TRANSIENT THERMAL PERFORMANCE PREDICTION METHOD FOR PARABOLIC TROUGH SOLAR COLLECTOR UNDER FLUCTUATING SOLAR RADIATION

Tohru Suwa, Shye Yunn Heng
TAKASAGO Thermal/Environmental Systems Laboratory
Malaysia-Japan International Institute of Technology
Universiti Teknologi Malaysia, Kuala Lumpur

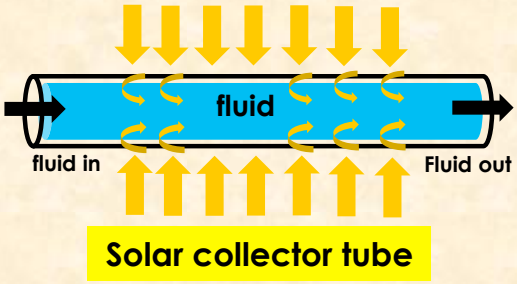
Advanced Research in Electrical and Electronic Engineering Technology
24-26 November 2015, Bandung, Indonesia

Introduction

- Decelerate global warming
- Renewable energy
- Solar thermal applications

Parabolic Trough Solar Collector

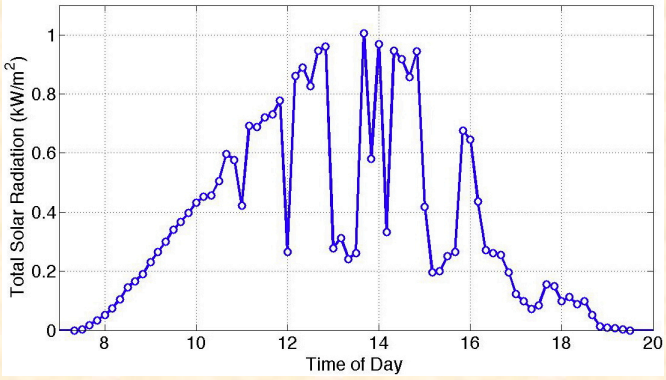
- Power generation
- Adsorption chiller



Solar collector tube

Background

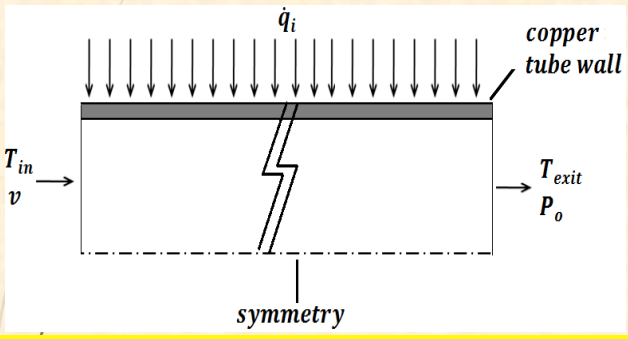
- Early design stage
  - Solar radiation intermittency
  - Transient thermal prediction
- Fast transient thermal prediction method is required
  - Solar collector exit temperature



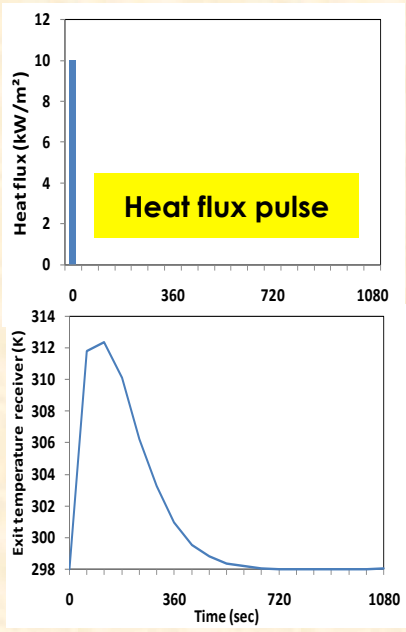
Methodology

- Transient thermal response for single heat pulse
  - Solar radiation
  - Fluid velocity
  - Tube length
- Superposition principle
  - Exit temperature for consecutive heat pulses

