FABRICATION AND ANALYSIS OF A SOLAR UPDRAFT TOWER

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Introduction:
Solar Updraft Tower (SUT) is a design concept for a renewable energy power plant for generating electricity from solar heat. It mainly consists of a chimney, a collector and turbines. Stack effect is the main principle of solar updraft tower. The movement of air in and out of a structure or a container due to pressure difference is called as stack effect. This is caused due to the difference in air densities resulting from temperature and moisture difference. Under the collector area, air is heated by solar radiation. Since the density of hot air is less than that of ambient air, the hot air rises and moves towards the chimney base. This moving hot air drives the turbines producing power. Conventional wind turbines cannot be used in solar updraft tower. These turbines are different as they have larger area with multiple blades compared to windmills. Customised wind turbines are used depending on the conditions and height of the tower. The idea of solar updraft tower was proposed in late 19th century but lost the race against cheap oil prices. But now it is slowly gaining recognition due to ever raising oil prices and more encouragement given to clean energy. Unlike solar panels which uses photovoltaic effect, here solar thermal energy is used to produce power. Although several prototypes have been built, no practical units are in operation. This is due the fact that small scale power plants are inefficient and large scale plants are costly to build but they can generate significant quantity of power. Solar updraft power technology has a relatively low conversion efficiency and has relatively high investment costs per MWh of electricity produced. On the other hand, the operating costs are very low with no absolutely no pollution.

Objectives of the project:
1. To successfully generate energy from solar updraft tower.
2. To test the model at different temperatures and varying wind velocities.
3. To operate the power plant 24*7 by using water thermal storage system.
4. To improve the efficiency of solar updraft tower using biomass waste compost.
5. Analysis of different parameters of solar updraft tower using ENERGY 2D software.

Methodology:
1. Approximation of tower height, collector area and angle of inclination based on trial and error method with help of an anemometer.
2. Selection of suitable material for the tower, absorber plate and collector.
3. Selection of appropriate wind turbine and its positioning in the tower.
4. Installing waste compost chamber inside the collector area.
5. Installing water thermal storage system around the collector area.
6. Assembly and fabrication of different components of power plant.
7. Testing the model at variable conditions.

Design was based on the diameter of the turbine blade.

- Diameter Of The Turbine – 8cm
- Length of the blade – 2.4cm
- Width of the blade – 3.2cm
- Blade Angle – 60 Degrees
- No. Of Blades- 7
- Tower Height – 2m
- Tower Diameter – 7.5cm
- Tower diameter at the tip – 8cm
- Tower base diameter – 18cm
- Collector Dimension- 2m * 2m
- Collector Inclination Angle- 15 Degrees

Materials selection:

1. TOWER – PVC pipe
   It is selected due to its low density and low thermal conductivity, it is also readily available and costs less.

2. COLLECTOR – Green house transparent sheets
   They are used to trap the incoming solar radiation and the heat does not escape through the sheets.

3. ABSORBER – Aluminium sheets
   They have good absorbability and reflectivity, also they are easily available and cost less than copper sheets.
Table 1: Results of S.U.T. performance

<table>
<thead>
<tr>
<th>INLET TEMP. (CELCIUS)</th>
<th>OUTLET TEMP. (CELCIUS)</th>
<th>MAX RPM</th>
<th>MAX AIR VELOCITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.3</td>
<td>34.9</td>
<td>144.7</td>
<td>0.7 m/s</td>
</tr>
<tr>
<td>36.8</td>
<td>41.6</td>
<td>193.1</td>
<td>1.0 m/s</td>
</tr>
<tr>
<td>33.1</td>
<td>38.3</td>
<td>176.2</td>
<td>0.8 m/s</td>
</tr>
</tbody>
</table>

Conclusion:
- The temperature difference should be as large as possible to get the maximum pressure difference.
- Output obtained depends on the time of the day and season of the year.
- S.U.T is best suitable for arid areas where agriculture and other activities is not possible as it requires large piece of land.
- Small scale power plants are inefficient.