Abstract: Integrated Solar Heat and Power Generation System (12) is a combination of benefits and features of conventional vacuum tube solar water heaters and flat mirrors and property of infrared radiation filtration by water or other infrared absorbing fluids used in front of photovoltaic solar panel (2) to absorb the infrared spectrum of sunlight for increase temperature of water and pass remain spectrum of sunlight to use in photovoltaic solar panel (2). This system is also capable to disinfection water by solar radiations as by product.
Description

Title of Invention: INTEGRATED SOLAR HEAT AND POWER GENERATION

Technical Field

[0001] This invention relates generally to hybrid solar water heater and electrical power generation and solar disinfection.

[0002] In particular, although not exclusively, the invention relates to simultaneously produce heat and electrical power by filtration of solar spectrum and absorbing infrared part of solar spectrum with transparent vacuum tube filled with water as infrared filter and photovoltaic panel placed in back of array of transparent vacuum tubes.

Background Art

[0003] Solar power is a largely untapped source of energy. In some dry regions of the world, power may be extracted from the sun rays on a continuous basis, due to weather system with low levels of humidity in the atmosphere.

[0004] Sun radiate energy, have part in ultraviolet spectrum (UV) and part in infrared (IR) Spectrum. Common Solar Systems only use one part of sun radiate, some of them are Photovoltaic Base, and others are solar thermal Base. Therefore, most of solar ir-radiation energy are wasted in this systems.

[0005] Photovoltaic panels are a commonly solution used to convert solar energy to electrical power. It is considered to concentrate the solar energy on photovoltaic panels using flat mirrors to increase their expose to solar irradiation. However, photovoltaic panels are sensitive to heat in that they lose efficiency with rising temperatures.

[0006] Therefore, it would be desirable that new technologies would offer a better efficiency in solar energy conversion for photovoltaic panels. To augment the efficiency of photovoltaic cells, the state of the art suggests to use air or water to lower their temperature, and presents several inventions combining the production of thermal energy with the production of electric energy. The present invention, on the contrary, deals with a very particular architecture for a photovoltaic/thermal integrated system aiming to optimize the conversion factor of solar energy in electric and thermal energy (and, therefore, to cut production costs). In particular, the invention hereby described, also exploits the infrared-a radiation lost in normal photovoltaic cells, cuts the cost of present solar panels, and improves the efficiency of the photovoltaic component by lowering its temperature.

Summary of Invention

[0007] Integrated Solar Heat and Power Generation System is a combination of benefits and features of conventional vacuum tube solar water heaters and flat mirrors and property
of infrared radiation filtration by water or other infrared absorbing fluids to increase
the efficiency of simultaneous production of heat and power from solar energy.
Transparent vacuum tube filled with water or other infrared absorbing fluids used in
front of photovoltaic solar panel to absorb the infrared spectrum of sunlight for
increase temperature of water and pass remain spectrums of sunlight to use in pho-
tovoltaic solar panel. This system is also capable to disinfection water by solar ra-
diations as by product.

Technical Problem

Common solar systems with solar panels or photovoltaic panels use only half of the
spectrum of light from the sun's visible and ultraviolet light to generate electricity, and
the other half of the solar spectrum (the infrared spectrum) is wasted as heat and the
current simple photovoltaic systems cannot use it.

On the other hand all commercial solar systems, could generate electricity
(photovoltaic panels) or heat (solar water heater) alone and technologies capable of
generating both electricity and heat from the sun at one device by sunlight filtration
method is not yet available commercially.

Main aim of this invention is to provide an integrated heat and power generation
system capable to produce heat and power from solar energy with low cost and simple
technology compare to current systems.

Solution to Problem

Sun radiate energy, have part in ultraviolet spectrum (UV) and part in infrared (IR)
Spectrum. Common Solar Systems only use one part of sun radiate, some of them are
Photovoltaic Base, and others are solar thermal Base. Therefore, most of solar ir-
radiation energy are wasted in this systems. To overcome this problem this invention
proposed a system that use full spectrum of sun.

Advantageous Effects of Invention

Low-cost and high-efficiency thermal collector coupled with a photovoltaic panel
without reducing (and in some cases increasing by means of augmenting flat mirrors
and decreasing temperature of photovoltaic panels) the efficiency of the latter.

Exploitation of the infrared before it reaches silicon (where it will be lost) to produce
thermal energy.

Low cost thermal production compared to existing solar panels.

Disinfecting water in transparent solar tubes.

