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REVIEW ARTICLE

Solar energy and its different technique of green extraction- a review

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Abstract

Solar energy and other renewable sources of energy is the need of hour ,due to dependence on fixed fossil fuel reserve and growing population also add problem like shortage of fresh water availability ,interrupted electricity and high emission of carbon dioxide .although various solar tower ,solar collector, solar pond ,biogas ,wind energy ,hydel energy are being used for the production of electricity in a clean method ,various solar still, MED (multiple effect distillation) , other desalination method are regularly revised and improved to produce fresh water . also technology like SCo_2 cycle, VARS, ORC cycle are being used with varying fluid concentration and its type o produce cooling effect at its beast environmental support, This work mainly review the different Renewable resources like wind ,hydro, solar with focus on solar collector(PTC, Heliostat, Fresnel) and their efficiency at different load condition , in this work focus is also made on the review of different hybrid technique for desalination ,some brief discussion is also made for poly-generation system ,also application of various fluid and its properties requirements for solar absorber is also reviewed.

1. Introduction

Growing population and industrial development have brought demand for fresh water and protection of environment against degradation.at some place desalination techniques are being used to fulfill demand again it is having drawback of high-power consumption. It is found availability of fossil fuel is difficult in remote area as compared to the easily available renewable resources like solar and bio mass [1]. Also, solar energy found to be best alternative against the various problems like global warming, shortage of fossil fuel and the increasing demand of industry and society [2-4]. Extracting and collecting solar energy using concentrated solar power is a useful method of producing thermal energy from medium to high temperature. [5,6] But due to some cost associated problems like installation, operation and complex technology solar collector system is being less preferred at high temperature [7]. So, system like ORC is being coupled with it due to their low maintenance, flexible operation at low temperature. and to cater need at high temperature steam Rankine cycle and supercritical carbon dioxide cycle (sco2) is coupled due the their high energetic efficiency at high temperature also due property of working fluid in super critical cycle [8-9].along with solar other renewable energy resources being used include wind, biomass, hydro , geothermal and with technological advancement various hybrid system are also modelled as concentrated photovoltaic /thermal ,wind turbine , parabolic trough collector [10].solar energy is also bring into use to produce refrigeration effect .solar cooling system also reduce demand of electricity in peak load hours as it does not

