Effect of different water flow gap distance in thermal performance of solar photovoltaic panel

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Abstract— **In the current work, the CAD model of solar panel (photovoltaic) has been developed by using design modeller. The model has been simulated using ANSYS software on fluent solver in workbench in order to observe various parameters affecting the thermal performance of solar panel (photovoltaic). Five types of configurations of solar panel (photovoltaic) with water flow gap i.e. flow gap of 10mm, 20mm, 30mm, 40mm and 50mm have been used. The simulation of the optimized model gives lower value of temperature distribution with respect to different mass flow rate at constant solar radiation. It is also observed from present analysis that solar panel (photovoltaic) with 10mm and 20mm of water flow gap exhibits lower temperature with thermal energy gain with enhancement of 65 to 70 percent of total efficiency, the regression analysis is also performed for developed optimized models for determination of optimum developed optimized model and it was observed that 10mm of water flow gap have effective results as compared to other configurations.**

Keywords— Solar panel (photovoltaic), Temperature Distribution, Thermal energy gain, Total Efficiency, Regression analysis.

I. INTRODUCTION

Solar energy, radiation from the solar able to producing heat, inflicting chemical reactions, or generating power. The total quantity of sun electricity incident on the earth is vastly in extra of the world's present day and anticipated strength necessities. If certainly harnessed, this rather diffused source has the capability to satisfy all destiny electricity wishes. Inside the twenty first century solar energy is expected to turn out to be increasingly appealing as a renewable power source because of its inexhaustible deliver and its non-polluting individual, in stark evaluation to the finite fossil fuels coal, petroleum, and herbal gasoline.

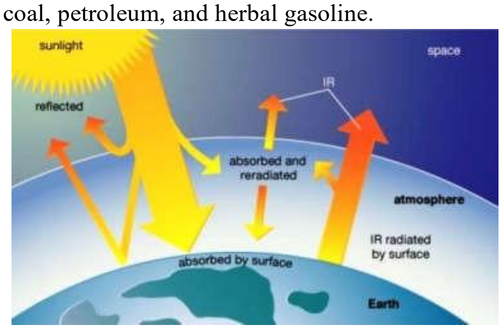

Figure 1.1 – Solar energy

The solar is a very powerful energy source, and sunlight is by far the biggest supply of energy received via earth, however its intensity at earth's surface is actually quite low. This is essentially because of the tremendous radial spreading of radiation from the remote sun. A highly minor extra loss is because of Earth's atmosphere and clouds, which absorb or scatter as tons as 54 percent of the incoming daylight. The sunlight that reaches the surface consists of nearly 50 percent visible light, 45 percentage infrared radiation, and smaller quantities of ultraviolet and different varieties of electromagnetic radiation.

II. OBJECTIVE OF THE WORK

- The main objective of the proposed research work is to validate the ANSYS analysis of simulations result of different configurations of solar panel models by comparing the results of base paper reported in the literature.
- To develop the different configurations of solar panel with different water flow gap and to simulate them with solar radiation effect.
- To analysis of the performance parameters of temperature distribution, thermal energy gain and total energy on different configurations of solar panel (photovoltaic) models.
- To predict the temperature distribution on optimized solar panel models along the influences of mass flow rate.

III. RESEARCH FORMULATION

- Create the geometry.
- Meshing of the domain.
- Set the material properties and boundary conditions.
- Fluent solver.
- Obtaining the solution.
- Results.

IV. RESULTS

Validation of the Existing Simulation results with Base paper data

The validation of the previous research work is done by carrying out the simulations work on the solar panel with different flow gap is done by ANSYS software on fluent domain 15.0 Workbench. Before starting the research work, the models proposed is validated by base paper work that has been already done. For this purpose, the work done in base paper is considered to determine the validation graphs and data evaluated using formulas provided in literature.

