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Theoretical Analysis for Dual Renewable Resource Combined Energy Plant for Several Applications in Hilly Areas

Ojashw Sharma[1], Shivasheesh Kaushik[2], Chetan Prasad[1] and Hina Gupta[1]
[1]B.Tech scholar in ME Engineering, Amrapali Group of Institute, Uttarakhand, India
[2]Assistant Professor in ME Engineering, Amrapali Group of Institute, Uttarakhand, India

ABSTRACT: Solar energy and wind energy are present for limited hours. As a result it is often necessary to use a storage system to store both of the energies when they are available and the day time solar radiation can be used at night time in wide range for various applications as we are using energy in a combined way.The result shows that an optimized design of a rock bed can serve the purpose of heating at night with comfort and electricity generation for surrounding village areas. Our theoretical investigation based on the charging and discharging time calculation and amount of heat transfer from atmosphere to heat bed regenerators which is presented in past research with this we are combining another concept for improving the results for space heating, power generation and for solar drying application. We are also generating power by rotating solar turbine by the means of high velocity wind flow during its peak availability time and air flows upward from ground level due density difference concept which is produced by the presence of solar radiation which falls inside through transparent polythene covered poly house atmosphere in day time which further passes through the heating bed regenerator filled with heat absorbing material. We use solar radiation/energy, plants to build a required pressure difference so that we can get an appropriate air flow to rotate a turbine. In poly house we are also doing plantation i.e. seasonable timbering, crop drying, drying of tea leafs, dry fruits, spices etc.

I. INTRODUCTION

As we all know the devices operated by renewable resources are eco-friendly but they are not continuous in operation. e.g. solar energy is dependent on sun, wind mill are reliable on winds, in order to generate power from hydro energy we need water resource.We can solve this problem by using various resources together.Basically we are using solar energy and wind energy to run a turbine so that we can generate power in a cheaper and eco-friendly manner, also provide space heating system in winters and crop drying.The papermainly based on design and fabrication of an effective solar air heater. It gives main idea of A flat-plate collector (two pass) consists of cover plate of glass,battens to holdthe glass in place, air as heat exchanger medium, metal plate painted black as absorber andinsulation. This is the main and useful component of this solar air heater. Now in my view this paper does not laid much stress on the material of which plate of solar airheater is made. This is the main reason behind the decreasing efficiency of this solar air heater. The shape of solar air heater chamber will be in cubic shape having a inlet valve onthe roof. The power generation chamber will be over the solar air heater in same shape but havingdifferent dimensions. A black sheet will be best for trapping the heat so it can be spread over theground in crop drying space [1].

The research paper gives main concept of space heating, a basic and awesome application of rock bedcells and regeneration solar air heating chamber.In this paper again main and useful content is design of solar air heater chamber. This paper also laid stress on the material of chamber and heater.In my view the main drawback of this paper is that all the content in this paper is hypothetical.There is no practical evidence and any mathematical formulae related to its efficiency and calculation of area, efficiency and power of turbine.So this paper only gives the theoretical concept of space heating which can be useful tool for ourpractical approach.A regenerative rock bed cells results in 24 hour operation of this set up.Rock bedscells stores heat in presence of sun and liberate them in the absence of sun. Solar energy canalso be supplied in the absence of sun [2]. In this paper key point is the Determination of Heat-Transfer Parameters for Flow in PackedBeds using Pulse Testing and Chromatography Theory. The best part of this paper is that it gives theoretical as well as practical approach forregenerative cells. In other words it is fully packed source of information about regenerative rock bed cells. In my views this paper has full content but still some practical application is lacking. The amount of heat stored is more for the materials with high thermal conductivity. So marble is the most suitable material for rock bed cell/ regenerative cells asit has more thermal conductivity, its temperature density is also most suitable as

