Power Generation using Greenhouse Effect

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Abstract

This paper deals with the utilization of solar thermal radiations to generate electric power by constructing a greenhouse. The process of greenhouse power generation is a way of solar thermal energy conversion. A significant observation about the temperature difference is noticed between a greenhouse and water body under shades. The power generation using greenhouse employs a heat engine to alternately evaporate and condense a working fluid. In the closed cycle configuration, a working fluid such as propane or anhydrous ammonia is assessed for its practical merits of electric power generation. Systems must be designed with regard to potential efficiency issues. These issues should be properly researched in order to design systems that are effective.

Keywords: GLASS-BOX, GLASS-HOUSE, RADIATIONS, SOURCE, SINK

I. INTRODUCTION

Renewable energy is gaining traction as an important area of focus for governments worldwide. It is increasingly essential to a country’s energy portfolio, not only to combat climate change but also to diversify sources and protect against external shocks. As government must do more with fewer resources, a renewable energy is also increasingly part of economic sustainability calculation. A clean energy future demands greater investment in renewables, which in addition to environmental benefits could provide attractive dividends such as job creation, economic growth, energy security, and greater insulation from oil price volatility. [1]

Solar energy is an abundant energy resource. Indeed, in just one hour, the solar energy intercepted by the Earth exceeds the world’s energy consumption for the entire year. Solar energy’s potential to mitigate climate change is equally impressive. Except for the modest amount of carbon dioxide (CO₂) emissions produced in the manufacture of conversion devices. The direct use of solar energy produces very little greenhouse gases, and it has the potential to displace large quantities of non-renewable fuels. Some of the solar energy absorbed by the Earth appears later in the form of wind, wave, ocean thermal, hydropower and excess biomass energies. [2]

The solar irradiance, i.e. amount of power that the sun deposits per unit area that is directly exposed to sunlight and perpendicular to it, is 1 368 watts per square meter (W/m²) at that distance. This measure is called the solar constant. However, sunlight on the surface of our planet is attenuated by the earth's atmosphere so less power arrives at the surface — about 1 000 W/m² in clear conditions when the sun is near the zenith. [3]

Several solar technologies, such as domestic hot water heating and pool-heating, are already competitive and used in locales where they offer the least-cost option. And in jurisdictions where governments have taken steps to actively support solar energy, very large solar electricity (both PV and CSP) installations, approaching 100 MW of power, have been realized, in addition to large numbers of rooftop PV installations. Other applications, such as solar fuels, require additional R&D before achieving significant levels of adoption. [2]

II. WORKING PRINCIPLE OF GREENHOUSE POWER GENERATION

It is a process which utilizes the greenhouse effect that uses the heat energy stored inside the glass house to generate electric power. The earth is surrounded by a thin sheet of atmosphere. Most of the radiations emitted by the sun are reflected back in the universe because of scattering with clouds, gases, dust particles and ozone layer while few that penetrates towards the surface, after reflection by the surface, doesn’t leave out due to layers of gases atmosphere. This increases temperature near surface. This is called greenhouse effect.

Such an atmosphere is also be created by constructing a glass-house. The thermal radiations of sun enter the glass-house which doesn’t come out from the glass house. As the time passes, the temperature inside the glass-house increases more than surrounding atmosphere. This glass-house will act as heat source of the heat engine. On the other hand, a container containing water under shades have the temperature lower than the atmospheric temperature. This container will act as heat sink.

The generation of power uses greenhouse effect employs the thermodynamics of a working heat exchanger and use the temperature difference as the driven force. This heat engine utilizes the heat energy stored inside the glass house to heat a liquid with low evaporating temperature as working fluid such as anhydrous ammonia, propane etc.
III. EXPERIMENTAL ANALYSIS

A. Experiment Setup:

On a warm sunny day where the maximum atmospheric temperature recorded was 31.8°C, I had exposed a glass box of dimension 500mm * 500mm * 500mm to sunlight for 10 hours. Simultaneously, a container of aluminum was also kept under the shades. The glass-box was kept 15 minutes after the sunrise and the atmospheric temperature was 19.2°C. After keeping the whole apparatus, the first temperature was recorded after 20 minutes. After the regular interval of 1 hour, the temperature of atmosphere, glass-box and the water was recorded for next 10 hours.