Table – Validation result of solar panel

Validation			
Mass flow rate (Kg/s)	Temperature (K) Validation	Thermal energy gain (W) Validation	Total Efficiency (%) Validation
0.01	428	484	43.5
0.03	426.98	476	45.69
0.05	423.98	453	47.96
0.06	421.66	442	50.66
0.08	398.96	434	52.96
0.1	366.89	429	53.88

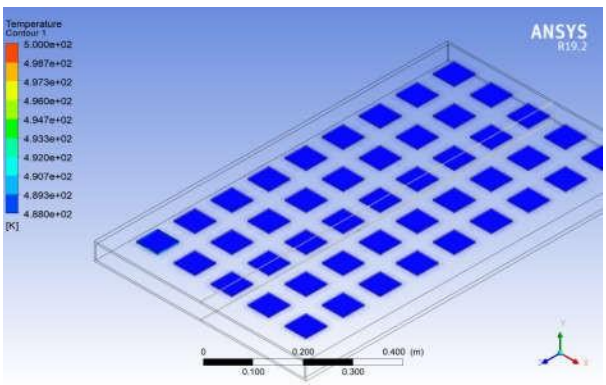

Figure - Temperature distribution of solar panel (Validation model).

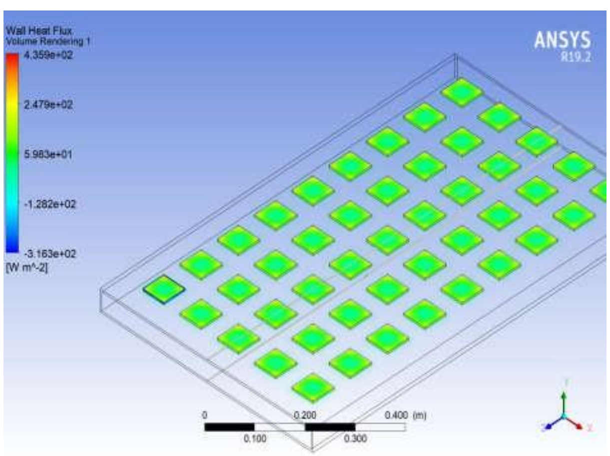

Figure - Heat flux distribution of solar panel (Validation model).

V. Optimization Results Analysis of Temperature Distribution with Thermal Energy Gain and Total Efficiency of Solar Panel with Different Flow Gap

The different flow gaps of solar panel models are simulated and optimization results of temperature distribution, thermal energy gain and total efficiency at constant radiation effects are presented in graphs below.

Table – Thermal enhancement result of solar panel with water flow gap of 50mm

Flow gap (50mm)			
Mass flow rate (Kg/s)	Temperature (K) Flow gap (50mm)	Thermal energy gain (W) Flow gap (50mm)	Total Efficiency (%) Flow gap (50mm)
0.01	427.33	482.69	44.88
0.03	424.88	474.33	47.69
0.05	420.65	451.28	49.89
0.06	412.68	440.65	51.24
0.08	395.38	431.22	54.66
0.1	384.48	426.65	56.78

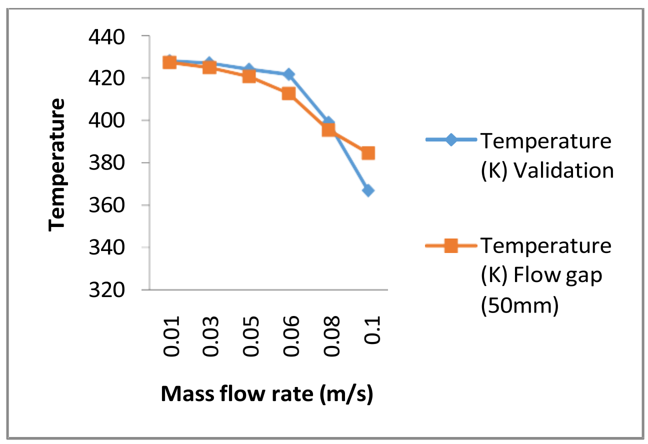

Figure - Temperature distribution of solar panel photovoltaic with water flow gap of 50mm.

