

## ABSTRAK

### ANALISIS UNJUK KERJA *PHOTOVOLTAIC THERMAL* DENGAN SIRIP TIPE *CROSS-CUT HEATSINK* SUSUNAN *STAGGERED* MENGUNAKAN METODE PENDINGINAN ALAMI

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Peningkatan kebutuhan energi listrik dan ketergantungan terhadap bahan bakar fosil mendorong pengembangan energi terbarukan, khususnya energi surya melalui sistem *photovoltaic* (PV). Namun, kenaikan temperatur permukaan akibat radiasi matahari dapat menurunkan efisiensi listrik PV. Penelitian ini menganalisis efisiensi *thermal* dan elektrik unjuk kerja sistem *Photovoltaic-Thermal* (PV/T) dengan penambahan sirip pendingin tipe *cross-cut heatsink* susunan *staggered* menggunakan pendinginan alami. Pengujian dilakukan di luar ruangan menggunakan panel monokrystalin 50 Wp dengan variasi tutupan *heatsink* 0, 33, 66, dan 99. Parameter yang dianalisis meliputi irradiansi, temperatur PV, temperatur *heatsink*, arus, dan tegangan keluaran. Hasil menunjukkan bahwa penggunaan *cross-cut heatsink* mampu menurunkan temperatur permukaan PV dan meningkatkan efisiensi sistem. Tutupan *heatsink* 99 memberikan hasil terbaik dengan efisiensi termal sebesar 53,41% dan efisiensi listrik 18,26%. Secara keseluruhan, pendinginan alami menggunakan *cross-cut heatsink* terbukti efektif dalam meningkatkan kinerja sistem *Photovoltaic-Thermal*.

**Kata kunci:** *Photovoltaic-Thermal*, *cross-cut heatsink*, pendinginan alami, efisiensi termal, efisiensi listrik.

## ***ABSTRACT***

### ***PERFORMANCE ANALYSIS OF A PHOTOVOLTAIC THERMAL SYSTEM WITH STAGGERED CROSS-CUT HEATSINK FINS USING A NATURAL COOLING METHOD***

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The increasing demand for electrical energy and the continued dependence on fossil fuels have encouraged the development of renewable energy, particularly solar energy through photovoltaic (PV) systems. However, an increase in surface temperature caused by solar radiation can reduce the electrical efficiency of PV modules. This study analyzes the performance of a Photovoltaic–Thermal (PV/T) system with the addition of staggered cross-cut heatsink fins using a natural cooling method. Experimental testing was conducted outdoors using a 50 Wp monocrystalline photovoltaic panel with heatsink coverage variations of 0, 33, 66, and 99. The analyzed parameters included solar irradiance, PV surface temperature, heatsink temperature, output current, and output voltage. The results indicate that the use of cross-cut heatsinks effectively reduces the PV surface temperature and improves system efficiency. The 99 heatsink coverage produced the best performance, achieving a thermal efficiency of 53,41% and an electrical efficiency of 18,26%. Overall, natural cooling using cross-cut heatsinks is proven to be effective in enhancing the performance of the Photovoltaic–Thermal system.

***Keywords:*** *Photovoltaic–Thermal, cross-cut heatsink, natural cooling, thermal efficiency, electrical efficiency.*