

A Concept for Solar Operated Water Desalination System

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Abstract - An economically sustainable model for water purification and desalination process is presented in the following paper. The system is designed as a standalone, off-the-grid water purification system. It utilizes a parabolic trough as a heat concentrator, a tube collector filled with heat transfer fluid (HTF), and a boiler to distil sea/brackish water for the desalination process. The paper relate to the designing the solar operated Desalination system.

The current troughs are designed and fabricated to facilitate the necessary energy required to raise the HTF temperature to the desired temperature. A non-toxic, non-hazardous HTF is selected as the working fluid for the solar trough hot loop.

Index Terms– Solar Desalination, Distillation, Water purification, Parabolic trough.

I. INTRODUCTION

Over 75% of the earth's surface is covered with water, only 3% of the Earth's water is fresh water, and not all of that is suitable for drinking [1]. The growing stress on the ground water sources worldwide is increasing the need for alternative freshwater supply. The demand for fresh water is especially critical in rural and impoverish communities. With advanced and economical desalination techniques, the availability of fresh drinking water can be greatly increased to full fill this need.

Meeting the need for clean water and clean energy are the toughest challenges humanity faces in the 21st century. Some developing countries have huge areas and large population groups where electricity distribution grids cannot be transmitted. In the case of India, one-third of the population, amounting to 450 million people, have no access to electricity. Furthermore, about 1.9 million children die in India every year; with 20% of the deaths due to gastro-intestinal disease, usually caused by unsafe drinking water. Globally, more than one billion people lack access to clean drinking water. Unsafe water and poor sanitation cause 80% of all diseases in the developing world. Solar water disinfection systems using photo-catalysts and UV radiation have been proven as one of the most appropriate technologies for water purification, especially in remote regions of developing countries where access to electrical power is either limited or unavailable.

Desalination methods are classified into two types either a membrane process or a phase-change (thermal) process [2]. In a typical membrane process, a pressure is applied to the salt water to overcome the pressure driven by the chemical potential across the membrane. The applied pressure forces the water through a semi permeable membrane, which has pores small enough to restrict transport of salt, microbiological organisms and other unwanted material. This process has a high rate of water production but requires regular system maintenance, chemical treatment and frequent replacement of the membrane, which can be costly. The current level of maintenance required is undesirable for systems located in remote or impoverished areas. In a phase change process, commonly called thermal distillation, salt is removed by

evaporating the water and condensing the vapour in a separate collection tank. In general, thermal distillation process requires a large amount of energy input however it is a low grade thermal energy that can be obtained directly from the sun using concentrated solar collectors unlike the membrane desalination processes which require high grade (electric) energy input. This process has the added benefit of removing other impurities in addition to pasteurization of water which can occur if done at temperature above 71^oC and for longer than 15s [3]. Thermal distillation, therefore, not only provides desalinated water, but also purified drinking water.

Parabolic trough collectors are a low cost implementation of concentrated solar power technology that focuses incident sunlight onto a tube filled with a heat transfer fluid. The efficiency and cost of the parabolic trough collector designs is influenced by structural stiffness, choice of materials, assembly tolerances, mirror cleanliness and wear. Current performance estimates of solar trough optical field efficiencies are 54.2%

II. LITERATURE REVIEW

In 2008, Markus Forstmeier, Wilhelm Feichter , Oliver Mayer. [1]. 33% of the world populace does not have entry to clean water sources and the vast majority of these individuals are not associated with the electrical matrix in the meantime. In this way, photovoltaic (PV) fuelled water filtration presents itself to be one of the arrangements in territories with high sun radiation like India or the MENA (Middle East and North Africa) district. Besides, the natural effect of the procedure can be diminished generously as no fuel supply is required. The paper introduces an idea of joining a layer filtration plant with PV power supply as it were. As PV is a fluctuating vitality source and the customary layer prepare needs a steady power information to keep up weight and stream on the films to ensure their lifetime, some difficulties in the framework outline should be tended to. Minor coupling of off-the-rack segments does not carry out the occupation. A full-scale framework for reasonable water cleaning has been composed and tried in the lab and a pilot area. The outcomes are displayed in the paper. Past the ecological advantages, the framework likewise contends with standard frameworks available. In view of the test comes about, a cost model has been inferred, the primary

cost components for the framework will be built up and an outline methodology for a little scale PV controlled framework, ready to supply a homestead or town with safe consumable water, is introduced.