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make use of tradition system for producing refrigeration effect because refrigeration system can only have around 40-50 % of energy requirement in domestic as well as commercial purpose taken together,[11-12]. Solar cooling technology make mostly use of adsorption and absorption system with cop of 0.4-1.4 depending on various configuration of the system [13-14]. To cater the need of society poly-generation system are also being used in which cooling, heating, power, hydrogen and desalination process is carried out simultaneously. till now more focus is done on combined system run by solar energy. To make continuous use of solar energy in combined cooling, heating and power system thermal energy storage is used and found to be best in solar CCHP(combined cooling , heating and power) load management[15].some research is also done with the aim of efficient use of solar energy to cater multiple demands simultaneously such as desalination , cooling, capturing of carbon dioxide , production of LNG so to have overcome the problem the problem of intermittent solar energy ,and it was found that cogeneration system of LNG and liquid carbon dioxide can produce 14.6ton/h of LNG ,1.693ton/h of desalination water and 2.6ton/h of carbon dioxide[16].At some place wind energy is occupying the position as wind is clean source of energy it does not produce carbon dioxide and other harmful pollutant like sulphur dioxide ,mercury and nitrous oxide too. But wind energy is function of wind speed so it is counted under distributed production, also lack as power source in low load and at high demand of load as it produce excess energy when air is there and no energy can be harnessed when there is low velocity so to have efficient use of this clean resource it is required to be coupled with other energy resources [17-18].some research on hybrid system of solar ,wind, PV panels and reverse osmosis design ,simulation and optimization shown an energy saving of over 80% [19].Solar energy is also used to produce energy in form of production of hydrogen for fuel cell which help to reduce the dependence on fossil fuel also reduction in pollutants,[20].PEMFCs (proton exchange membrane fuel cell) is a fuel cell which has higher efficiency ,generally fuel cells are used to convert chemical energy of hydrogen to electricity, PEMFC can further be classified into low temperature or high temperature PEMFC , when high temperature proton exchange membrane fuel cell are used with absorption system it can serve either as a heat pump or refrigerator[21].till now multiple application is brought into light but some work is also made regarding the depth understanding of solar energy , solar energy can be harnessed from two ways photovoltaic and concentrated solar power in which later is found to be more efficient, high in potential and low in cost ,research have been focused on CSP (concentrated solar power)Technology , concentrating solar irradiation using reflector onto receiver where it is absorbed by the heat transferring fluid. PTC(parabolic trough collector),SPT(solar power tower),PDC (parabolic dish collector), central receiver system, LFR(linear Fresnel reflector) are important categories of this technology.[22].CSP technology uses like LFR, PTC also varies with temperature range as the mentioned two system is being used for low temperature less than 400 C , whereas SPT are used for temperature above 450C [23].various type of heat transferring fluid used in CSP technology are air, water, compressed gas, thermal oil, molten salt, organic compound and liquid particle. Amongst all synthetic oil is found to be best option for heat transferring fluid [23-25].when solar powered system are being used desalination purpose then used as solar still ,are used in those area in which there is shortage of electricity and fossil fuel , classified into passive and active system.in the first case direct solar energy is being used where as in latter case solar energy is supported with photovoltaic thermal, thermoelectric effect, solar collector ,solar air heater are used for evaporation purposes.[26].solar energy perceived at earth surface is quite less due absorption and diffusion of solar energy while entering in earth atmosphere. Hence solar collector is being used and continuously improved to increase the solar rays' accumulation and this can achieve reducing the cost and optimizing the size of collector, out of different solar technology PTC (parabolic trough collector) is efficient amongst all. the different component which makes it so viable is line focus concentrator, parabolic mirror, absorber tube, tracker. Heat from solar energy is absorbed in the absorber tube in which working fluid is flowing , this fluid is made to pass through the focal line of mirror [27] when solar energy is being used in co-generation plant like solar plant is used to preheat water in gas power plant reduction in fuel consumption and exergy destruction is seen, but effective results can be dependent on proper selection of technology also aperture area are compared as PTC because of its high concentration ratio allow temperature to be reached at 400C whereas in term of cost Linear Fresnel collector found to have high solar energy concentration.

1.1 Solar collectors

Heliostat field is one of the solar concentrating system which can produce high density radiant flux, it is a mirror which reflect the radiation of solar beam to a central receiver system. heliostat in its most intuitive and simple form is a flat or spherical continuous mirror, but in continuous surface area aperture area is always minor because it is costly to produce such area of large aperture, to solve the problem of aperture area , joining of multiple facet mirror are made like in a solar one plant in which 12 curved facets are used to form a heliostat, and it resolve the problem of alignment also in this the facets and their center are normally aligned as PTC and Spherical surface [28]. In term of discussion about PTC such conclusion is seen it is a parabolic concentrating technology. in this technology with continuous tracking direct solar radiation is being focused parallel to the collector axis. Modes of tracking found useful in this technology is 1-axis and 2-axis.these modes are being differentiated based on solar radiation collecting capacity second one found to have more than first because the second method work at lower incidence angle, but in term of installation cost is first factor in addition to capacity of solar collecting ability so 1 axis method found to have lower cost than 2-axix .in terms of orientation of PTC ,east west tracking system and north south tracking system are being used. In parabolic trough collector technology highly reflective mirror of parabolic curvature is being used to focus the solar radiation on absorber tube placed at its focal line [39].

