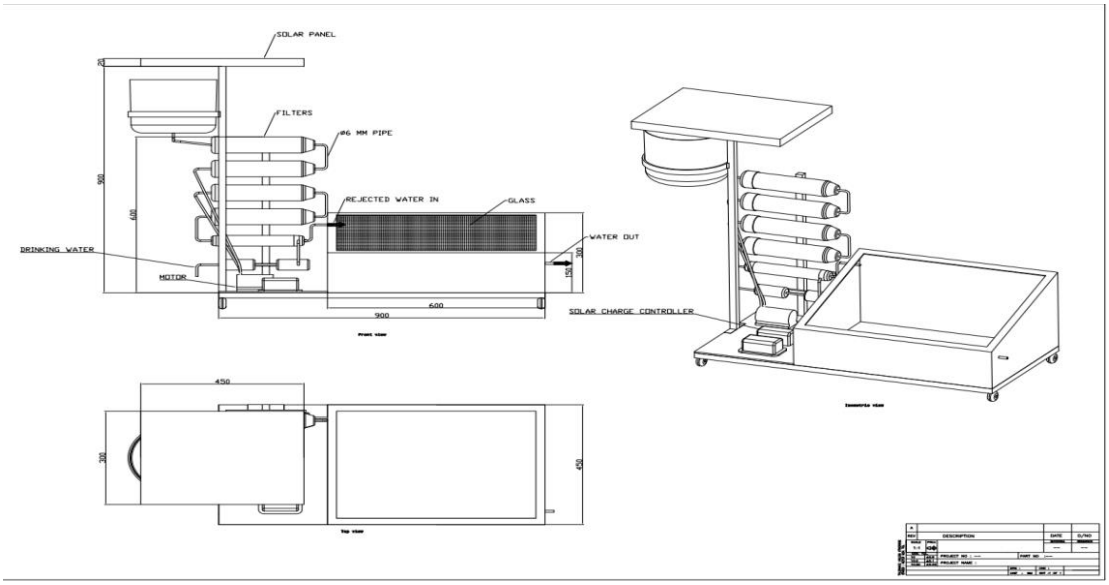


Fig.3.6.1. 2D design model

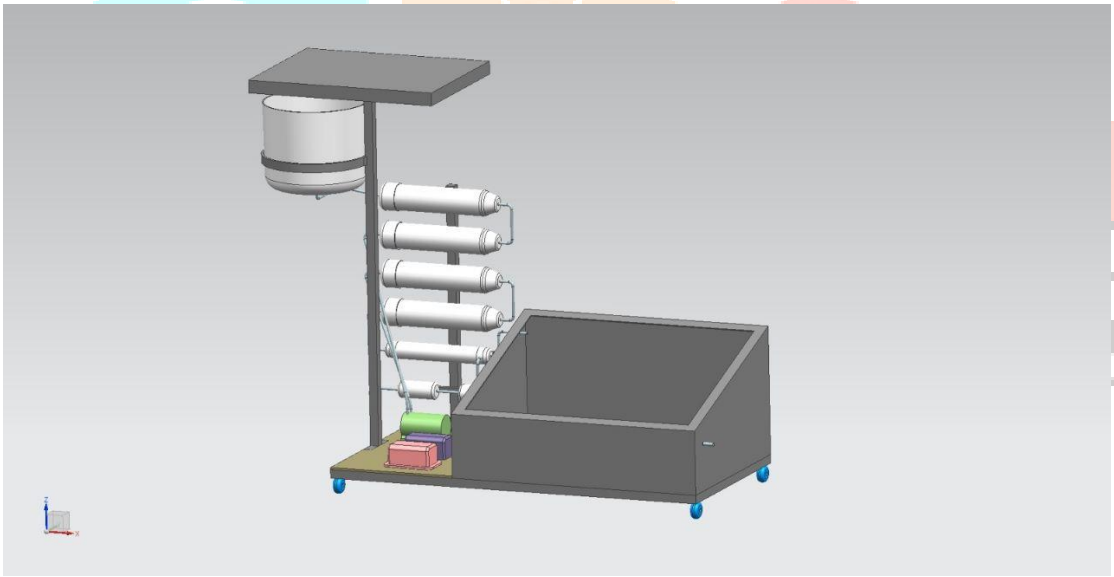


Fig.3.6.2. 3D design model

4. TESTING AND RESULTS

4.1. Final Result table using stainless steel panel

After performing standard test on different adhesive tapes by peel testing machine we conclude with following sample result.

