Impedance Adjustment Method Study of Thermo-Acoustic Electric Generator Without Resonator

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Background

Thermo-acoustic electric generator is a novel thermal-to-electric power conversion mechanism. It has a potential application in deep-space detection due to the characteristic of long-term and high efficiency. In order to decrease the dimension and weight, the linear alternator is used to replace the resonator. It makes impedance match between engine and alternator more important when the resonator is replaced by alternator. There were rarely analysis of impedance adjustment method in the connecting part. In this present, a new impedance adjustment method is proposed and tested. The effects of structure and dimension of connecting part to impedance and performance are analyzed and tested.

Contribution

In this present, impedance adjustment setup in the connecting part was analyzed and built. Setups with different dimension and position were tested in existing thermo-acoustic electric generator without resonator.

- Simulation results supplied method of improving thermo-acoustic electric generator without resonator.
- Appropriate filling could cause maximum 20.2% electric power increase with about 10.3% system efficiency increase.
- The shape, dimension and position of filling would intensively affect performance.
- It supplied a kind of impedance adjustment method to thermo-acoustic electric generator without resonator.

Results

There were obvious difference between installing or no installing adjustment setup. It showed maximum 20.2% electric power increasing when appropriate ellipsoid was installed with about 10.3% system efficiency improvement. Increase of length of major axial could improve the performance.

Effect of filling position

- When the filling was placed near second cold end, more acoustic power would transmit into the linear alternator branches with less loss.
- When ellipsoid was placed near inertia feedback tube, the flow would be blocked.

Effect of filling dimension

There were obvious difference between installing or no installing adjustment setup. It showed maximum 20.2% electric power increasing when appropriate ellipsoid was installed with about 10.3% system efficiency improvement.

Increase of length of major axial could improve the performance.

Effect of filling position

The position of filling could affect the flow and whole machine performance.

<table>
<thead>
<tr>
<th>Position</th>
<th>Electric power (Watt)</th>
<th>System efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60.2</td>
<td>11.8%</td>
</tr>
<tr>
<td>2</td>
<td>57.1</td>
<td>12.2%</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>9.5%</td>
</tr>
</tbody>
</table>

Experimental setup

A test bed was used to test the performance caused by the structure and dimension of filling. With the same hot end temperature, the electric power and system efficiency were measured when adjustment setups were installed.