2. Heating mode and different heat transfer fluids conceptual explanation

In PTC technology more energy fulfilment capacity is seen as compared to others in concentrated solar power plants. heat transfer enhancement in this technology bring decrease in risk of absorber tube deflection as it bring down the temperature gradient around the tube in the absorber, also increase in thermal efficiency and reduction in thermal loss is also seen while carrying heat transfer enhancement ,for this passive method like turbulator, twisted tape are being used .thermal efficiency can also be increased by use of Nano fluid in addition to turbulator as the second method increase demand for pumping work as it lead to high value of pressure drop along the tube , so Nano fluid is used , Nano fluid is a mixture of base fluid and nano particles . Cu, Al_2O_3, Al, CuO, ZnO SiO_2, TiO_2 are different fluid being used [29]. Some research have shown that use of water/Al_2O_3 in a PTC have increased thermal efficiency by 8.5 % , also Syltherm 800/Al_2O_3 use found to increase the efficiency by 7.6%[30].recent advancement found that use of carbon nanotubes and it was found that efficiency is enhanced by 4.4% using with Therminol VP-1/SWCNT , also use of hybrid Nano fluid is also seen .one of such is Syltherm 800/(Al_2O_3 - TiO_2) [31]. Many research work on selection of different fluid for a system is done, however focus was also made on single fluid for different PTC operating condition and design because when single fluid is able to cater different need then it may prove to be cost effective also.so when study was made in which single Nano fluid was used for three PTC system namely the evacuated tube collector, the non-evacuated tube receiver and bare tube receiver. Different parameter was considered like solar irradiation level, incident angle, ambient temperature and speed of wind, volumetric flow rate, fluid inlet temperature was seen.it was found use of Nano fluid in evacuated tube receiver increases thermal efficiency and with increase in concentration also high collector thermal efficiency is achieved. Also, with increase in temperature in evacuated receiver system thermal efficiency is increased because thermal losses are high at high temperature and hence margin of increase in thermal efficiency is also high. Similar results are observed for non-evacuated and bare tube receiver .in term of concentration evacuated receiver show higher efficiency bare tube receiver shows the lowest [32].

3. Hybrid Nano fluid detailed overview [52]

Hybrid Nano fluid is an innovative material which is obtained by combining two different nanoparticles to a base fluid because of its characteristics like good heat absorbing capacity, transportability, long term stability and the good heat transfer rate it is found to have significant contribution in harnessing solar energy, it also possesses good thermo-physical properties. At present the hybrid Nano fluid in which metal composites and base fluid is found to be more effective which has replaced mono fluid at many place.

Table 1: Conceptual Overview of hybrid Nano fluid

Preparation	Stability	Thermophysical Property
➢ Preparation of Nano fluid include two method 1-step and 2-step method. ➢ In 1- step method physical vapour deposition approach is used in which sedimentation of nanoparticle is done, this approach helps in controlling the size of particle, increases suspension stability and decreases particle aggregation. ➢ 1- step method is carried out using pulse wire evaporation. In this high voltage is passed through the skinny wire in which evaporation occurs.it converts in form of plasma and this plasma when get condensed form nanoparticle by bringing it in contact of inert gas. This powdered nanoparticle is mixed with Nano fluid in exploding bottle in the pulse wire evaporator to obtain hybrid Nano fluid. ➢ 2- step method, in this firstly dry powder of nanoparticle is formed by compressing the solid sample which is evaporated by the help of noble gases and this form suspension which is added to the base fluid.	The factor affecting stability of the mixture (hybrid Nano fluid) is high surface tension due to which mixture agglomerate easily. This agglomeration makes the nanoparticle settle in duct and thus sealing of duct in which Nano fluid flows, it also lowers the thermal characteristics of the Nano fluid. Method to found stability in Nano fluid is preparation of homogenized Nano fluid using ultrasonic vibrator, surfactant addition method, pH value control method, electrostatic stabilization, electro steric stabilization.	Thermophysical property depends on the quantity of nanoparticles added to the base fluid, various factors affect the Nano fluid. The thermal conductivity of a liquid depends upon the heat transfer capacity without breaking the flow and loss in pressure. In addition to it for hybrid Nano fluid varies with shape, size and material sort of nanoparticle. As fine sized shows higher thermal conductivity as compared to coarse. Also, metallic nanoparticle has higher thermal conductivity than Non-Metallic one. Viscosity also affect the thermal conductivity hybrid Nano fluid which depends on volume concentration lineally.

