

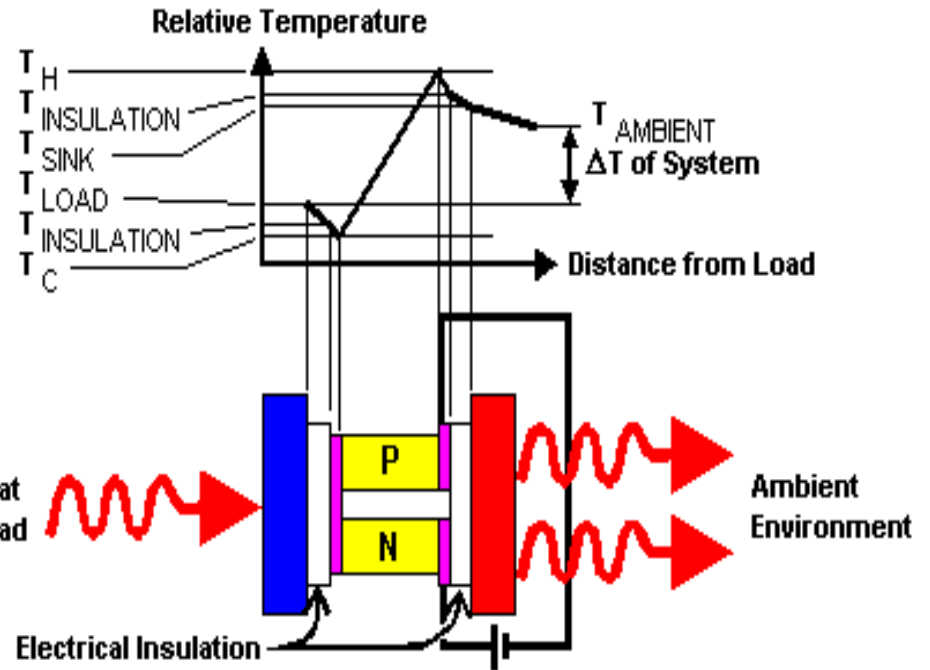
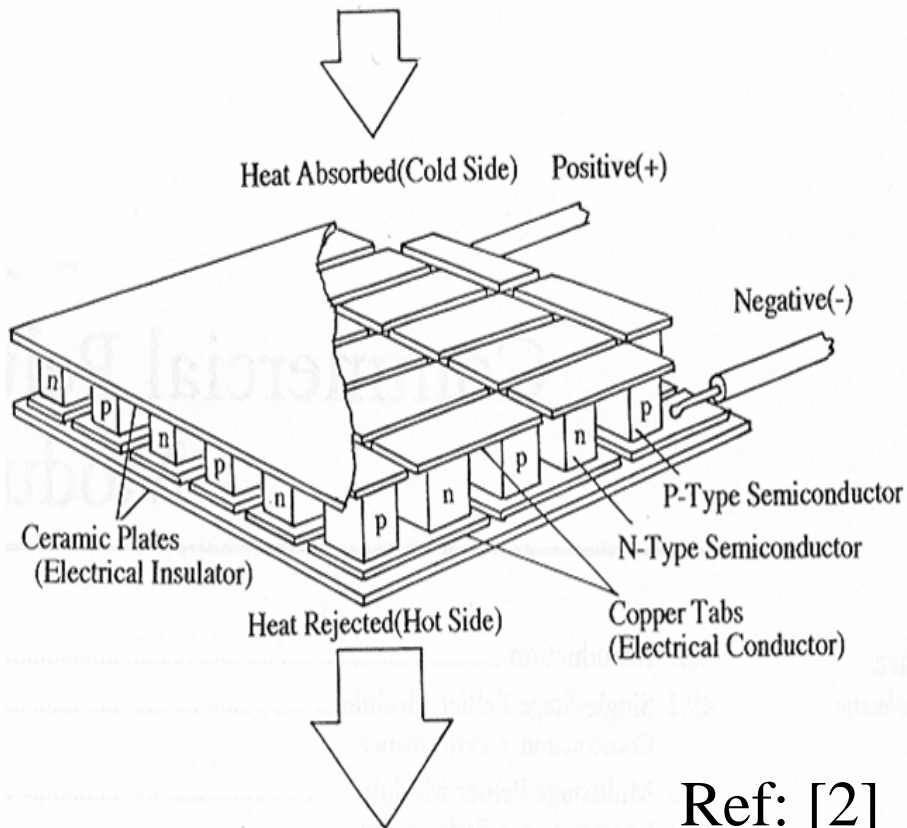


