THESIS INFORMATION

Title:	**Research on Water Cooling of PV Cells to Improve the Efficiency of Power Supply and Heat Supply (PV/T)**
Major:	**Thermal Engineering**
Major code:	**62520115**
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Abstract:

The thesis researches two solar cell water cooling systems to improve the efficiency of power and heat supply: (1) An active water heating system using water PV/T module (PVTAHW) and (2) A water heating heat pump system using water PV/T module (PVTWHP). Through the overview analysis in Chapter 1, the study proposes 6 models of PV/T modules and proceeded to build a theoretical basis in Chapter 2. From there, 5 numerical simulation programs were built for PV modules, PV/T module and 2 systems in Chapter 3. In Chapter 4, the numerical simulation programs are verified by many experiments in Ho Chi Minh City and by the results of previous studies that show high reliability. On the foundations built in the previous 4 chapters, Chapter 5 performs evaluation and analysis to select the appropriate PV/T module model for each system. The results show that model MD5 is most suitable for the PVTAHW system and model MD6 is most suitable for the PVTWHP system. From there, assessments and analyzes on both systems are performed to determine operating parameters. At the same time, the thesis evaluates the performance for each system under year-round weather conditions in Ho Chi Minh City based on the energy efficiency, exergy efficiency and heat and electricity output of the system. The results show that: (i) The PVTAHW system's average annual energy and exergy efficiency is 76.18%, 20.83% respectively. The PVTAHW system has heat and electricity output of 1845 kWh/year and 551 kWh/year respectively. The total output

generated by the PVTAHW system is 2396 kWh/year, 4.36 times higher than the electricity output generated by the PV module (549 kWh/year). (ii) The PVTWHP system has an average annual energy and exergy efficiency of 102.1% and 0.75% respectively. The PVTWHP system has heat and electricity output of 3256 (kWh/year) and -144 (kWh/year) respectively. The total system output is 3112 kW/year. The PVTWHP system has proven its energy efficiency when compared to systems operating independently in heat and power supply, specifically: To generate the same heat output in 1 year, the PVTWHP system only providing electricity to the compressor about 738 kWh/year, 7.2% lower than an air-water heat pump (AWHP) of 795 kWh/year. At the same time, the PVTWHP system generates 595 kWh/year of electricity, 7.6% higher than a PV module of 549 kWh/year. Finally, the conclusions, new contributions of the thesis and recommendations for further research directions are presented in Chapter 6.

Contributions of the thesis:

1. The thesis presents two models of water PV/T modules, MD5 and MD6, with 2CT tube arrangement and using a type B heat exchanger that has never been published by previous studies.

2. The thesis has built 5 complete and reliable numerical simulation programs to simulate predictions for a PV module, 6 PV/T module models use type A or type B heat exchangers, a PVTAHW system and a PVTWHP system using Inverter or Non-Inverter compressors. From there, the thesis has evaluated the influence of operating parameters on: (i) the efficiency of water PV/T module models; (ii) energy efficiency, exergy efficiency and heat and electricity output of two systems: (1) PVTAHW system and (2) PVTWHP system using Inverter compressor. Through the results achieved, the thesis recommends using a suitable PV/T module model for each system and appropriate operating parameters so that the system operates effectively in year-round weather conditions. Specifically. (i) The PVTAHW system using MD5 is best, the appropriate water flow and water volume is 0.02 kg/s and 220 liters for the system to operate all year with hot water temperature reaching

about 50^{o}C; (ii) PVTWHP system with Inverter compressor using MD6 is best, suitable water flow and volume is 0.02 kg/s and 250 liters for the system to operate all year with hot water temperature reaching about 60^{o}C .

3. Develop a program to automatically generate data on solar radiation intensity by day and hour from the average monthly solar radiation intensity to create data on solar radiation intensity by hour and day of the year in Ho Chi Minh city and Da Nang city.

4. The thesis proposes a new evaluation method for the PVTAHW system and PVTWHP system based on energy efficiency, exergy and heat and electricity output in year-round weather conditions. This method is useful and should be implemented for similar systems.

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