Wide temperature range test of high capacity Stirling cryocooler

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Introduction

Background & Objective
✓ Gamma-type Stirling cryocooler driven with linear compressor is tested to investigate industrial applicability.
✓ Stirling cryocooler can cover wide temperature range from room temperature to its no-load temperature.
✓ Cooling capacity of Stirling cryocooler is controlled only by adjusting input voltage to linear compressor.

✓ Developed high capacity Stirling cryocooler was tested at 110, 120, 150, 190 K
  → 110, 120 K for re-liquefaction of LNG
  → 150, 190 K for industrial ultra-low freezing system

Specifications and experimental setup

Cooling performance

<table>
<thead>
<tr>
<th>Linear motor</th>
<th>Rated power = 9 kW (45 Hz)</th>
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</thead>
<tbody>
<tr>
<td>Piston</td>
<td>Diameter = 96 mm</td>
</tr>
<tr>
<td>Displacer</td>
<td>Diameter = 83 mm</td>
</tr>
<tr>
<td>Regenerator</td>
<td>OD(130), ID(86), sintered random fiber(STS316L)</td>
</tr>
<tr>
<td>Cold/Warm end H.X.</td>
<td>Slit type, water cooled for warm-end H.X.</td>
</tr>
<tr>
<td>Charging P. &amp; operating freq.</td>
<td>2500 kPa, 45 Hz</td>
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</table>

- Silicon diode sensor(DT670A) for temperature of cold head
- Accelerometer for displacement of piston and displacer
- Dynamic pressure sensor for compression space

Experimental Results

Cooling performance

- Dynamic behavior

Summary

✓ A high capacity Stirling cryocooler is tested at 110, 120, 150, 190 K with maximum heat load of 1.2 kW.
✓ The measured COP increases as operating temperature and its value is 0.15, 0.19, 0.29, 0.50 at 110, 120, 150, 190 K respectively.
✓ % Carnot COP is 24 ~ 30 %, and it slightly increases as operating temperature.
✓ The dynamic behavior of cooler is discussed with the measured waveform
  • Displacement of piston and displacer and pressure amplitude increase as operating temperature
  • Phase difference between piston and displacer is not much affected by operating temperature.