Use Thermosyphon effect by applying conventional evacuated solar water heaters
concept and just replace dark vacuum tubes with transparent water filled vacuum tubes
to absorb infrared spectrum of sun light and disinfecting water inside of system simul-
taneously.
[0017] Use one structure for a hybrid solar system capable to generated heat and power and disinfect water from solar energy, extremely reduce costs and space needed for installation.

**Brief Description of Drawings**

[0018] Figure 1 shows the outline of the invention: a system supplied with transparent vacuum tube filled with water (1) removes part of heat from the panel by absorbing infrared spectrum of incident sunlight and warm up water inside of transparent vacuum tubes that connected to water storage in tank (3) by means of Thermosyphon effect, just like conventional evacuated tube solar water heaters. Sunlight that is passing through water inside transparent vacuum tube and absorbed infrared part of it by water, reach to photovoltaic panel surface and generate electricity due to photovoltaic effect. The system is equipped with a water input (10) and water output (11), two flat plate mirrors (4) to augment sun radiation and increase efficiency of the system. Water storage tank (3), holes for placed of transparent vacuum tubes (9) rubber washers for sealing (6), fiber layer (7) for thermally isolating water storage tank, stainless steel core of water tank storage(8), structure of system (5).

**Fig.1**

[0019] [Fig.1] is a schematic view of integrated solar heat and power generation unit in accordance with the present invention.

**Description of Embodiments**

[0020] Five cm. of water can absorb 30% of solar radiation with negligible diminishing of the conversion capacity on the amorphous silicon, and very slight reduction of the efficiency on the monocrystalline silicon (from 15% to 13%). This last reduction is in part compensated by the better efficiency obtained by keeping silicon at a relatively low temperature. Therefore, the invention hereby aims at the realization of hybrid systems, coupling heat and current production by means of a photovoltaic system protected with a water layer. In addition in this invention, transparent vacuum tube used to carry water, so this water exposed to solar UV radiation. High energy ultraviolet radiation from the Sun can also be used to kill pathogens in water.

The SODIS (solar water disinfection) method uses a combination of UV light and increased temperature (solar thermal) for disinfecting water. [Fig.1] shows the outline of the invention: a system supplied with transparent vacuum tube filled with water (1) removes part of heat from the panel by absorbing infrared spectrum of incident sunlight and warm up water inside of transparent vacuum tubes that connected to water storage in tank (3) by means of Thermosyphon effect, just like conventional evacuated tube solar water heaters. Sunlight that is passing through water inside transparent vacuum tube and absorbed infrared part of it by water, reach to photovoltaic panel
surface and generate electricity due to photovoltaic effect. The system is equipped with a water input (10) and water output (11), two flat plate mirrors (4) to augment sun radiation and increase efficiency of the system. Water storage tank (3), holes for placed of transparent vacuum tubes (9) rubber washers for sealing (6), fiber layer (7) for thermally isolating water storage tank, stainless steel core of water tank storage(8), structure of system (5).

**Industrial Applicability**

[0021] Fig. 1 is a perspective view of the integrated solar heat and power generation unit in accordance with the invention. The invention is a solar panel including: (1) a system for the production of electric energy, and (2) a system for the management of a water as infrared light absorbing fit to the production of hot water and electric energy, with an higher efficiency of electric energy production in comparison to other state of the art systems, and providing efficient thermal heating of water. The element of novelty of the industrial invention hereby lays in the particular system for infrared filtration of sun light with water filled transparent vacuum tubes, that absorbing infrared light cause heat up water and reduce photovoltaic solar panel temperature, on the other hand, using transparent vacuum tubes allow us to benefit from Thermosyphon effect for circulation of water in solar water heater tank: on the one hand, the invention generates a very efficient system for electric energy production, and on the other hand, it allows the thermal heating of the water. As by product of the system, water in transparent vacuum tubes exposed to UV solar radiation and being disinfected.

[0022] As one of the application of this invention, we could use this system as source of heat and power generation from solar energy and solar water disinfection for rural or urban homes.

**Citation List**

**Patent Literature**

[0023] PTL 1: EP 203 1664 A2

**Non Patent Literature**

Claims

[Claim 1] A system for the production of electric energy and thermal energy and solar water disinfection, composed of array of water filled (or any other transparent infrared absorbing fluids) transparent vacuum tubes connected to water storage tank to facilitating Thermosyphon effect in front of a photovoltaic panel.

[Claim 2] A system as per claim 1 where the water in transparent vacuum tube has the purpose of absorbing sun light before hit photovoltaic panel surface and increase its temperature.