B. Observation Table:

<table>
<thead>
<tr>
<th>TIME</th>
<th>Atmospheric Temperature</th>
<th>Glass Box Temperature</th>
<th>Temperature Difference</th>
<th>Water Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:40</td>
<td>19.6</td>
<td>22.9</td>
<td>3.3</td>
<td>19.6</td>
</tr>
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<td>7:40</td>
<td>21.5</td>
<td>32</td>
<td>12.4</td>
<td>19.6</td>
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<td>21.9</td>
<td>41.2</td>
<td>21.3</td>
<td>19.9</td>
</tr>
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<tr>
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<td>47.1</td>
<td>26.1</td>
<td>21</td>
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<td>19.9</td>
<td>26.6</td>
<td>3.6</td>
<td>23</td>
</tr>
</tbody>
</table>

IV. RESULT AND ANALYSIS

A graph of temperature (in degree centigrade) versus time (in hours) is plotted as per the observation which shows the variation of temperature of the source (glass-house) temperature and atmospheric temperature at regular interval. The graph is shown below.

![Graph](image)

Fig. 1. Variation of Temperature with Time

After the 20 minutes, first observation is made to see the temperature change inside the glass-box. The temperature observed was 22.6°C inside the glass-box and the atmospheric temperature was 19.6°C. But after 2 more hours, there was a significant rise in the temperature inside the glass-box. At 8:40 AM, the atmospheric temperature was 21.9°C whereas the source temperature was 41.2°C.

After 8:40 AM, it seems that the temperature inside the glass-box is set-up to a significantly high value and ascends with the atmospheric temperature. Between 10:40 AM to 4:40 PM, the atmospheric temperature varied between 4°C whereas the
temperature inside the box once increased to 50°C. After 4:40 PM, the atmospheric temperature starts falling as sun proceeding to west but the temperature inside the box doesn’t fall instantaneously. At 12:40, a small fall in the graph is noticed which was due to the cloudy weather condition of 10-15 minutes.

Another graph which shows the difference in the temperature between glass-box and the water container is shown in the fig. For almost 9 hours, the temperature difference between the glass-box and the water container was more than 20°C. With the help of the heat exchanger this temperature difference can be utilized to create the pressure difference between source and the sink in a close-loop heat engine to drive the turbine of the generator.

![Graph showing temperature difference between glass box and water](image)

Fig. 2: Temperature Difference between Glass Box and Water

After 2 more weeks another experiment is done to observe the temperature variation in different weather condition. The graph of the temperature variation inside the glass-house with the atmospheric temperature is shown in fig. The maximum temperature of the day was 32.1°C. The maximum temperature recorded inside the glass-box was 54.6°C.

![Graph showing variation of temperature with time after two weeks](image)

Fig. 3: Variation of Temperature with Time after Two Weeks

The main disadvantage of the greenhouse power generation is that it only works as long as the sun present in the sky. It can’t give desired results in the fused sunlight or in the rainy season. Even after the sunset where the atmospheric temperature doesn’t fall tremendously, the temperature inside the glass-box reduces nearly to the atmospheric temperature.

But the advancement in the study of solar energy, a number of techniques is being employed to concentrate solar radiation with the help of solar collectors and reflectors. Another way to increase the temperature difference is to reduce the temperature of the water body.

V. CONCLUSION

Moving forward in clean energy generation, greenhouse power generation can withstand to generate power in several kilowatts to few megawatts. In the places like greater plains of India where sun shines most of the day in a year, this technique of power generation effectively generate electric power. If the further study is made in this field with change in parameters like size of glass-box, it is expected to give more good results for the power generation.

REFERENCES

[2] Dan Arvizu (USA) and PalaniBalaya (Singapore/India) “Direct Solar Energy”