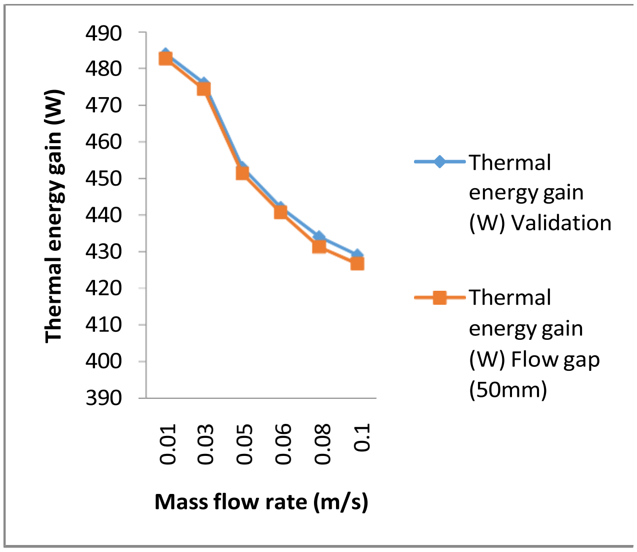

Figure - Thermal energy gain of solar panel photovoltaic with water flow gap of 50mm.

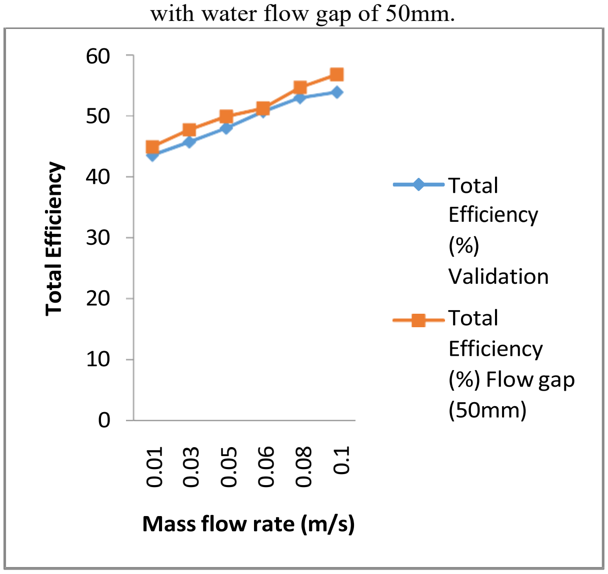

Figure - Total efficiency of solar panel photovoltaic with water flow gap of 50mm.

VI. Optimization Result of Solar Panel with Water Flow Gap of 40mm

Table – Thermal enhancement result of solar panel with water flow gap of 40mm

Flow gap (40mm)			
Mass flow rate (Kg/s)	**Temperature (K) Flow gap (40mm)**	**Thermal energy gain (W) Flow gap (40mm)**	**Total Efficiency (%) Flow gap (40mm)**
0.01	425.39	480.69	46.52
0.03	423.58	472.79	49.33
0.05	418.93	449.95	51.27
0.06	408.32	438.61	54.61
0.08	393.15	428.99	57.96
0.1	382.68	424.41	59.32

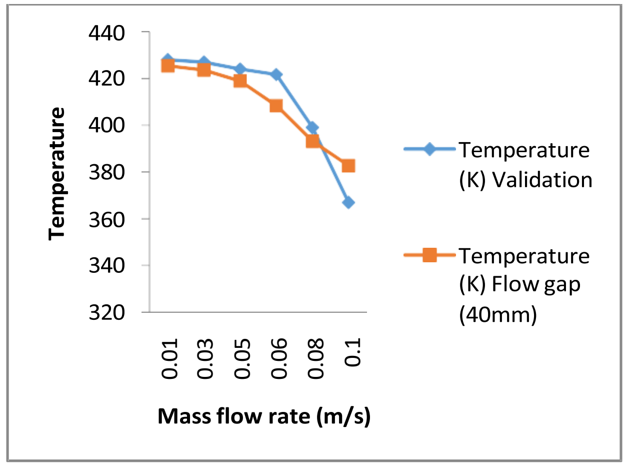

Figure - Temperature distribution of solar panel photovoltaic with water flow gap of 40mm.