[Claim 3] A system as per claim 2 where the transparent vacuum tube has the purpose of carrying out water (or any other transparent infrared absorbing fluids) inside it thermally insulated from ambient temperature by means of vacuum layer and facilitating Thermosyphon effect just like conventional evacuated solar water heaters. On the other hand expose water to solar radiation to act as solar water disinfection.

[Claim 4] A system as per claim 3 where the unit cost is lower than a conventional similar systems.

[Claim 5] A system as per claim 1 to 4 equipped with two flat mirror to augment solar radiation and increase output efficiency.

[Claim 6] A system for the production of electric energy and thermal energy and water disinfection all in one unit according to claims 1 to 4 and according to what has been described and explained in reference.
AMENDED CLAIMS
received by the International Bureau on 18 October 2016 (18.10.2016)

[Claim 1] [Amended] An apparatus for generate electricity and heat and disinfect water simultaneously by solar radiation, comprising:
An array of transparent vacuum tube filled with water (or any other infrared absorbing fluids)
A photovoltaic solar panel
A water storage tank
At least two flat mirrors.

[Claim 2] [Amended] The apparatus of claim 1 wherein said the array of transparent vacuum tube filled with water (or any other transparent infrared absorbing fluids), the array of transparent vacuum tube filled with water is placed in front of photovoltaic panel and has purpose of filtration of sunlight and absorbing infrared part of sunlight and produce heat and pass visible part of sunlight almost unaffected before hit the photovoltaic panel surface and increase its temperature and simultaneously expose water to sunlight for disinfection.

[Claim 3] [Amended] The apparatus of claim 1 wherein said the water storage tank, the array of transparent vacuum tubes is connected to water storage tank to facilitating Thermosyphon effect in front of photovoltaic panel.

[Claim 4] [Cancelled]

[Claim 5] [Amended] The apparatus of claim 1, equipped with at least two flat mirror to augment solar radiation and increase output efficiency of simultaneous production of electricity and heat and disinfected water.

[Claim 6] [Amended] The apparatus of claim 1 wherein said the array of transparent vacuum tube filled with water (or any other transparent infrared absorbing fluids), the transparent vacuum tube solar collector filled with water expose water to solar radiation and by means of SODIS effect cause disinfection of water and according to Thermosyphon effect naturally expose the water in storage tank to sunlight without need to any circulation pump.

[Claim 7] [Added] The apparatus of claim 1 wherein said the apparatus for simultaneously generate electricity and heat and disinfected water by solar radiation, does not need any circulation pump because water in transparent vacuum tube connected to water storage tank is circulated naturally trough Thermosyphon effect.

[Claim 8] [Added] The apparatus of claim 1, produce heat by absorbing infrared
part of sunlight in water filled transparent vacuum tube.

[Claim 9] [Added] The apparatus of claim 1, wherein improvement comprises the array of transparent water filled vacuum tube placed before solar panel for expose water to sunlight and generate heat and disinfect water and circulated water by means of Thermosyphon effect without need to pump and prevent solar panel heating simultaneously.

[Claim 10] [Added] The apparatus of claim 1 wherein said the array of transparent vacuum tube filled with water (or any other infrared absorbing fluids), the transparent evacuated tube itself have not any dark coating and visible light can pass through it.
In response to the International Search Report dated 30.08.2016 regarding the above-referenced PCT Patent Application, Applicant submits the substitute sheet 5 under PCT Article 19. The following claims have been amended to conform to PCT Rule 6.4(a). Claims 1-3 now depend from claims 1-3. Claim 4 is cancelled. Claims 5-6 now depend from claims 5-6. Claims 7, 8, 9, 10 are new added. It is believed that the amendments do not go beyond the disclosure of the application as filed.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
F24J2/20, F24J2/04, H01L31/052

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24J, H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of data base and, where practicable, search terms used)

Patsee, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 30-08-201 6
Date of mailing of the international search report 30-08-201 6

Name and mailing address of the ISA/Indian Patent Office
Plot No. 32, Sector 14, Dwarka, New Delhi-110075
Facsimile No.

Authorized officer
Maya Kumari
Telephone No. +91-1125300200

Form PCT/ISA/210 (second sheet) (January 2015)
### Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. 
   - **Claims Nos.:**
   - because they relate to subject matter not required to be searched by this Authority, namely:

2. 
   - **Claims Nos.:** 6
   - because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
     - Claim 6 does not meet the requirement of Article 6 PCT as the matter for which protection is sought is not clearly defined. The statement "A system for the production... what has been described"

3. 
   - **Claims Nos.:**
   - because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. 
   - As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. 
   - As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. 
   - As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. 
   - No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.
and explained in reference" does not define the boundaries of the claimed invention with a reasonable degree of certainty.
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