Solar photovoltaic (PV) power generation is an attractive technique to reduce consumption of fossil fuels and as a renewable energy. The temperature of PV module increases when it absorbs solar radiation, causing a decrease in efficiency. The power and efficiency of PV module usually falls at the rate of -0.5%/°C and -0.05%/°C respectively as increase of ambient temperature. To actively cool the PV module, an automatic solar cooling system is designed by using DC brushless fan and DC water pump with interrupter mechanism. PIC 16F877A was used to control the DC brushless fan and water pump for switch ON and OFF depending on temperature PV module. The open-circuit voltage (Voc), short circuit current (Isc) and every change temperature on PV module were shown to compare the performance with and without cooling system. The results showed that the PV module with cooling system is higher in term of output power and efficiency compare to without cooling system. The higher efficiency of PV cell, the payback period of the system can be shortened and the lifespan of PV module can also be longer.

**Introduction**

**Novelties of the proposed topology are:**
1. Used microcontroller PIC 16F877 as a controller system to switch on and off the DC water pump and DC fan.
2. Used the temperature detector for detecting the surface temperature of PV module.
3. Can prolong the life span of the PV module.
4. The payback period of the PV application system can be shortened.

**Intelligent Cooling System Using PIC 16F877A for Solar Panel**

**Results and Discussion**

<table>
<thead>
<tr>
<th>Type</th>
<th>Power Generated (W)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Cooling</td>
<td>70</td>
<td>33</td>
</tr>
<tr>
<td>With Cooling</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

*Table 1: Power generated by PV module with and without cooling system.*

**Figures:**
- Figure 1: Block diagram of automatic solar panel cooling system.
- Figure 2: The DC brushless fan and DC water pump of PV module cooling system.
- Figure 3: The weather condition of solar irradiance.
- Figure 4: The weather condition of temperature.
- Figure 5: The temperature of solar panel for with and without cooling system.

**Novelties**

- High performance and lightweight are the desired properties for geopolymer ceramic matrix composites.
- Due to the complex fabrication method of advanced ceramic technology nowadays, we offer simplest and user-friendly method for high performance ceramic properties.
- To produce equal quality to other advanced ceramic by using waste materials.
- Widens technology of geopolymer ceramic.

**Geopolymer as a new technology which using aluminosilicate sources to produce a compacted network structure binder which is an alternative to the Ordinary Portland Cement (OPC). However the development of this technology is not limited only on the binder processing but it can be used on the other application such as ceramic technology. Geopolymer ceramic which using waste materials such as fly ash and others is very strong, hard, and chemically inert ceramic which can be used in several applications, including those in extreme environments. High performance and lightweight are the desired properties for geopolymer ceramic matrix composites.**

**Potential Applications**

- High performance and lightweight criteria.
- Chemical resistance.
- Good oxidation resistance.
- Excellent creep resistance.

**Product Description**

- Excellent performance.
- Chemical stability.
- Waste friendly.
- Low processing energy.
- Waste friendly.

**Geopolymer Ceramic Matrix Composites**

**Product Properties**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Geopolymer Ceramic</th>
<th>Geopolymer Ceramic Matrix Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source material</td>
<td>Environmental friendly</td>
<td>Waste</td>
</tr>
<tr>
<td>Strength (MPa)</td>
<td>~120</td>
<td>~140</td>
</tr>
<tr>
<td>Density (g/cm^3)</td>
<td>2.4—2.6</td>
<td>1.9—2.1</td>
</tr>
<tr>
<td>Hardness (GPa)</td>
<td>~7.00</td>
<td>~7.5</td>
</tr>
<tr>
<td>Withstand temperature (°C)</td>
<td>&gt;1300</td>
<td>&gt;1300</td>
</tr>
</tbody>
</table>

**Publications**