In 2010, M. Vivar, I. Skryabin, V. Everett, A. Blakers [2]. Another idea for a half and half sun oriented water cleansing and photovoltaic framework for addressing the requirements for clean water and power in one coordinated, independent, and financially savvy framework is introduced in this article. The purified water and power (PWAP) recipient contains two gadgets completely incorporated into a solitary unit, utilizing two practically discrete sub-modules. These two sub-modules can be collected in two distinctive physical game plans: (a) one inside the other, whereby the exemplified photovoltaic cells are inserted into the photograph synergist reactor; or (b) one over the other, whereby the photovoltaic cells are connected to the photograph synergist reactor by method for a typical exemplification. Otherworldly division of a straightforward PWAP structure, photovoltaic and photograph reactant yield, and related misfortunes are dissected. In this half breed framework, it must be commented that the photovoltaic force yield is decreased to the banquet of the water cleaning process, as just part of the range is utilized for photovoltaic change because of the particular ingestion in the distinctive materials. Potential locales for half breed power and water refinement frameworks incorporate both rustic and urban territories. Specifically compelling are the urban locales of the creating scene, which may speak to a bigger addressable business sector because of their particular needs. An underlying investigation of this potential has been directed for the instance of India.

In 2012, M. Vivar M. Fuentes, N. Dodd, J. Scott, I. Skryabin, K. Srithar [3]. A progression of introductory investigations to show the practicality of cross breed photograph catalytic-photovoltaic frameworks for synchronous water cleansing and power era have been led. Business TiO₂ (Peroxide P25) suspended nano particles have been utilized as a photograph impetus and a natural color (Methylene Blue) as a contamination. The photovoltaic yield of the mixture framework was seen to be identified with MB color photograph corruption, whereby as the toxin debased the optical transmission to the cell progressed. At the point when the color decolourisation was finished, the expansion in photovoltaic yield was somewhere around 32 and 37% relying upon the underlying color focus. The discoveries show both advancements can work at the same time, creating drinking water and producing power to bolster a pump, which sets up the way for a complete self-ruling framework.

In 2012, Ozuomba J.O. Edebeatu C.C., Opara M.F., Udoye M.C. also, Okonkwo N.A. [4]. There is an earnest requirement for spotless, unadulterated savoring water numerous nations. Regularly water sources are harsh and there are numerous coastal areas where ocean water is plentiful yet consumable water is not inexhaustible. Immaculate water is likewise required in a few businesses, healing centres and schools. Refining is one of the procedures that can be utilized for water sanitization and sun oriented radiation can be the wellspring of warmth vitality. A roof-type solar water distillation (RSWD) unit was created and tried under real ecological states of Urualla, an old town in the Eastern piece of Nigeria. The

framework incorporates four noteworthy parts; a rectangular wooden bowl, a safeguard surface, a glass rooftop and a condensate channel. The RSWD could create 2.3m³ of refined water inside six days. In spite of the fact that the condensate was not sufficiently expansive contrasted with human need as is unconventional to numerous sunlight based stills, the productivity can be upgraded by utilizing extensive sun based safeguard surface and by any strategy that can increment brilliant vitality.

In 2012, S.L. Jadhav, B.L. Chavan and S.S. Patil [5]. Solar stills of four unique limits were created and tried for water refining. The distilled water production rate performance (PRP) was dissected. The most astounding rate of PRP was recorded between 11.30 am and 12.30 twelve in all the sun powered stills concentrated on. It was 0.0287 L/m²/hr in unit I, 0.0288 L/m²/hr in unit II, 0.0279 L/m²/hr in unit III and 0.0267 L/m²/hr in unit IV. The study uncovers that the sunlight based stills. The pH of refined condensate was 7.0 demonstrating nonpartisan character. The TS, TDS, TSS, sulfates, phosphates and chlorides were lessened to zero after the sun based refining in all the four sun based stills. It guarantees that the refined water is "Unadulterated" water.

In 2012, M. Fuentes, M. Vivar, J. Scott, K. Srithar, I. Skryabin [6]. To begin with results from a first self-sufficient optically adjusted photocatalytic-photovoltaic framework for water cleaning exhibit the attainability of the idea. Complete photograph debasement of an organic dye (Methylene Blue) has been accomplished when utilizing the framework self-governingly. For an underlying convergence of 0.01g/L of MB dye and a normal UV of 4.6W/m², the aggregate photograph decolourisation of the color after 80 min was 95.1% and the expansion in the aggregate photovoltaic yield force was of 19%. Lof contaminated water was sanitized.

