Numerical study of novel air-based PVT designs validated using standardized testing approach.

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1. Introduction

Photovoltaic Thermal (PVT) solutions have shown potential for covering thermal and electrical demand in residential applications.

Integration of PVT to buildings contributes to clean, decentralized affordable energy production and development of sustainable cities.

Air-Based PVT technology is suitable for integration to buildings yet is not widely adopted.

Challenges

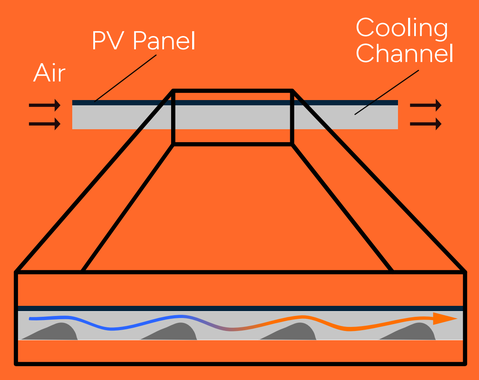
- Performance enhancement of Air-Based PVT deemed essential.
- Current literature lacks unified approach.

Strategy

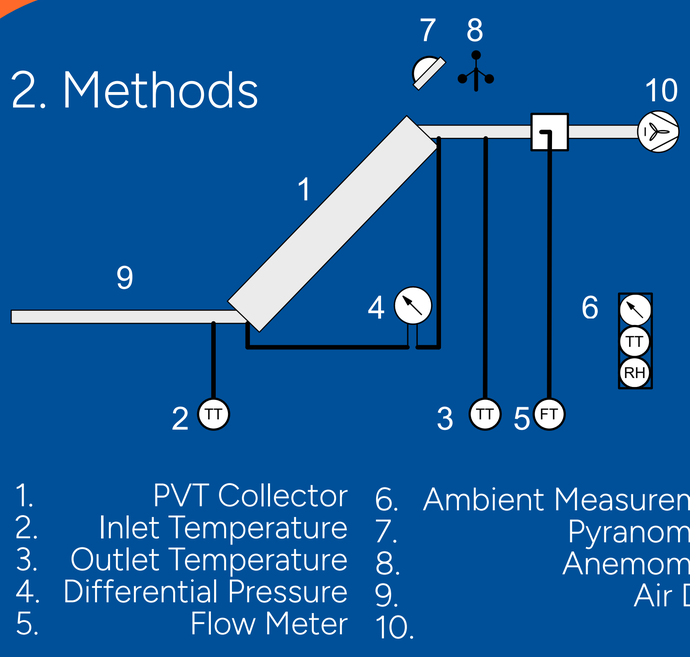
- Heat transfer enhancement designs inspired from Solar Air Heating technology.
- Investigate performance with standardized methodology.

Aim of Study

- Construct Computational Fluid Dynamics (CFD) simulation model.
- Validate by experimental test data.

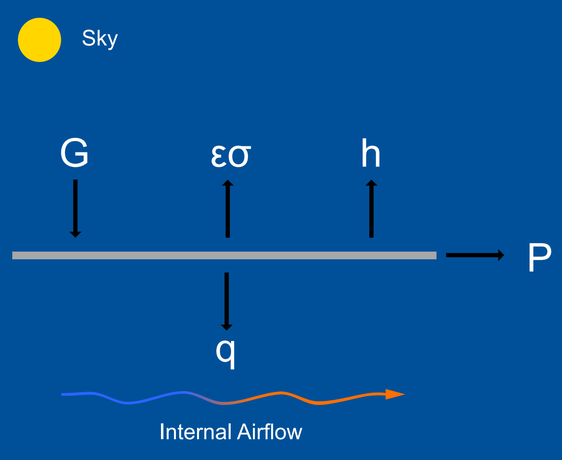


2. Methods

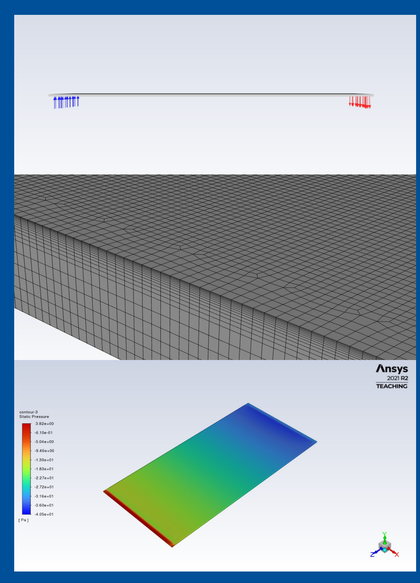


1. PVT Collector
2. Inlet Temperature
3. Outlet Temperature
4. Differential Pressure
5. Flow Meter
6. Ambient Measurement
7. Pyranometer
8. Anemometer
9. Air Duct
10. Fan