INVESTIGATION OF THERMAL PERFORMANCE OF THERMOELECTRICS

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Outline

- ▶ Background
- ▶ Fundamental issues
- ▶ Objective
- ▶ Experimental setups
- ▶ Results
- ▶ Conclusions



Ref: [2]

- ▶ Thermoelectric cooling
 - ▶ based on Peltier, Joule, and Fourier effect
 - ▶ Array of p- and n-type semiconductor element junctions are sandwiched between ceramic plates.

Fundamental problems

- ▶ Low coefficient of performance
- ▶ High thermal contact resistance
- ▶ Low effectiveness of heat exchanger

$$Q_c = 2NI\alpha T_c - \frac{I^2 NR}{G} - 2NkG \Delta T$$

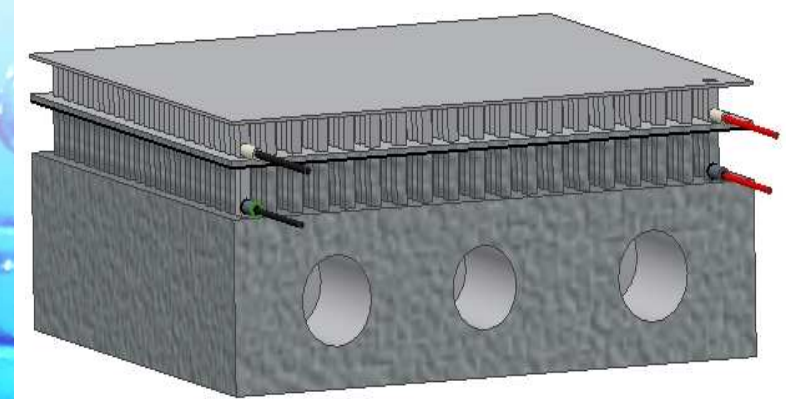
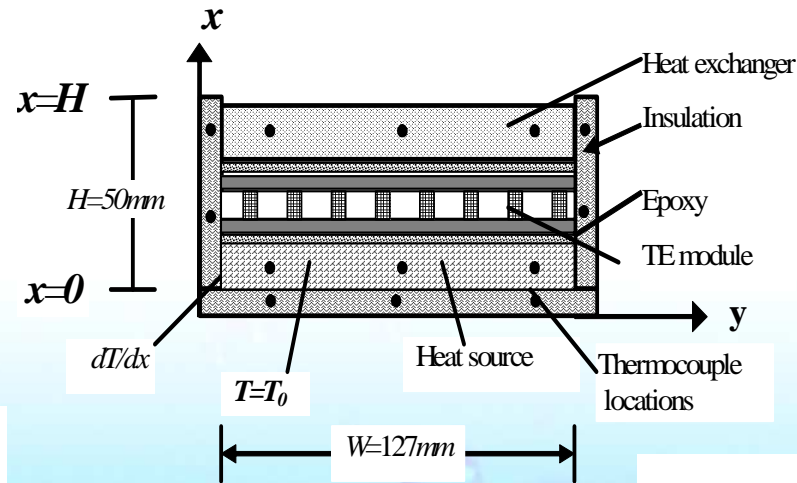
$$W = 2N\alpha\Delta TI + \frac{I^2 NR}{G} = IV$$

$$COP = \frac{q}{q_{in}} = \frac{\alpha T_{cm} - .5I^2 R - k\Delta T}{I(\alpha\Delta T + IR)}$$