In 2012, Hong-Jhang Syu, Shu-Chia Shiu, Ching-Fuh L [7]. In this work, we explore in incredible point of interest the silicon nanowire (SiNW)/poly (ethylene dioxythiophene): poly (styrene sulfonate) (PEDOT: PSS) hybrid solar cells (SCs). As a result of the light-catching impact, SiNW/PEDOT: PSS SCs ingest more light than planar Si/PEDOT: PSS SCs. Likewise, the light assimilation increments with the length of the SiNWs. In any case, the SiNW' sleng this not by any means the only element that impacts the SCs. In this manner the SiNW/PEDOT: PSS SCs with the most brief wire length of 0.37 mm have the best execution interm sof the most elevated force change effectiveness of 8.40%, the biggest short out current thickness of 24.24 mAcm⁻², and open circuit voltage of 0.532V, contrasted and the SCs of other wire lengths. There a sonsare two-fold. Initially, long SiNW stend to total at the top segment, making the penetration of PEDOT: PSS troublesome, so the scope of PEDOT: PSS on the SiNWs is not finished. Second, the expansion of SiNW length significantly diminishes the minority-bearer lifetime. Our examination will create SiNWSCs with enhanced execution.

In 2015, A.H. Beitelmal, D. Fabris [8]. A monetarily supportable model for water purging and desalination procedure is exhibited. This framework is composed as a standalone, off-the-network water cleaning framework. It uses an explanatory trough as a warmth concentrator, a tube gatherer loaded with warmth exchange liquid (HTF), and an

evaporator to distil ocean/harsh water for the desalination process. The paper diagrams the procedure of planning and improving the sunlight based fueled refining framework and the procedure of creating the illustrative trough. The present troughs are planned and created to encourage the vital vitality required to raise the HTF temperature to the configuration temperature of 120 OC. A non-poisonous, non-risky HTF is chosen as the working liquid for the sun powered trough hot circle. Framework execution investigation is directed through an arrangement of examinations while parametric investigation is performed utilizing a PC model custom worked for this framework. The PC model reproduces the thermodynamic and warmth exchange forms where a scope of ideal stream rates is resolved. An expansion in the evaporator water temperature is watched tentatively for the new scope of HTF stream rates got from the PC model. The greatest temperature recorded tentatively is 124 OC surpassing the configuration temperature of 120 OC. This framework is intended to fit into a standard delivery holder for simplicity of transportation around the world.

III. OBJECTIVES

- i) Design of the Solar worked water desalination framework.
- ii) Fabrication of Solar worked water sanitization framework.
- iii) Cost Reduction.

IV. PROBLEM DEFINITION

The developing weight on the ground water sources worldwide is expanding the requirement for option new water supply. The interest for new water is particularly basic in rustic and devastates groups. With cutting edge and conservative desalination procedures, the accessibility of crisp drinking water can be incredibly expanded to lighten this need. The present troughs are planned and created to encourage the important vitality required. A non-harmful, non-dangerous HTF is chosen as the working liquid for the sun oriented trough hot circle. Framework execution investigation is directed through an arrangement of examinations.

V. METHODOLOGY

For planning and manufacture of sun powered worked desalination framework different segments are required, for example, Parabolic Trough Solar Collector, PV-Panel, Heat exchanger, Battery, Pump, Boiler, and Valves and so on.

A. Parabolic Trough Solar Collector

In allegorical trough gatherer, long, Parabolic mirrors center the beams of the sun into a safeguard funnel. The mirrors track the sun on one direct hub from north to south amid the day. The funnel is situated over the mirror in the inside along the central line and has a warmth retentive medium running in it. The gatherer is for the most part made out of one twisted glass mirror, with either silver or aluminium covered on the rear of the glass. The glass is around 4mm thick and low in iron, augmenting the reflectance of approaching daylight.

Illustrative trough gatherers are an ease usage of concentrated sun oriented force innovation that centres episode daylight onto a tube loaded with a warmth exchange liquid. The productivity and expense of the allegorical trough gatherer plans is impacted by basic solidness, decision of materials, get together resiliences, mirror cleanliness and wear.

