DISTRIBUTED AND SELF-ADAPTIVE MICROFLUIDIC CELL COOLING FOR CPV DENSE ARRAY RECEIVERS

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Introduction:
Cooling devices for dense array CPV receivers require high compactness, low average temperature and high temperature uniformity to avoid mismatch losses.
This study compares the impact of a conventional microchannel cooling device with the matrix of microfluidic cells with individually variable coolant flow rate when applied to a CPV receiver formed by a matrix of PV cells (6 strings of 8 in series) with identical irradiance distribution and average temperature.

Cooling system description:

Impact of the cooling device on the CPV performance:

Typical Cell Light IV Characteristic

350 Suns, AM1.5G (37.2 W/cm²) 25°C

Typical Cell Electrical Parameters

- $J_{SC} = 4.14 \text{ A/cm}^2$
- $V_{OC} = 2.97 \text{ V}$
- $P_{MAX} = 10.68 \text{ W/cm}^2$
- Efficiency = 30.5%

CONCLUSIONS:

- The advances in Concentration PV cell technology imply the increase of the Fill Factor and, therefore, lead to higher impacts of the mismatch losses associated to the CPV receiver’s temperature non-uniformities.
- The matrix of microfluidic cells with individually variable coolant flow rate is able to provide high temperature uniformities under time dependent and non uniform heat loads.
- Global power generation of microchannels and microfluidic cells are respectively 72.6% and 79.7% with respect to the sum of the ideal isolated cells production at the same illumination and temperature conditions.
- Power generation applying the microfluidic cells cooling device is 9.7% higher than the one with conventional microchannel technology (at equal average temperature).

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