Experimental test rig according to ISO 9806 - Thermal performance of solar collectors

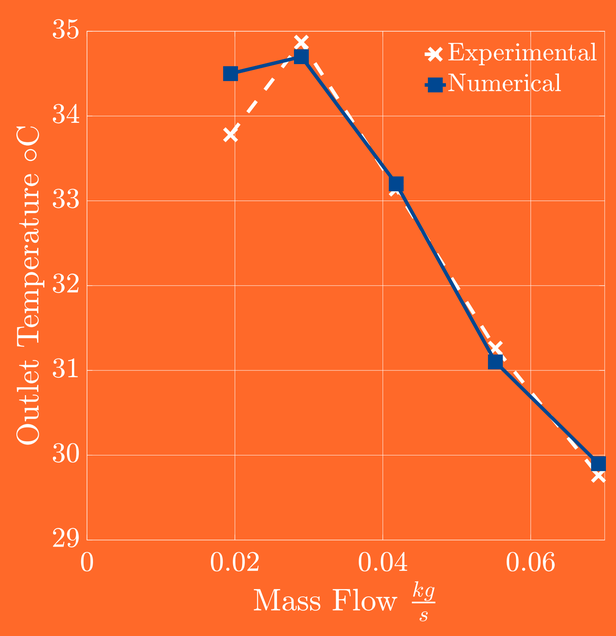


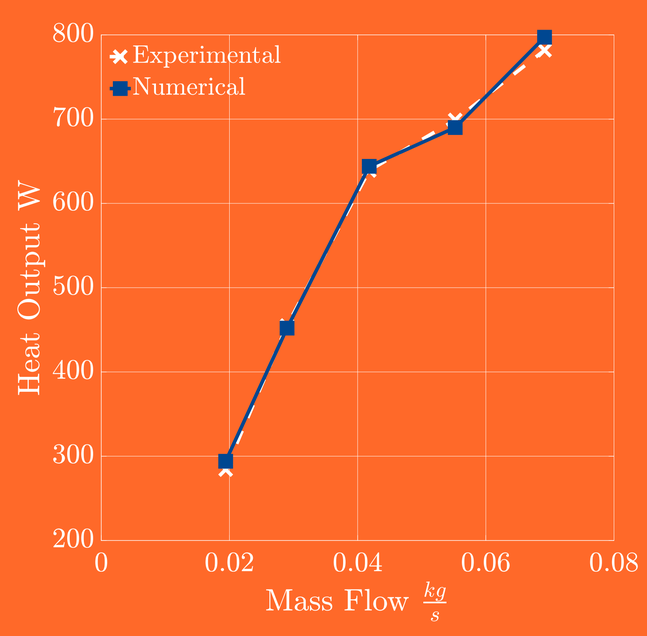
Calculation of suitable Boundary Conditions

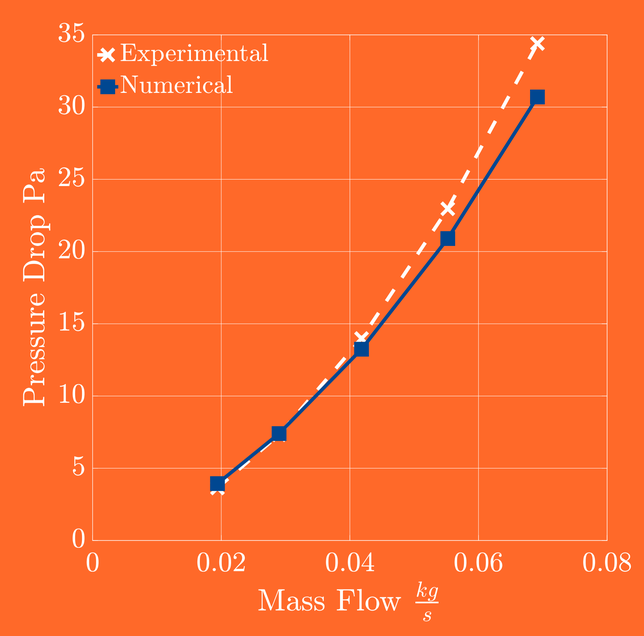


Meshing and Simulation of CFD model

3. Results







Mean Absolute Error MAE	0.25 °C	8.44 W	1.38 Pa
Normalized Root Meas Square Error NRMSE	1.07%	7.7%	17.1%

4. Conclusion

- Agreement of experimental and numerical results indicates correct validation of the model.
- CFD modelling sourced with ISO 9806 data is feasible practice.
- Investigators in possession of a ISO 9806 thermal performance report and schematics of the collector geometry, are able to successfully simulate thermal collectors or PVTs.
- As such, novel performance enhancing methods can be further explored with extensive design variations at the early design stage.

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