4. Parametric study of Solar hybrid and integrated system

Different hybrid system is being forwarded as per demand of society, hybrid system is generated for energy saving due to continuous degradation of fossil fuel, whereas integrated system concentrates on procuring waste energy using different thermal system, so in this section different hybrid system will be discussed and their affecting parameter will also be analyzed. as in this work [33] solar and wind powered system is defined in which energy is stored using molten salt based thermal energy storage and electrochemical synthesis of ammonia. In this alkaline salt is used for ammonia synthesis and many subsystems like Rankine cycle combine to form the hybrid system in term of parametric study it is found that solar and wind energy is stored in form ammonia production, when energy is in excess as in month of august. Solar radiation intensity effect is also limited on energy and exergy efficiency of Rankine cycle, efficiency increase for increase in solar radiation from 0.1 to 0.43 kW/m2 then marginal change is seen. As Rankine Cycle operating condition also matter, as it depends on inlet pressure of turbine. In another work [35] quadrupled hybrid system with aim of water and biofuel yielding it was found that Parabolic trough collector and other solar energy harnessing system sustainability is maintained with the help of optimization of operating fluid as well as integrating into a hybrid system such as PTC/bio mass/ geo thermal /hydro .bio mass due to its availability and renewable nature it was found to support the solar system when solar energy is not there or in case of intermittent geothermal energy. Also, this work aims at improvement of thermal efficiency of the PTC, reduction in cost and production of bio diesel from salina micro algae. parameter affecting growth of micro algae are solar intensity, salinity and air injection, as it affects the production of bio diesel. Parameter affecting efficiency of PTC in this quadrupled system are nanoparticle concentration, weight ratio of the working fluid in the PTC. In [37] focus is made on combination of Parabolic trough collector with sensible heat storage reservoir although there are different types of thermal energy reservoir ,classified according to the method of storing energy and its storage duration like sensible hear ,latent heat, thermo chemical(based on dissociation and synthesizing process based chemical reaction).the third method of energy storage found to be effective under wide temperature range and for long term storage, but due to different factor found less application in industry. Sensible heat storage system found to have liquid and solid material as a heating medium for energy storage purpose. In this work focus is also on sizing methodology in an integrated hybrid solar energy system using small PTC collector to fulfil need in the bitumen storage process. In this different objective were seen such flow of heat transfer fluid, thermal energy storage capacity, economic and technical feasibility in integration, potential of small parabolic trough collector against the fossil fuel in medium temperature heat consuming process, analysis of hourly cost of storage system ,exergy efficiency of SPTC with thermal energy storage.it was found that solar field exergy decreased at high temperature also there is increase in cost at high temperature but it lead to high renewable energy fraction ,high quality in storage and its storage capacity. In [38] this poly-generation solar hybrid biomass system has been discussed, this system aims at increase in efficiency and payback period of the hybrid system consist of VAR cooling, Desalination, solar and biomass system. It is found system energy and exergy efficiency at high steam fraction and bled steam pressure is found to be high. also, improvement is made in efficiency using VAR cooling and Desalination. About the parametric study in [40], it is seen selection of solar technology is based on Direct Natural Irradiance for a particular place and the cost of solar thermal collector which depends on its size and technology and these factor influences the cost of energy generation. It is found that PTC, Parabolic Dish collector to be suitable technology for place like India. In this work scholars simulate the result based on various parameter like generator heat, cooling produced by VAR system and DNI as it was a poly-generation process. it was seen exergy and energy efficiency of this system on DNI and biomass efficiency. It is found to have increment in efficiency of PTC with DNI. But overall marginal change is seen as system depend on biomass in case solar radiation is not there, also more heat requirement is being fulfilled by biomass hence in case of decrease of DNI but increase in biomass heat increases overall efficiency.