Different sunlight based vitality concentrators are accessible in the business sector today from which illustrative troughs and direct Fresnel reflectors are the most widely recognized. Allegorical troughs have as of late re-developed as a minimal effort yet successful arrangement. This arrangement depends on a set up innovation and capacity by concentrating the sun based vitality into a funnel along the trough mirror's central length. Straight Fresnel reflectors are a developing innovation comprising of a variety of mirrors to center sunlight based warm vitality on a particular area. There are points of interest to both of these two frameworks and for instance allegorical troughs have high optical productivity, while direct Fresnel reflectors are less vulnerable to wind stacking, possess less space, and are less demanding to keep up. Fresnel reflectors encounter vast variety in optical effectiveness with the biggest diminishing in proficiency is amid the winter season. Illustrative troughs are more fitting for little scale applications because of their effortlessness, simplicity of creation and higher vitality gathering productivity per unit cost over other authorities' techniques. An allegorical trough works by reflecting and thinking the warm vitality it gets from the sun into a funnel conveying a heat transfer fluid (HTF) fittingly set at the trough's central length and thusly consumed by the HTF. The HTF then courses through a heat exchanger (HEX) situated in a kettle to move the warmth into the seawater and heat it to the point of boiling before returning back to the illustrative trough. The created water vapor is then dense in a consolidating tube which is additionally utilized as a pre warmer for the approaching renewing water. Fig. demonstrates the model and real explanatory trough.

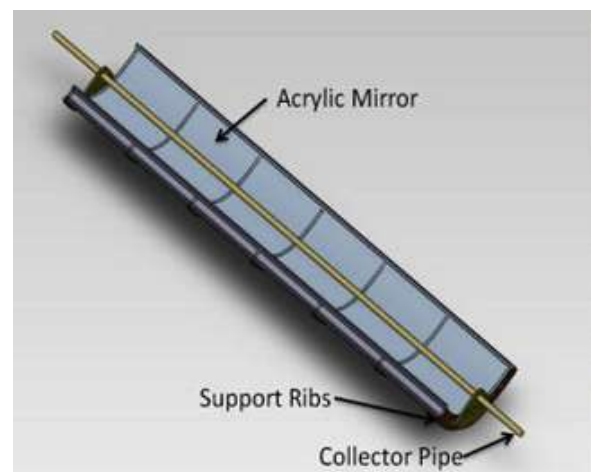


Fig. 2 Model of parabolic trough

B. PV-Panel

A photovoltaic (in short PV) module is a bundled, associated get together of normally 6x10 sun powered cells. Sun oriented Photovoltaic boards constitute the sunlight based cluster of a photovoltaic framework that produces and supplies sun based power in business and private applications. Every module is

evaluated by its DC yield power under standard test conditions, and commonly goes from 100 to 365 watts. The proficiency of a module decides the region of a module given the same appraised yield – an 8% effective 230 watt module will have double the region of a 16% productive 230 watt module. There are a couple of sun based boards accessible that are surpassing 19% productivity. A solitary sunlight based module can deliver just a constrained measure of force; most establishments contain various modules. A photovoltaic framework commonly incorporates a board or a variety of sunlight based modules, a sun oriented inverter, and once in a while a battery and/or sun based tracker and interconnection Wiring.

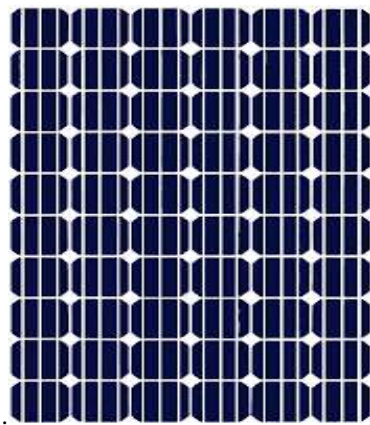


Fig. 3 PV-Panel

C. Heat exchanger

A Heat exchanger is a gadget used to exchange heat between one or more liquids. The liquids might be isolated by a strong divider to forestall blending or they might be in direct contact. They are broadly utilized as a part of space warming, refrigeration, cooling, power stations, substance plants, petrochemical plants, petroleum refineries, regular gas preparing, and sewage treatment. The great illustration of a warmth exchanger is found in an inside ignition motor in which a coursing liquid known as motor coolant moves through radiator loops and wind currents past the curls, which cools the coolant and warms the approaching air.

