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SOLAR WATER PURIFICATION WITH THE HELP OF CSP TECHNOLOGY

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ABSTRACT

Solar distillation[1] mimics nature's hydrologic water cycle by purifying water through evaporation (using solar energy) and condensation (rain). It is one of the most basic purification systems available today to obtain high quality drinking water and can remove non-volatile contamination from almost any water source. This low-tech technology should therefore be ideally suited for developing and emerging countries where sun shines in abundance.

In the past century numerous designs have been realised with footprints ranging from small area to thousands of square meters. Among the challenges that remain are: (1) its low yield, (2) obtaining local commitment to operate/maintain large scale systems properly, and (3) relatively high initial investment costs. The objective of this research has been to address challenges 1 and 3 by using solar water purification by Concentrating Solar power (CSP)[3] technology to realize a small scale single slope solar still for personal use with adequate efficiency and at low production costs.

Key words: Solar distillation, Purification, Drinking water, CSP technology

INTRODUCTION

Water purification[4] is the process of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water. The goal is to produce water fit for a specific purpose. Most water is purified for human consumption (drinking water), but water purification may also be designed for a variety of other purposes, including meeting the requirements of medical, pharmacological, chemical and industrial applications. In general, the methods used include physical processes such as filtration, sedimentation and distillation, biological processes such as slow sand filters or biologically active carbon, chemical processes such as flocculation and chlorination and the use of electromagnetic radiation such as ultraviolet light. The purification process of water may reduce the concentration of particulate matter including suspended particles, parasites, bacteria, algae, viruses, fungi; and a range of dissolved and particulate material derived from the surfaces that water may have made contact with after falling as rain.

The standards for drinking water quality are typically set by governments or by international standards.[5-9] These standards will typically set minimum and maximum concentrations of contaminants for

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the use that is to be made of the water. It is not possible to tell whether water is of an appropriate quality by visual examination. Simple procedures such as boiling or the use of a household activated carbon filter are not sufficient for treating all the possible contaminants that may be present in water from an unknown source.

Current problems and solution on them

Although there are many technologies for water purification, then where the actual problem is arising. For people concerned about the quality of their municipally-supplied drinking water and unhappy with other methods of additional purification available to them, solar distillation of tap water or brackish groundwater can be a pleasant, energy-efficient option.

In Concentrating Solar Power (CSP) technology the incoming radiation is tracked by large mirror fields which concentrate the energy towards absorbers. They, in turn, receive the concentrated radiation and transfer it thermally to the working medium. Solar water purification by CSP technology is used as a principle of solar thermal heating system. Solar thermal systems convert sunlight into heat. "Flat-plate" solar thermal collectors produce heat at relatively low temperatures (27 to 65°C), and are generally used to heat air or a liquid for space and water heating or drying agricultural products. Concentrating solar collectors produce higher temperatures. They are most often used where higher temperature heat is desirable, there are large thermal loads, and/or where there are limitations in the area available for installing solar collectors, since they provide more energy per unit of collector surface area.[2]