5. *Seasonal thermal Energy storage system*

The thermal energy storage act as key element in the utilization of solar energy as it provides energy when solar energy is not available in this storage system there is another new technology being used to store energy for a season gap so seasonal thermal energy storage system is being developed . In seasonal thermal energy storage (STES) energy stored in summer is used in winter.it can be classified as [50].

Table 2: Classification of seasonal thermal energy storage system

Sensible Heat Storage (SHS)	Thermochemical Heat Storage (THS)	Latent Heat Storage (LHS)
• Sensible heat storage unit converts collected solar energy into sensible heat in selected materials which can be regain when required. It is simple, inexpensive and reliable, in this stored heat amount is dependent upon the specific heat of substance. • Storage medium of SHS is pebble, gravel, soil. • It consists of storage type like Water based system (Water tank, Aquifer) Rock or ground-based system • It is Environmentally friendly making use of cheap material, Relative simple system in construction and operation, easy to control, Reliable, but it is having Low energy density, huge volumes required in case of district	• Thermochemical energy storage is advantageous over other two in term of energy storage and low heat losses. also it is possible with thermochemical energy storage to store energy at ambient temperature for longer period without any losses. • Storage level is organic and inorganics material. • In this storage type includes active storage and Passive storage • Higher energy density than sensible heat storage Provide thermal energy at constant temperature • It Lack in thermal stability , also	• Latent heat storage provides higher energy then sensible heat in term of storage.it make use of Phase Change Materials (PCM) these material undergoes phase changing process in form of latent heat. Due to a range in PCM it serves purpose in varying temperature heat storage. • Storage medium include metal chlorides, metal hydrides, metal oxides • It includes system like Thermal-sorption (Adsorption, Absorption) Chemical reaction which make it suitable for high temperature condition. • Highest energy density, compact system Negligible heat losses

heating, Self-discharge and heat losses problem, High cost of site construction Geological requirements are some disadvantages associated with it.	problem like Crystallization Corrosion High cost of storage material are few drawback of it.	• Poor heat and mass transfer property under high density condition Uncertain cyclability High cost of storage material

Table 3: Conceptual Overview of different parameter and their effect in thermal energy storage system [51]

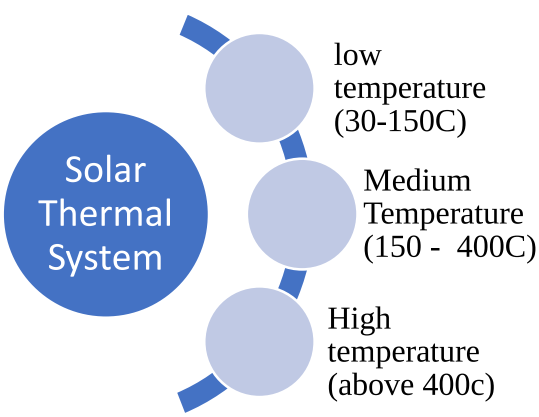
Parameter affecting operation	Parameter assessing economic feasibility
Storage efficiency: In terms of storage efficiency TTES (tank thermal energy storage) and PTES (Pit thermal energy storage) found Under SHS to have sound storage temperature i.e. achieving high storage temperature and hence efficiency. Good insulation but it is limited in terms of space requirement, leakage, and decease in efficiency with increase in storage in terms of water equivalent. Under SHS another efficient storage system is ATES (aquifer thermal energy storage) BTES (borehole thermal energy storage). BTES Lacks in development due to lengthen start-up and proper underground condition. ATES is limited in use due requirement of aquifer within suitable depth.	Storage Volume Cost: SHS has low storage volume cost compared to LHS and THS. PTES and low temperature ATES can be used in making use of solar thermal system.
Energy Density: TTES and PTES has good energy density as compared to ATES and BTES. LHS system has best energy density can provide energy density at almost constant temperature but the problem encountered in its use is presence of corrosive material and poisonous which lack thermal stability and hence require complex and complicated system while using it.	Storage Capacity Cost: SHS has low storage capacity cost compared to LHS and THS.