perrequirement and also it is cheaper and easily available [3].
This paper is good as far as environment is concerned. It shows all the uses and benefits of solarenergy over the other non renewable resources.This paper also gives relation between area of sample space and amount of heat energy collected in that area or space for given time duration.This paper describes perfectly the meaning of word “go green”.Solar energy is best source of heat as compare to other fossil fuels. Solar energy is a renewable resource thus, will not deplete .while fossil fuels are most costly hence not suitable for this project [4]. This is a kind of blog page throwing light on wind turbine power calculations. It gives relation between power developed and area swept by blades of wind turbine. It also gives proof of the above mentioned relation by an experimental setup. Some graph also shows relation between efficiency and rate of air flow. The power of wind turbine is directly proportional to area swept by blades ofturbine, air density, and air flow velocity and power coefficient. Power will be maximum at powercoefficient =0.59.normal air density is 1.23kg/m 3 and average air velocity be 12m/sec. So forthese values power developed is 3.6 MW [5]. This paper gives a broad classification of material used in rock bed cells/regenerative cells. The Comparison between alumina oxide, quart, volcanic rock, and basalt were made.The various materials are classified on the basis of bulk density, specific heat, and maximumoperation temperature. The comparison is also done as per by graphical representation. In this paper to prove the above data an experimental approach is also given. Alumina oxide pebble is the most suitable material for rock bed cells/regenerative cells. Alumina oxide pebble has 2350 kg/m^{-3} bulk density and 1090 j (kg K)$^{-1}$ mean specific heat and 1800°C maximum operation temperature.[6] This paper gives concept of greenhouse and all useful information about it.This paper is useful in reducing cost of crop chamber after giving concept of green poly house. This paper also gives the idea of assembling green poly house as per the requirement of ourproject. The main result of this paper is that poly sheet in place of tin chamberwould reduce the establishing cost of the setup and also poly sheet is more effectivethan tin shed in respect of its heat loss coefficient, reflectivity, absobitivity, transmissivity and various other factors [7].
Now the best part of our project is that it is cheaper way to generate power and to provide heat system. We are using poly sheets and metallic frame to cover our set up which reduces the cost of bricks and various material used to build a solid building structure. We are also using combination of solar energy, tidal energy and powerful concept of regeneration cells which increases efficiency and continuity of our setup.

The present paper deals with a unique system which can be divided into three phases:

- Poly house.
- Regenerator cells.
- Power generation chamber.

Best part of our project is that it may provide power 24*7 and space heating in winters. After researching and analyzing various earlier references, we can assure that in future no further changes can be done in this.

A. Major Concept:

1. SOLAR ENERGY: Due to sunlight the radiant energy of solar strikes on outer side of poly sheets then the air within the poly house gets heated and due to this air losses its density and a density difference created and air gets accelerated towards power generation chamber because there is no path for air flow except towards power generation chamber.
2. WIND ENERGY: Wind is one of the major part needed to run our turbine. Therefore we choose an appropriate place for it. Our big problem is the pressure of air. We cannot get solar energy in night time and during rain but by using concept of regeneration rock beds we store heat and can maintain a pressure in night time an during rains. Thus this property makes our project 24*7 running.

II. MATERIAL AND METHODOLOGY

As we mentioned in introduction our set up consists of poly house in which normal plantation is done. We are thinking about wheat cultivation for that purpose. On other end a turbine setup is situated which is main part of power generation between poly house and turbine section; there is a concept of bed rock to increase continuity of our project.

- A part is poly house.
- B part is rock bed cell.
- C part is power generation chamber.

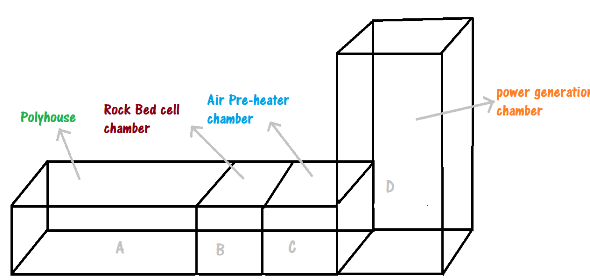

Fig. 1. Outer Design.

A. Polyhouse

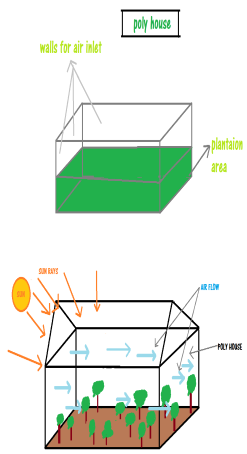

Fig. 2. Poly House.

Poly house is a place where plantation is done. We choose wheat and grains as major crop. The poly house will also contain those crops which are to be dry i.e. tea leafs, fruits etc.

The benefit of this part is that it provides appropriate air flow pressure to run the turbine. We can use various material for polyhouse but our main motive is to minimize the cost for whole setup, so it can be more efficient. The materials we may use are glass, polycarbonate, plastic films (polyethylene) etc.

Advantages and disadvantages of various materials are mentioned below:

a) GLASS: Glass has been the preferred traditional glazing because of its permanence and beauty. However, glass is one of the least efficient materials for retaining heat due to its high heat transfer rate (i.e. allowing the cold temperature to transfer though the glass very easily) and poor insulating characteristics.

Advantages:

- Longevity
- Traditional look
- Light clarity

Disadvantages:

- Fragile and less forgiving to knocks
- Poor thermal efficiency (3mm glass R=0.95 and 4mm glass R=1.0)
- Potential to burn plants due to the level of clarity

b) POLYCARBONATE: Polycarbonate (Twin wall) UV treated polycarbonate provides better clarity than Polyethylene film and nearly as much as glass (at about 89% clarity). It is also significantly stronger and more durable, making it a practical and increasingly popular choice for today's greenhouse growers.