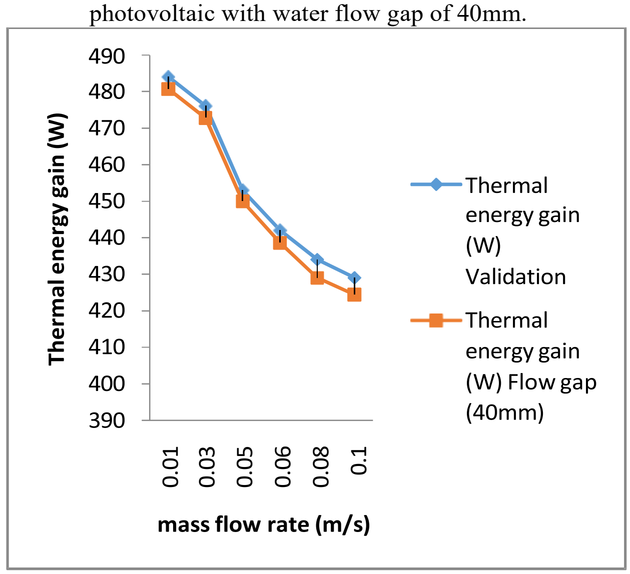

Figure - Thermal energy gain of solar panel photovoltaic with water flow gap of 40mm.

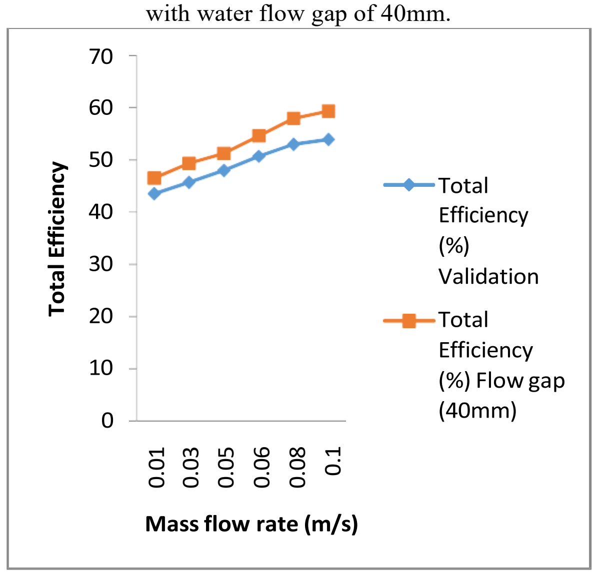

Figure - Total efficiency of solar panel photovoltaic with water flow gap of 40mm.

VII. Overall comparison of solar panel (photovoltaic) for Temperature Distribution with thermal energy gain and total efficiency of solar panel with different flow gap:

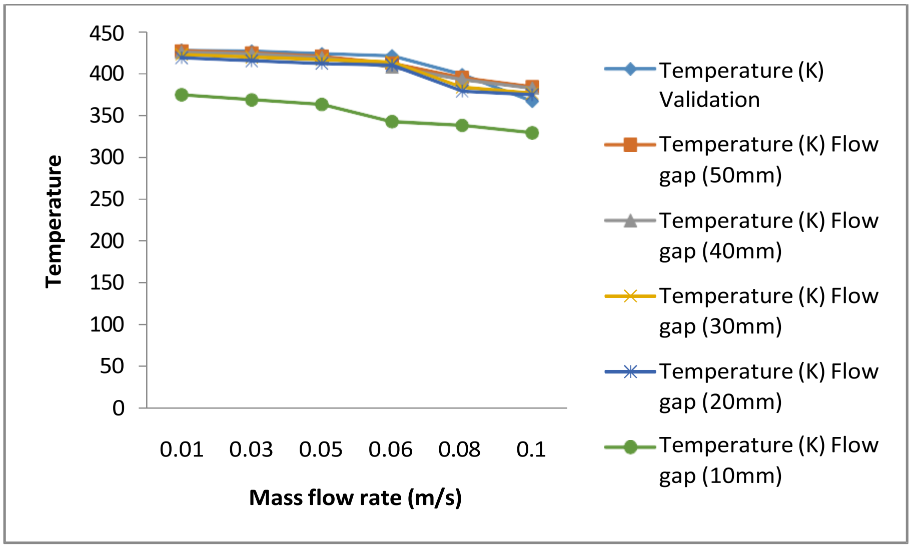

Figure - Overall comparison of temperature distribution of solar panel (photovoltaic) with different flow gap.