6. Thermal-solar systems and its application

Classification based on temperature [41].

6.1 Solar cooling

Solar operated cooling system is itself a wide in range in which VARS and VCRS system can be employed as VARS uses heat source to produce cooling effect a brief description of the solar technology has been tabulated below.



6.2 Solar operated supercritical SCo_2 cycle

In this work [34] s-CO_2 (super critical carbon dioxide cycle) is integrated with solar plant and operated at low and high temperature. This system makes use of solar field to provide multi heating (heating at different temperature). The parameter which creates difference between simple s-CO_2 and cycle operated through multi heating solar power plants is that in first case heat is supplied by a set of heliostats through single receiver and primary heat exchanger while in the latter case it was making use of two heat supplies with its own heliostat .it was found that multi heating give better efficiency, lower cost and softer thermal requirement. In terms of concentration ration it was found that if concentration ratio is decreased then optical efficiency is increased and thermal loss are also lowered. In this work thermal coherence is used to obtain higher efficiency, also heliostat with smaller surface is used by the system with higher efficiency.

6.3 Solar operated desalination plant

Solar energy is finding application in terms of completing another demand of hour that is clean and potable water now a day, Solar still desalination at present found to be a useful method which can be used for desalination as it is a simple and oldest technique to be known. in this solar still and solar radiation is used to produce water based on similar phenomenon as occurring in nature. So, this method is mostly used to produce fresh water at low quantity as in case of dispersed production. In this method the important factor affects the system are solar radiation intensity, surrounding temperature and wind speed. In solar still desalination passive and active method are defined. In active solar still desalination use of solar auxiliary system is made i.e., solar still, flat plate collector, vacuum tube, spot concentrator. In case of passive, it makes direct use of solar energy in form of suspended absorbent, felt fabric, sponges, wicks [36]. Also in case of remote island with proper sunlight it is found [35] among different passive method the focus is on use of the vacuum method and cooling water layer is efficient.

Table 4: Overview of different collector used in solar cooling

Parabolic trough collector in refrigeration	• Absorption cooling system [61-62] • In this refrigeration system a parabolic reflector with the transparent cover, absorber tube along with sun tracking mechanism is being used. • In this refrigeration process double effect refrigeration is found to be more economical as compared to single effect due to availability of high temperature • In terms of COP of cooling system, it is found that flat plate collector and this PTC is same although Solar fraction was found higher in case of Flat plate as compared to PTC. • In term of selection of best collector and working fluid medium for absorption system having different collector, it is found PTC and Libr-H_2O. is best combination for maximum COP [65]
	• Adsorption cooling System • In this in addition to collector adsorbent and adsorbate proper selection is also must. • In one of the adsorbent cooling system with PTC space cooling was carried with the temperature of 4^0C and COP of system was resulted to be 0.75 with the olive water and methanol pair [63]
	• Ejector based absorption refrigeration. • In this PTC supported ejector-based refrigeration system it is found that Libr-H_2O pair shows exergy efficiency of 4.76% [64]
	• Cost and payback period • In term of cost and payback period PTC is superior to ETC and FPC. • Thermodynamic efficiency of PTC is superior to that of ETC and FPC.
Compound parabolic collector in refrigeration	• It is a non-imaging collector which reflect rays to the absorber tube. • In absorption refrigeration system using CPC with NH3-LiNO3 and NH3-LiNO3-H2O COP was quite improved as 24% [66]
	• Adsorption cooling using CPC • It is found that adsorbent bed is important in term of solar adsorption. • Low heat and mass transfer in adsorbent bed shows low COP. • CPC found better in terms of adsorption cooling then absorption cooling .