TEST REPORT	Report No. AB/OSD/04/2023-24/418	
Name of Client	Sample Code	AB/OSD/04/2023-24/418
	Sample Location	Drinking Water
	Sample Collected By	Aavanira Biotech Pvt. Ltd.
Collage project	Method of Sampling	IS:3025 (Part 1)
	Sample Type	Drinking Water
	Sample Collected On	22.04.2023
	Sample Received on Date	22.04.2023
	Analysis Date	22.04.2023
	Reporting Date	22.04.2023
Sample returned /stored	Stored at 4 C for 1 week from the date of reporting	

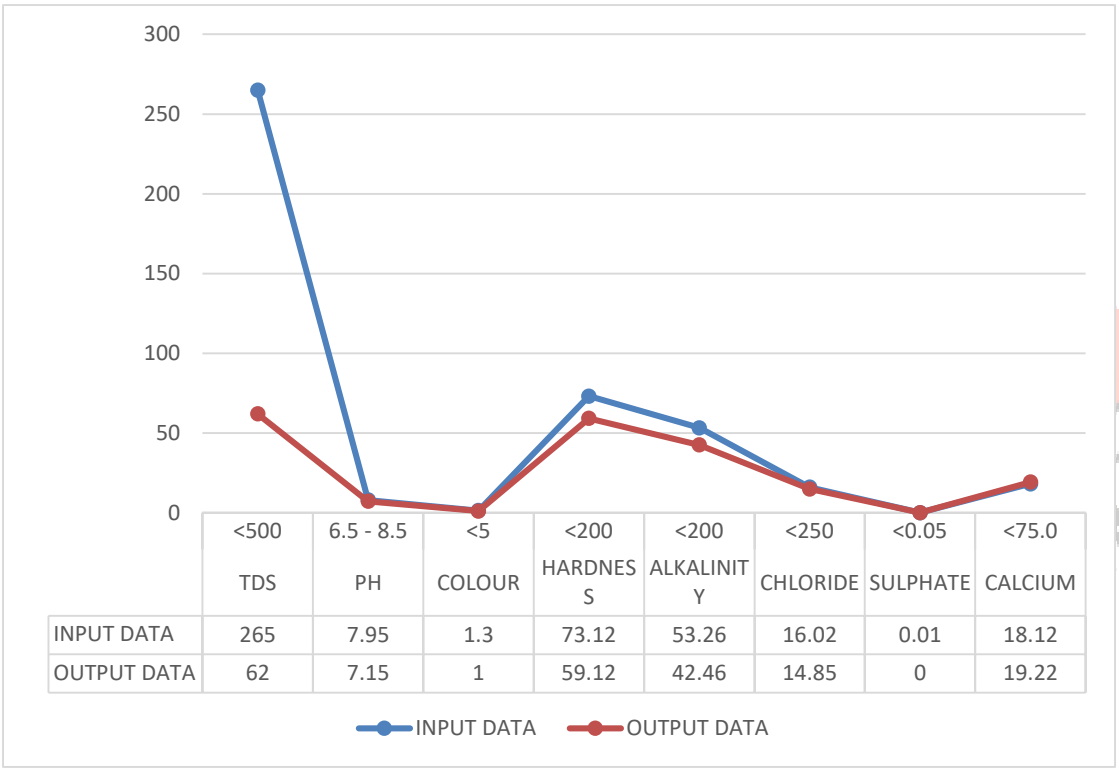
TEST PARAMETERS

Sr. No.	Parameter	Result	Limit as per IS:10500	Unit	Standard Method
1	Colour	1.3	<5	Hazen Units	IS:3025 Part-04 (R.A:2002)
2	Odour	Agreeable	Agreeable	--	IS:3025 Part-05 (R.A:2002)
2	Turbidity	0.51	<1.0	NTU	IS:3025 Part-10 (R.A:2002)
3	TDS	265.0	<500	Mg/Lit	IS:3025 Part-16 (R.A:2002)
	Chemical Parameters				
1	pH	7.95	6.5 to 8.5	--	IS:3025 Part-11(R.A:2002)
2	Total Hardness as $CaCO_3$	73.12	<200	mg/lit	IS:3025 Part-21(2009)
3	Total Alkalinity as $CaCO_3$	53.26	<200	mg/lit	IS:3025 Part-23 (R.A:2003)
4	Chloride as Cl	16.02	<250	mg/lit	IS:3025 Part-32 (R.A:2003)
5	Sulphate as SO_4	5.13	<200	mg/lit	APHA:22ND edition-(4500-SO_4E)
6	Residual Chlorine	BDL	0.2	mg/lit	APHA:22ND edition-(4500-Cl B)
7	Sulphides as S	BDL	<0.05	mg/lit	IS:3025 (Part 29)
8	Ammonia	BDL	<0.5	mg/lit	APHA:22ND edition-(3500-Cr B)
9	Nitrate as NO_3	1.0	<45.0	mg/lit	APHA:22ND edition- (4500-F F)
10	Fluorides as F	0.26	<1.0	mg/lit	APHA: 22ND edition-(4500-F F)
11	Phenol	BDL	<0.001	mg/lit	IS: 3025 Part-43(R.A: 2003)
12	Detergent	BDL	<0.2	mg/lit	APHA: 22nd edition -(5540 C)
	Elemental Parameters				
1	Calcium as Ca	18.12	<75.0	mg/lit	IS:3025 Part-02(2004)
2	Cadmium as Cd	BDL	<0.003	mg/lit	IS:3025 Part-02(2004)
3	Manganese as Mn	0.01	<0.1	mg/lit	IS:3025 Part -02(2004)
4	Iron as Fe	<0.1	<0.30	mg/lit	IS:3025 Part-02(2004)
5	Magnesium as Mg	4.25	<30.0	mg/lit	IS:3025 Part-02(2004)
6	Mercury as Hg	BDL	<0.001	mg/lit	IS:3025 Part-02(2004)
7	Selenium as Se	BDL	<0.01	mg/lit	IS:3025 Part-02(2004)
8	Zinc as Zn	0.22	<5	mg/lit	IS:3025 Part-02(2004)
9	Arsenic as As	BDL	<0.01	mg/lit	IS:3025 Part-02(2004)
10	Lead as Pb	BDL	<0.01	mg/lit	IS:3025 Part-02(2004)
11	Chromium as Cr	BDL	<0.03	mg/lit	IS:3025 Part-02(2004)

12	Aluminium as Al	0.28	<0.03	mg/lit	IS:3025 Part-02(2004)
13	Copper as Cu	<0.01	<0.05	mg/lit	IS:3025 Part-02(2004)
14	Boron as B	0.02	<0.5	mg/lit	IS:3025 Part-02(2004)
15	Barium as Ba	0.003	<0.7	mg/lit	IS:3025 Part-02(2004)