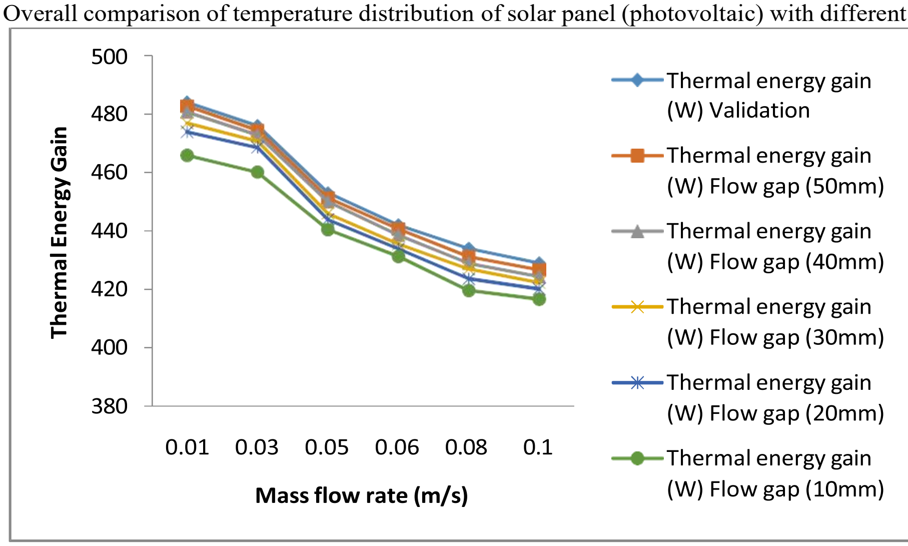

Figure - Overall comparison of thermal energy gain of solar panel (photovoltaic) with different flow gap.

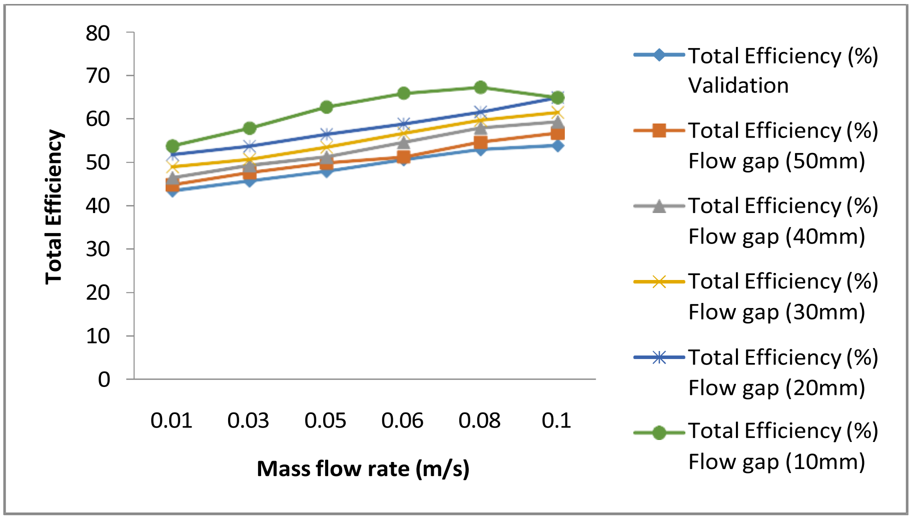

Figure - Overall comparison of thermal energy gain of solar panel (photovoltaic) with different flow gap.

CONCLUSIONS

- The different water flow gap in solar panel (photovoltaic) model was developed on design modeller (ANSYS) and analysis was done using the fluent solver.
- The temperature distribution is the fundamental parameter in the performance of solar panel (photovoltaic) different optimized profile flow gap. The flow gap is optimized to optimize the area of flow to predict the effect of temperature with mass flow rate, it was observed that as mass flow rate increased from 0.04 m/s the temperature is decreased significantly.
- In the study, water flow gap of 10mm to 20mm exhibits lower thermal energy gain from this effect it was observed that as the quantity of water is reduced with increase in mass flow rate the effect of thermal enhancement increases.
- The proposed five types of flow gap represented on result show that 10 and 20mm of water flow gap increases the total efficiency upto 65 to 70 percentage.
- The difference in temperature is observed by increasing the mass flow rate of 0.05 m/s, this decreases the thermal energy gain with decrease in temperature due to this effect the total efficiency of model is increased.
- The simulation of CFD models of solar panel (photovolataic) with different configurations of water flow gap show a good relation with base paper results presented in the literature.

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