Table 5: Brief overview of different solar collector techniques

Single slope solar still (SSSS) [55]	• It makes use of inclined glass cover for condensation • Inclined glass cover protect the radiation loss and heat loss. • Angle of inclination is sometime selected on the basis of latitude of place • Continuous solar tracking is seen to capture maximum radiation • Single tracking is done to capture solar rays for day • Also double basin solar still is found to be 85% more productive than single basin.
Double slope solar still (DSSS) [56]	• It has larger condensation area as compared to single slope so more productive in condensation. • Efficiency of DSSS with different sensible storage material like light cotton, sponge sheet is improved many times. • The water depth in basin also effect the desalination process , it is found at low water level water evaporates faster as compares to large water level.
Wick Type Solar Still	• It works similar to capillary action and evaporation process • In this wick is used through which feed water travels and gets heated while it travels by radiation. • In this water at high temperature is available because less quantity gets travel through wick.
Active solar still	• It produces more amount of freshwater per meter square area of solar still as compared to passive solar still. • It makes use of extra component which is not used as in case of passive solar like solar flat plate collector, reflector, condenser etc.
Active Solar still with reflector [57]	• Reflector are used in solar still to improve the efficiency of solar desalination as compared to without reflector • There are two types of reflector used in active system , Internal reflector and external reflector
Active solar still with condenser [58]	• Using condenser help to create larger temperature difference between water at basin and glass at top receiving the heat. • Drop wise condensation is found more effective then film wise condensation. • Three type of condenser are used to improve the productivity of solar still these are internal , external and built in condenser.
Active solar still with concentrator [59]	• Concentrator improves efficiency of desalination plant by concentrating more radiation. • Concentrator concentrate the radiation falling on large area over a small area using phenomenon of reflection and refraction.

	• Two types of concentrator found application imaging and non-imaging. • Concentrator can be classified on the basis of geometry as point focus and line focus. • Classification on the basis of tracking can be single path and double path • For large installation area Fresnel lens concentrator found application. As Fresnel lens act as truly convex lens which give reflection of rays as compared to refraction • When Fresnel lens concentrator uses nanoparticle mixed heat transferring fluid then water boils at relatively faster rate in the basin.
Humidification and Dehumidification	• It is process of desalination which works on similar process of rain. • In this film wise condensation occurs. • System efficiency deepens upon the glass, air, water temperature. • In this water in the basin add to air at constant dry bulb temperature when air is hot and condenses to water when air is cooled.
Active solar still using solar chimney And solar pond [60]	• In this solar power is converted to electric power using turbine. • Solar energy heat and impart energy to air which will then run the turbine placed at foot of chimney. • Solar chimney desalination method proves to be efficient method of desalination. • This method produces power in addition to fresh water.
Uses of nanoparticle in desalination plant	• In this nanoparticle is mixed with impure water. • It adds the thermal conductivity of base fluid like water and add heat transfer rate of fluid which thus increase the evaporation. • Nano fluid increase desalination process rate as it increase the conductive and transport property of the fluid.

7. Conclusions

The above research review brings an overview of solar energy as a renewable source and highlighting the various ways of harnessing the energy in environment friendly way. The following conclusions were drawn.

(i) Solar energy can be used in remote area for water purification using different technique like single slope solar still to reduce the water dependency of people on rain and leave healthier life.

(ii) Solar energy can be used to produce electricity for remote area where barren land is available and in desert area. To improve living standard of people.

(iii) Hybrid Nano-fluid can be used in heat transfer process in PTC and other solar technology due to its better stability and thermo-physical property.

(iv) Efficiency of the solar energy harnessing system can be improved using sensible heat storage system and latent heat storage system when there is seasonal thermal storage in comparison to thermo-chemical storage system.

(v) Storage of solar energy depends on different parameter like storage efficiency of storage system so tank thermal energy storage system is found to be best

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