16	Silver as Ag	BDL	<0.1	mg/lit	IS:3025 Part-02(2004)
17	Molybdenum as Mo	BDL	<0.07	mg/lit	IS:3025 Part-02(2004)
18	Nickel as Ni	<0.01	<0.02	mg/lit	IS:3025 Part-02(2004)
Microbiological Parameters					
1	Total Coliform	<2	Absent	MPN/100ml	IS: 1622 (R.A :1996)
2	Escherichia coli	<2	Absent	MPN/100ml	IS: 1622 (R.A :1996)

- **BDL –** Below Detectable Limit
- **Note:** For E-Coli and Coli form <2 can be considered as absent

4.2. Graphical Representation:-



	<500 TDS	6.5 - 8.5 PH	<5 COLOUR	<200 HARDNESS	<200 ALKALINITY	<250 CHLORIDE	<0.05 SULPHATE	<75.0 CALCIUM
INPUT DATA	265	7.95	1.3	73.12	53.26	16.02	0.01	18.12
OUTPUT DATA	62	7.15	1	59.12	42.46	14.85	0	19.22

5. CONCLUSION

From the study it can be concluded that the production and efficiency of solar still at water depth 0.01 m with nano - particles are 3.48 litres and 38.65% respectively. 38.09% increment in production and 12.18% increment in thermal efficiency was achieved when nano - particles mixed black paint is used. These results show that the water level and nano - particles mixed black paint has an intense effect on the distillate output of the solar still. The PPM of raw water is more than the PPM of distilled water given by the solar still is the proof of quality of distilled water. Currently industries use 90-degree peel strength measuring machine for finding peel strength of different adhesives, which is quite expensive, we introduce totally new idea of 180-degree peel strength measuring machine with fabrication in affordable range and gives precise reading.

6. FUTURE SCOPE

Distilled water is very useful for industries and laboratories. It be can use for drinking by adding a certain percentage of normal water. Solar still is very useful in desert or rural areas where no connection of electricity is available to run modern RO (Reverse Osmosis) systems. So this work will be useful for providing this facility in the villages which have not electricity connection. Ordinary people can setup small solar still on the roof of the building and get distilled water continuously. This work will also provide growth of the small-scale industries which produce distilled water in India. In the setup small investment is required initially and its maintenance is very little. The technology involved in the fabrication of solar still is very simple and can be maintained at the village level itself.

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