D. Battery

An electric battery is a gadget comprising of two or more electrochemical cells that change over put away concoction vitality into electrical vitality. Every cell has a positive terminal, or cathode, and a negative terminal, or anode. The terminal checked positive is at a higher electrical potential vitality than is the terminal stamped negative. The terminal checked negative is the wellspring of electrons that when associated with an outer circuit will stream and convey vitality to an outside gadget. At the point when a battery is associated with an outer circuit, electrolytes can move as particles inside, permitting the compound responses to be finished at the different terminals thus convey vitality to the outside circuit. It is the development of those particles inside the battery which permits current to stream out of the battery to perform work. In spite of the fact that the term battery actually implies a gadget

with various cells, single cells are additionally prevalently called batteries. Essential batteries are utilized once and tossed; the anode materials are irreversibly changed amid release. Normal illustrations are the soluble battery utilized for electric lamps and a huge number of compact gadgets. Optional (rechargeable batteries) can be released and revived various times; the first arrangement of the cathodes can be restored by opposite current. Illustrations incorporate the lead-corrosive batteries utilized as a part of vehicles and lithium-particle batteries utilized for convenient gadgets.

E. Pump

A pump is a gadget that moves liquids (fluids or gasses), or at times slurries, by mechanical activity. Pumps can be arranged into three noteworthy gatherings as indicated by the technique they use to move the liquid: direct lift, uprooting, and gravity pumps. Pumps work by some component (normally responding or rotational), and expend vitality to perform mechanical work by moving the liquid. Pumps work by means of numerous vitality sources, including manual operation, power, motors, or wind power, come in numerous sizes, from infinitesimal for use in therapeutic applications to extensive mechanical pumps.

F. Boiler

A boiler is a shut vessel in which water or other liquid is warmed. The liquid does not as a matter of course bubble. The warmed or vaporized liquid leaves the kettle for use in different procedures or warming applications, including water warming, focal warming, heater based force era, cooking, and sanitation.

G. Valves

A valve is a gadget that manages coordinates or controls the stream of a liquid (gasses, fluids, fluidized solids, or slurries) by opening, shutting, or halfway blocking different paths. Valves are actually fittings, however are typically examined as a different classification. In an open valve, liquid streams in a bearing from higher weight to lower weight.

H. Layout of Desalination system

From literature study, we propose the following equipment arrangement for water desalination.

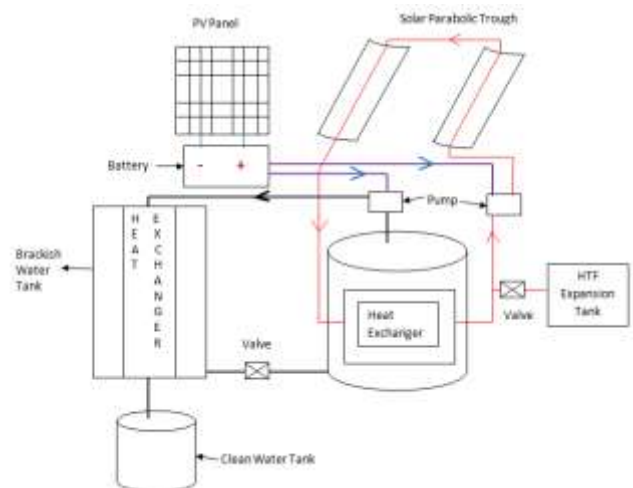


Fig.4 Layout of Desalination System

Fig.4 demonstrates the schematic of general procedure for water refinement framework. In this the HTF is going through sunlight based troughs where it is warmed by sun based radiations and exchange to kettle where the warm vitality of HTF is exchange to seawater or unpurified water by utilizing Heat exchanger loop which is going into the heater. The pivot of HTF is finished by pump. At the season of HTF is warmed by sunlight based vitality the temperature and volume of HTF is expansions. The abundance volume of HTF is goes into the HTF extension tank. The seawater or unpurified water which is to be refined is gone through the HEX into heater then into Brackish water tank. In Brackish water tank the Heat Exchanger is set where clean water is gathered into clean water tank and unpurified water which is not filtered is again recycled into kettle.

VI. RESULT

From Literature study & Solar Energy concepts, we have prepared the layout of solar operated Desalination system which is Eco-friendly system and No conventional Power is required for its working.

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