Single Heat Pulse

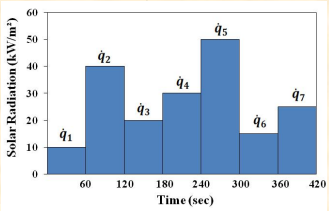


Axisymmetrical model of collector tube

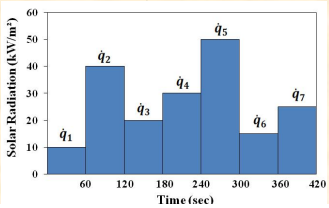


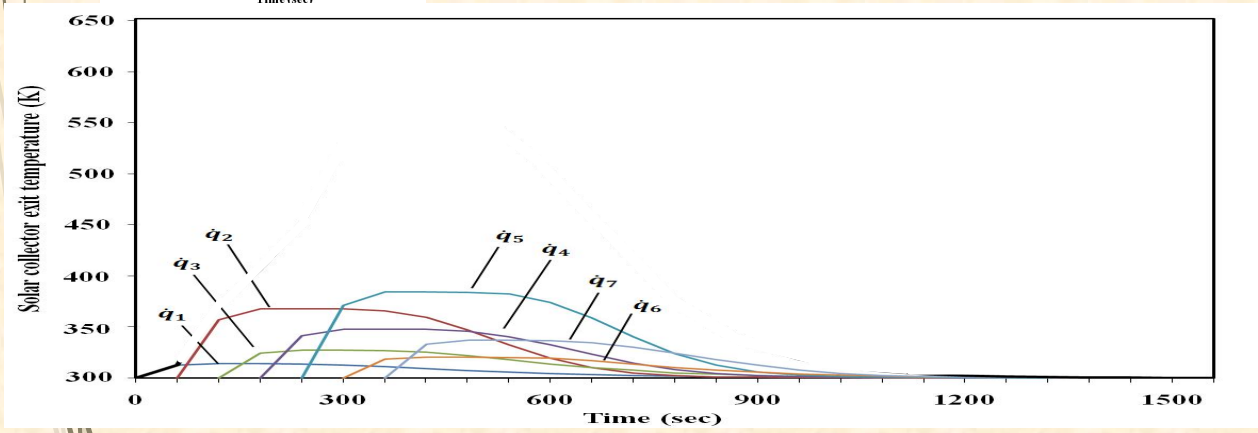
Temperature rise at collector tube exit

Superposition Principle

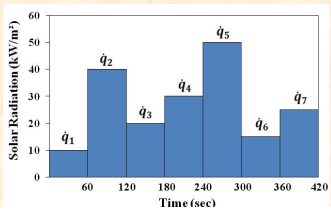


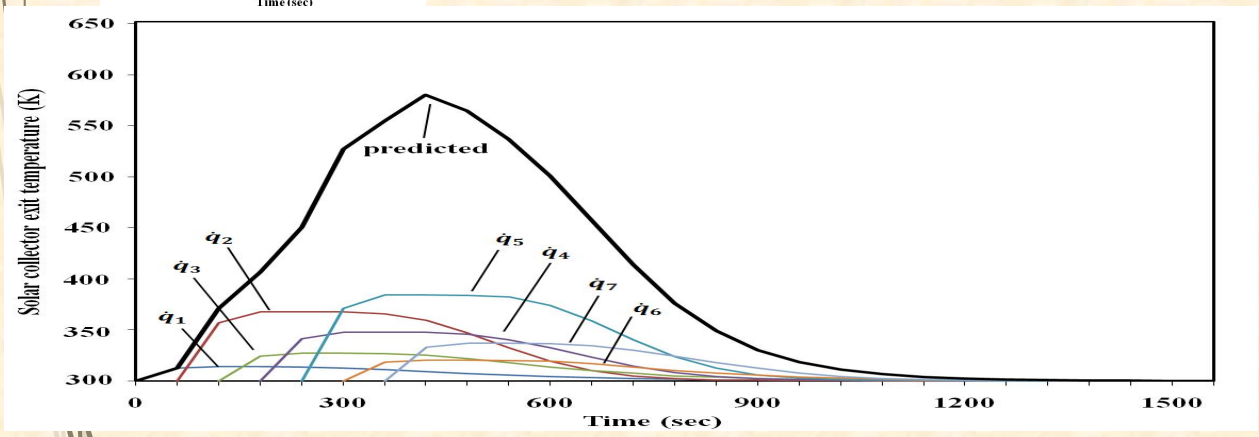
Superposition Principle



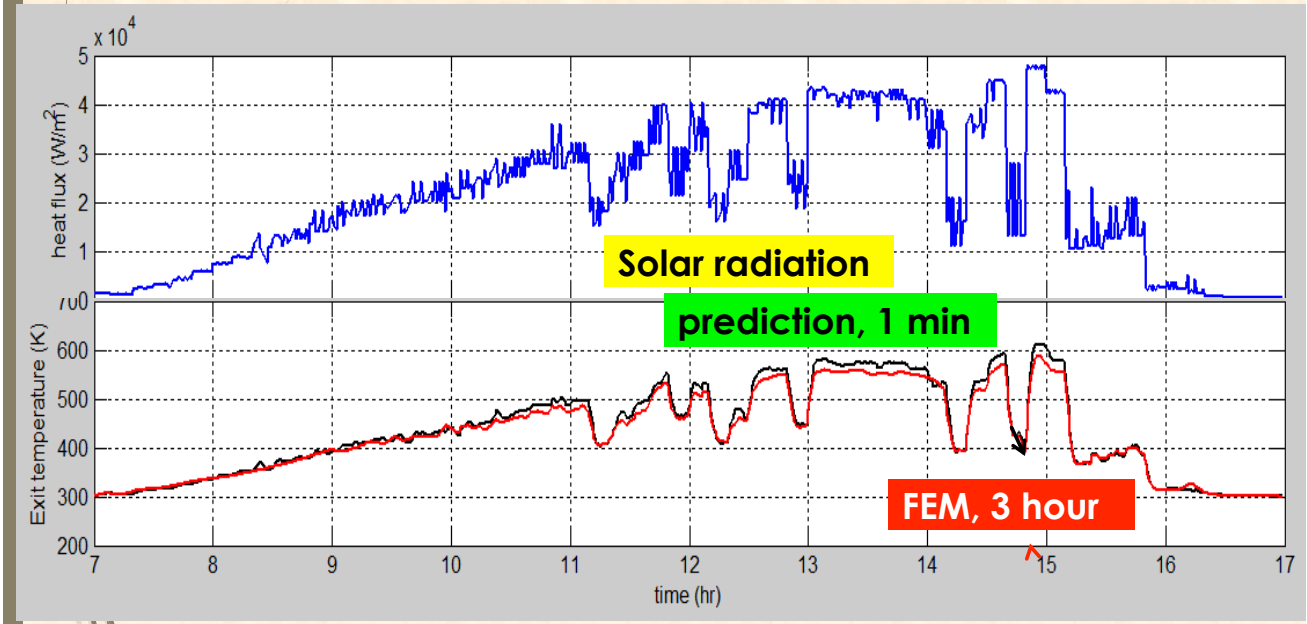


Superposition Principle





Prediction Result



Predicted collector tube exit temperature compared with FEM result

Future Work

- Improving accuracy
  - Heat capacity in tube
  - Radiation heat loss
- Expanding capabilities
  - Fluid velocity
  - Tube length

Conclusions

- Transient thermal performance prediction
- Significant CPU time reduction
- Accuracy improvement
- Capabilities expanded