Advantages:

- Good thermal efficiency (6mm Twinwall R=1.54). Keeps the warmth in longer into the night and offers better frost protection
- Very tough and durable
- Good longevity (provided it is a premium grade polycarbonate)
- Produces a slightly diffused light which helps prevent burning/scorching the plants

Disadvantages:

- Prone to scratching.
- The flutes in the twin-wall can attract moisture, mould and bugs - if not sealed sufficiently in the frame.

c) Plastic film (polyethylene): Polyethylene (plastic) film - sometimes also known as 'Poly-film' or 'AgPhane', this film is common among commercial growers due to its low cost per square meter. It is a versatile product and can handle the knocks without easily breaking although it can be susceptible to tears and punctures. Most commercial growers in colder climates choose to use a double layered system (with warm air blown between the inner cavity) to provide better thermal insulation, as polyethylene film has poor heat retention properties when compared to polycarbonate or even glass.

Advantages:

- Low cost per square meter
- Takes the knocks
- Diffused light - prevents burning and aids photosynthesis

Disadvantages:

- Relatively short lifespan and requires replacement
- Prone to rips and tears
- Poor thermal efficiency (R=0.83), unless double skinned.

B. Materials Used In Regeneration Cells:-

It is proposed that air–rock packed beds are suitable for thermal storage in solar power plants at temperatures of approximately 500–600 °C. However, little has been published in the field of thermal energy storage on the suitability of rock for this particular application. Desirable characteristics of rock for this application are presented, and the different rock types are discussed in the light of these requirements. A survey of the literature in other fields on rock characteristics shows which rock is most likely to be suitable. Results from thermal cycling tests (more than 900 cycles at rates of 2 °C/min) on a variety of rock samples are reported. Dolerite withstood this process well; some gneisses did but others did not. Geological maps showing the availability of potentially suitable rock in solar-rich regions of South Africa are presented. There are potentially suitable rock types (for example dolerite, granite, gneiss) in parts of the country which are deemed to have a good solar resource. Dolerite, which is found in copious quantities in insolation-rich regions, should be well-suited to packed bed thermal storage. In regenerator we are using those pebbles which have less thermal conductivity.

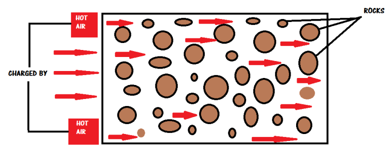

Fig. 3. Regeneration cell.

Table1: Properties of different rocks.

S.No.	**Rocks**	**Density kg/m^3**	**Specific heat J/kg-K**	**Thermal conductivity W/m-K**
1	Stone, Marble	2600	800	2.07 – 2.94
2	Stone, Granite	2640	820	1.73 – 3.98
3	Stone, Limestone	2500	900	1.26 – 1.33
4	Stone, Sandstone	2200	710	1.83
5	Clay	2650	1381	0.15 - 1.8(dry) 0.6 - 2.25 (saturated)
6	Waste plastic and Hard rubber	940	1600	0.03 - 0.1

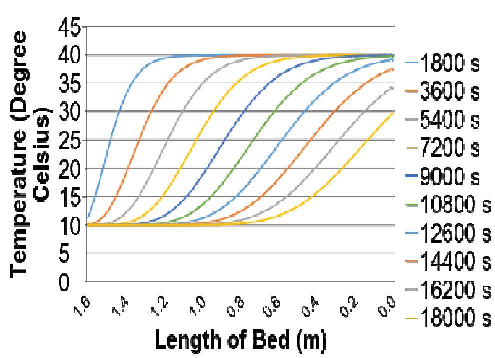

Fig. 3a. Graph showing previous literature temperature profile result for discharging time of regenerator bed using lime stone.

C .Air Pre- Heater Chamber

It is the next chamber after regeneration chamber. After passing through regeneration cell now the low dense air enters in air preheated chamber. The density of air is decreased further so that its velocity increases. In this chamber air gets more heated and attains appropriate energy required for turning the turbine which is in power generation chamber.

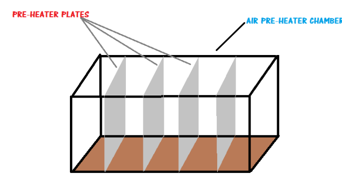

Fig. 4. Air preheater chamber.

