PVT Cooling System

Mechanical Engineering

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Abstract

Heat can severely reduce a photovoltaic (PV) panel's production of power by 10-25%. On a solar farm this can translate to thousands of watts being lost. The goal of this project is to design a retrofit system that uses water to reduce the temperature of a PV panel by 30°F. The designed system has been selected to satisfy the customer's needs and technically analyzed to ensure that the requirements were met. This analysis lead to the design of an aluminum heat exchange chamber installed directly behind a standard 77 in. by 39 in., 300-watt PV panel. The design uses forced convection to help cool the solar panel. A series of aluminum channels run vertically across the panel. Aluminum is used for its high heat conductivity and light weight design. Water is pumped along the channels and is used as the heat extraction medium. This product will drop the temperature of the PV panel by about 30°F and therefore increase its efficiency. The warm fluid that exits the system can be harnessed and reused for other useful applications if desired.

Design

- Nine trapezoidal channels run vertically behind the PV panel
- Inlet/outlet chambers at the end of the channels allow fluid flow
- The system is secured to the PV panel using C-Clamps for easy assembly and disassembly

Project Requirements

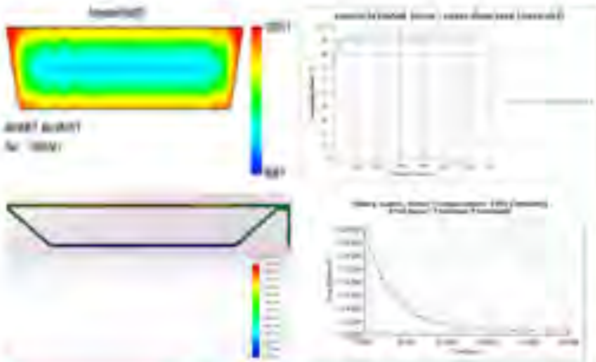
- Reduce the temperature of the PV solar panel by 30°F
- Accommodate existing industrial PV panels
- Sturdy
- Easy to assemble and disassemble

Prototype

- Channels were formed from 1mm thick aluminum sheet metal
- Foam gasket provides watertight seal
- A piping system was added to allow even distribution of water
- 500 GPH pump provides water to the channels

Technical Analysis and Simulations

- heat: Q=mcΔT   T1 = 115°F T2 = 85°F   msys = 20.3kg
  mframe = 3.5 kg mpanel = 16.8kg
- cpanel = 2918 J/kg*K   heat = 817.04kJ   Δt =20 min   heat rate = 681W
- cwater = 4179 J/kg*K   Tin = 75°F   Tout = 85°F mass flow rate = 0.03kg/s
- Δtnew = 5 min → new heat rate = 2723 W → new mass flow rate = 0.115kg/s
- density of water = 997 kg/s   volumetric flow rate = 1.1544*10⁻⁴ cubic meter / s
- dividing by volume system = 43,246 cubic centimeters   Δt to fill = 6 minutes 15 seconds
- A inlet = 0.000504031 square meter   inlet velocity = (mass flow rate)/(density*A inlet)
- inlet velocity of 0.229 m/s



Sponsors/Conclusion

- The system was tested and performed as it was supposed to
- Future improvements
  - Custom made clamps
  - Use gel type sealant
- Product can be mass produced using a single pressing process
- Expected cost is less than $200

Special thanks to Ajith Weerasinghe, Ph.D

2016