Design

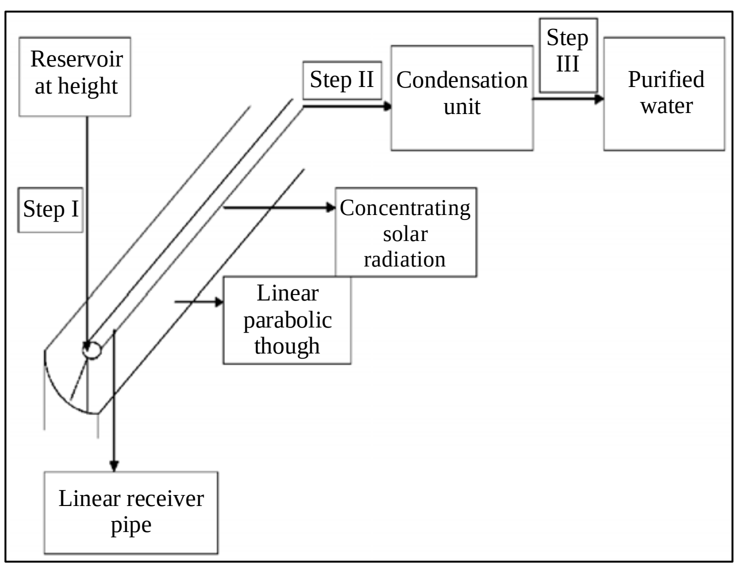

Fig. 1: Flow diagram of prototype

Concept of parabolic trough system

Parabolic trough system work on the principle of line focus, mobile receiver. Parabolic trough systems consist of parallel rows of mirrors (reflectors) curved in one dimension to focus the sun’s rays. The mirror arrays can be more than 100 m long with the curved surface 5 m to 6 m across. Pipes (absorber tubes) with a selective coating serve as the heat collectors. The coating is designed to allow pipes to absorb high levels of solar radiation while emitting very little infra-red radiation. The pipes are insulated in an evacuated glass envelope. The reflectors and the absorber tubes move in tandem with the sun as it crosses the sky. This system is useful for electricity generation, manufacturing of solar fuels, water purification etc.

All parabolic trough plants currently in commercial operation rely on synthetic oil as the fluid that transfers heat (the heat transfer fluid) from collector pipes to heat exchangers, where water is preheated, evaporated and then superheated. The superheated steam runs a turbine, which drives a generator to produce electricity. After being cooled and condensed, the water returns to the heat exchangers. Parabolic troughs are the most mature of the CSP technologies and form the bulk of current commercial plants. Most existing plants, however, have little or no thermal storage and rely on combustible fuel as a backup to firm capacity.

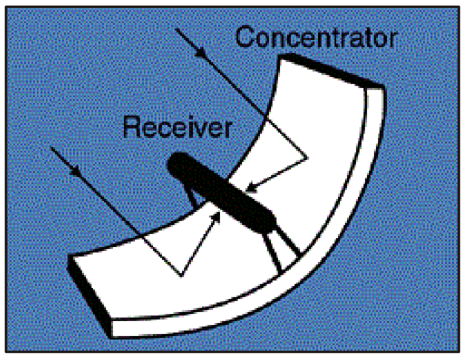

Fig. 2: Parabolic trough system

EXPERIMENTAL

Materials

(i) The main frame is made by PVC pipes owing to its corrosion resistance, low weight, long life and easy cleanability.

(ii) Metal sheet for better reflection of solar radiation.

(iii) Filters

(iv) Water cooled condenser.

Usage

(i) The user will fill the reservoir tank with water that needs to be purified.

(ii) Allow to open the valve for filling of pipe which is black coated for better absorption of solar radiations.

(iii) Then allow water to stay there for 10-15 min which will heat water.

(iv) All of sudden, heated water is then carried out through condensation unit. Due to this sudden change of temperature, if any foreign microbes are existing in water, can't sustain it.

Maintenance

(i) Daily cleaning of reflecting material.

(ii) Periodic checking of leakages (if any).

Table 1: Cost analysis

S. No.	Item	Worth (Rs.)
1.	Metal sheet	250
2.	Casing	200
3.	Reservoir and condenser	130
4.	Values and other	220
	Total	800

RESULTS AND DISCUSSION

Table 2:

S. No.	Parameters	Before	After
1.	pH	7-8	7-8
2.	Turbidity	0-0.2NTU	0-0.2NTU
3.	Dissolved oxygen	5-6 mg/L	4-5 mg/L
4.	Biological oxygen demand	18-19 mg/L	16.2 mg/L
5.	Chemical oxygen demand	5-5.2 mg/L	4.6 mg/L
6.	Suspended solids	Not visible	Not visible
7.	Chloride	57-58 mg/L	56-57 mg/L

Fig. 3: Prototype

Novelty of approach

(i) It produces water of high quality.

(ii) Maintenance is almost negligible.

(iii) The system will not involve any moving parts and will not require electricity to operate.

(iv) Wastage of water will be minimum unlike reverse osmosis in which almost 30% of the loaded water flows out in form of unusable water that can only be used for toilet or other cleaning purposes.

CONCLUSION

An attempt to look into the future is subjective at best, as emphasized above. This method for water purification is better because, no electricity is needed, construction cost of prototype is Rs. 800/-, maintenance is almost negligible and experimental values what we are having are under standards.

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