D. Power Generation Chamber

This is one of the important part of our setup. It works with the help of two non-conventional energy resources solar and wind. Solar works at day time and wind works at night time as well as day time. It contains some expensive devices such as turbine and generator (sensitive dynamo) so we have to cover this part with a strength full building. Now this chamber contains a turbine which must be sensitive and operated by air. By keeping these parameters in mind the best choice of turbine is axial flow solar turbine.The next part is the battery which stores the power which can be supplied to other sources later on.

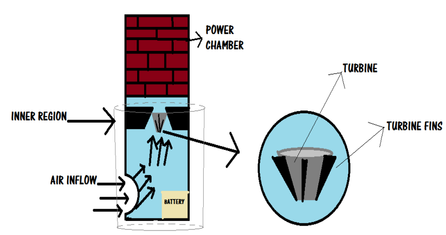

Fig. 5. Power Generation Chamber.

E. Process of Working

The operation principle is totally based on combined utilization of wind and solar energies .firstly the wind direction and velocity is detected by anemometer. Due to density and pressure difference maintained in poly house by the means of heat intensity increases inside the chamber by water vaporization through crops and solar radiation which fall on the fresh air present inside the poly house chamber further mix with outside wind velocity which enters through inlet from outside atmosphere produces a good heated air flow that is needed to rotate solar turbine with an appropriate speed. speed.

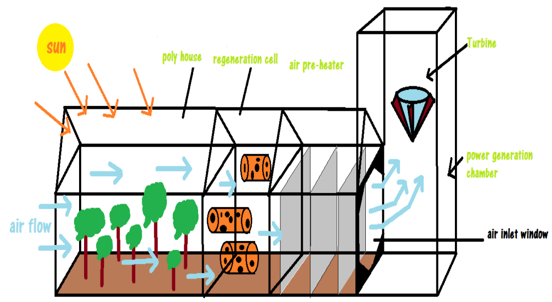

Fig. 6. Process of operation.

Rock beds are installed before the solar turbine chamber so that before high velocity air fluid expand on turbine passes through the heat bed regenerator where few amount of heat is absorbed by the absorbing material present inside bed which further utilized during night time when solar radiation will not present. Now when turbine rotates it converts mechanical energy into electrical energy which later on stored in batteries. And can be supplied to the sources. The hot air after wards used to heat the nearby spaces in winters as space heating application which is not harmful for us. In fact it is our basic need. So this setup is eco-friendly.The readings mention in table number 2 is for the room of dimensions 4x4x4. Now there are10 rooms of this size which means we have total area of (64x10m^3)640m^3.This area can accommodate on average 40 people of average size. So this can be established in a building where on average 7-8 family can live with comfort.

F. Depending Parameters

There are some points that are kept in mind during this setup as it is totally nature base.The points are as follows:-

- The setup must be situated at suitable place where we can have the appropriate air flow and sunlight.
- We require large area for this setup to have appropriate air flow and for large amount of solar energy can be collected.
- Numbers of regenerator rock beds are also a major dependent factor as it provides space heating and make it operable during night.

Table 2: Scale Parameters for Determining the Human Comfort regarding space heating.

No. of Beds	Ventilation load	Transmission load	Internal Heat Gain	Net Heat Load
3	506.58W	2838.8W	560W	2.785KW
6	1013.16W	5677.6W	1120W	5.57KW
9	2026.32W	11355.2W	2240W	11.14KW
12	4052.64W	22710.4W	4480W	22.28KW
15	8105.28W	45420.8W	8960W	44.56KW
18	16210.56W	90841.6W	17920W	89.12KW
21	32421.12W	181683.2W	35840W	178.24KW
24	64842.24W	363366.4W	71680W	356.48KW
27	129684.48W	726732.8W	143360W	712.96KW
30	259368.96W	1453465.6W	286720W	1425.92KW

CONCLUSION

By using combined wind energy and solar energy in the form of radiation, through regenerator beds and solar radiation chamber we are going to convert mechanical energy into electrical energy by solar turbines and radiation into heat storage through solar regenerator bed and different solar collector like dish collector or heliostat for the application of space heating and solar drying in hilly areas. Also the important part of our research is regenerator packed bed which provides heat energy continuity to our set up and space heating in winters, here continuity means it will also work throughout the year 24 hours. From this setup we conclude that combination of wind energy and solar energy can run a turbine to produce appropriate power which can be supply commercially throughout the villages of the hilly areas and excesses amount of power stored in batteries for several applicationswhich will supply as per requirements. It was observed after go through the latest research paper regarding solar regenerator beds using different heat absorbing material that those material who have high specific heat and lower thermal conductivity properties are suitable for the present research with less manufacturing cost and easily available in market and nature, some of them are mention above. After all the investigation it was concludedthat clay and lime stone show better result of the high heat storage capacity with high charging time and low discharging time for decided volume of 64 m^3

and is occupied by 4 persons for space heating application.

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