Focus

- ▶ Objective
 - ▶ Perform comparative analysis of various heat exchangers and their impact on coefficient of performance
- ▶ Heat exchangers
 - ▶ finned heat sink, liquid-cooled heat exchanger, cascaded thermoelectric, and forced air-cooling

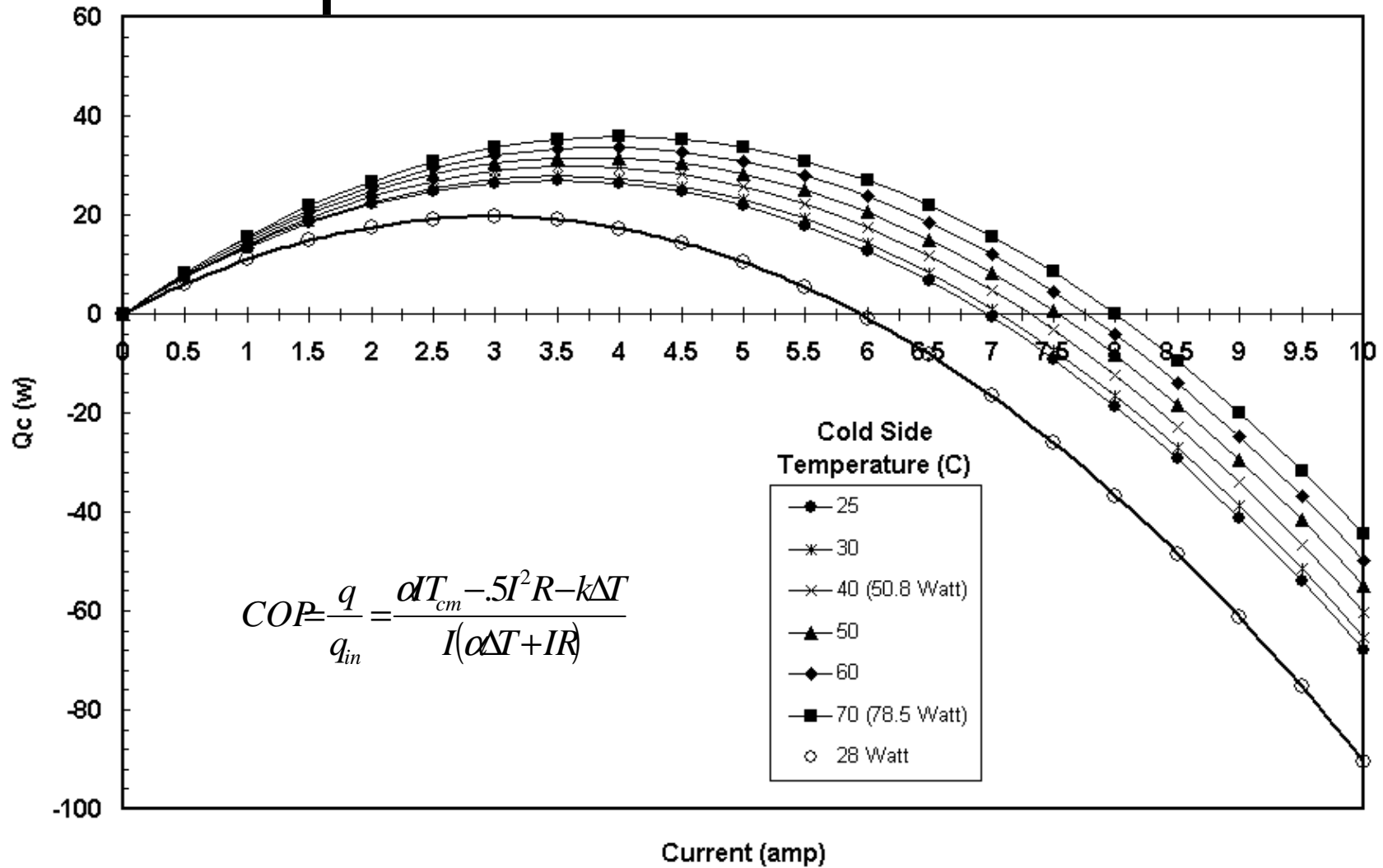
Apparatus



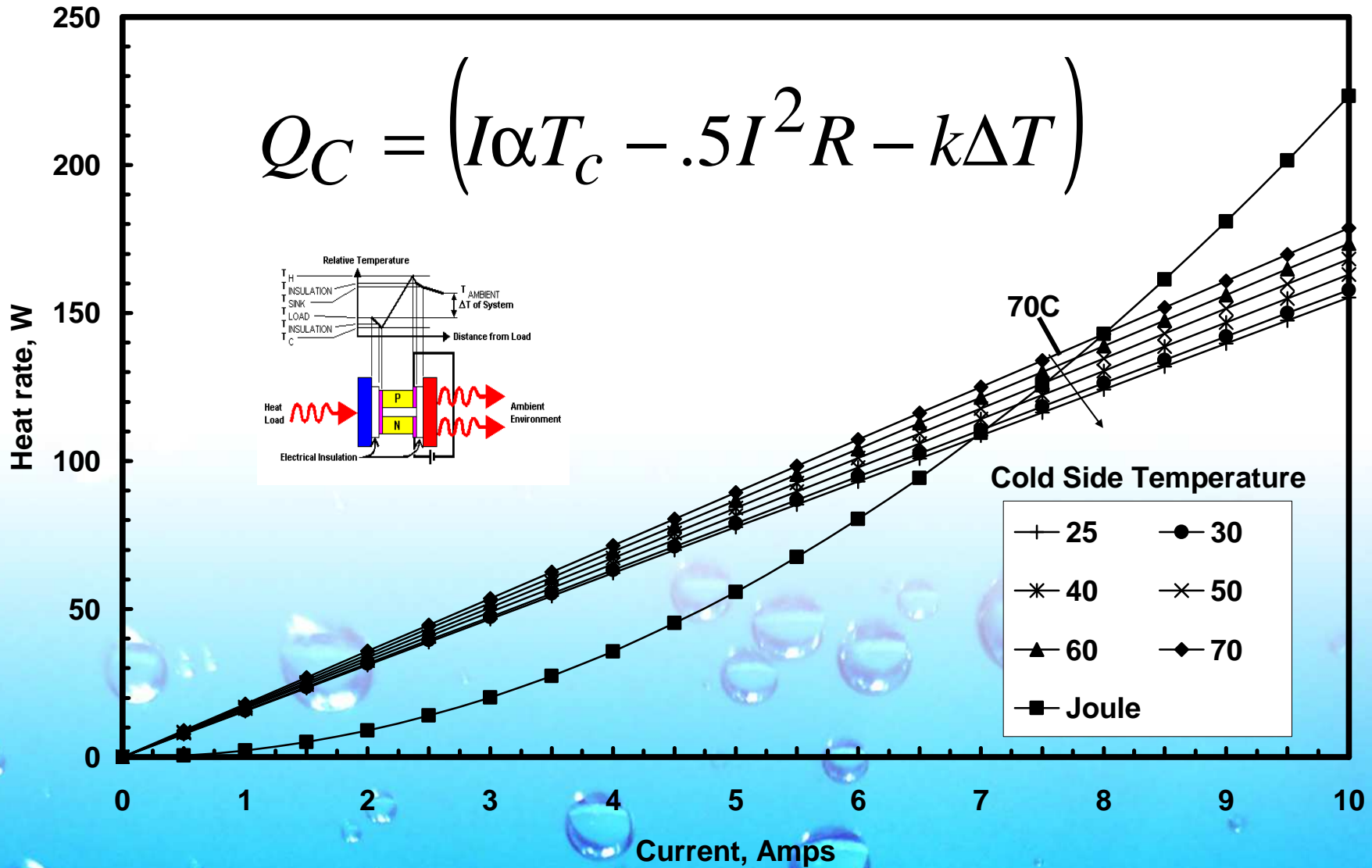
Measured Parameters

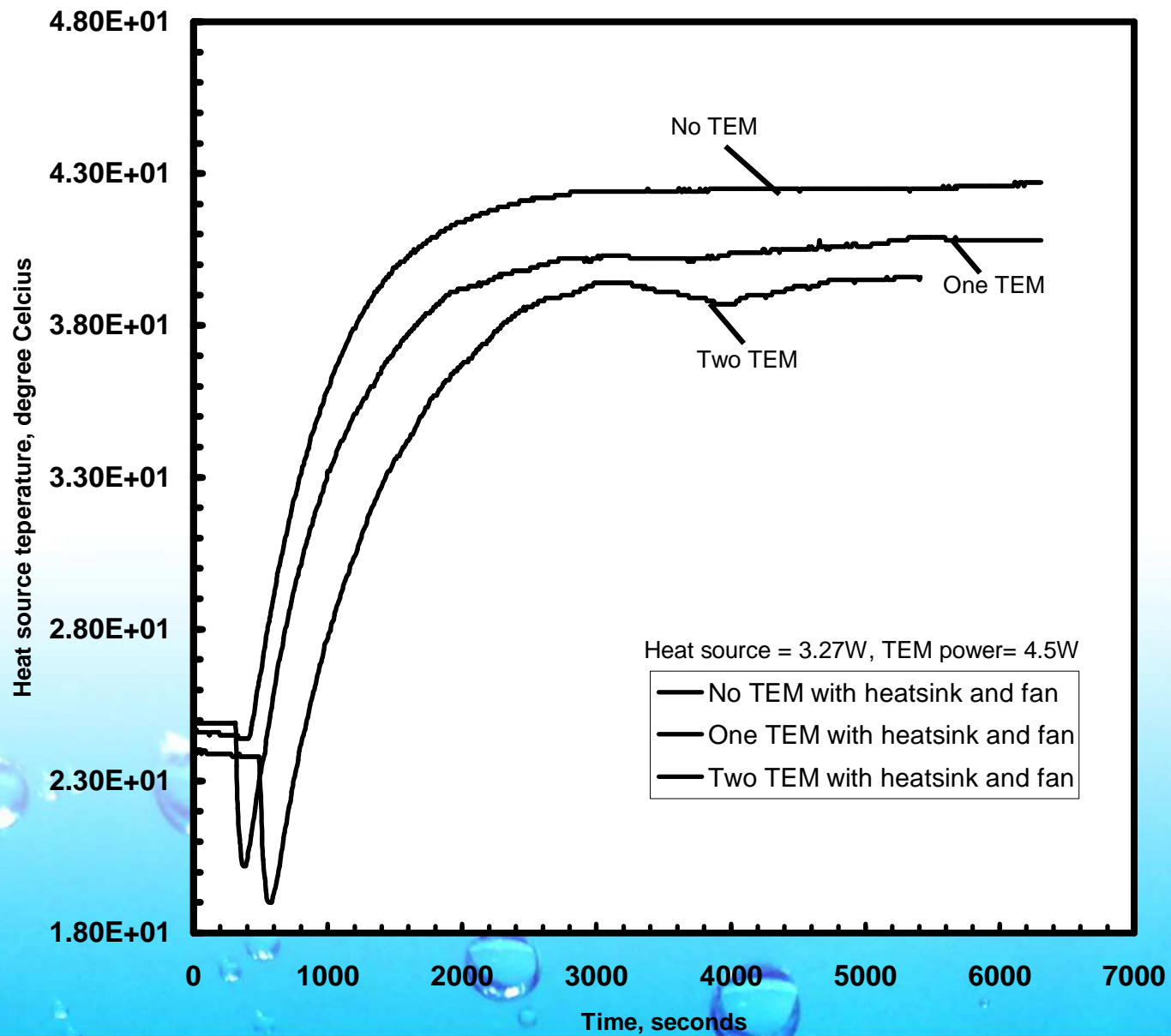
- ▶ Hot- and cold-side as well as junction temperature
- ▶ Work or power input to the TEM
- ▶ Heat transfer rate from the exchangers
- ▶ Power density of the heat source
- ▶ Fan power
- ▶ Optimum current

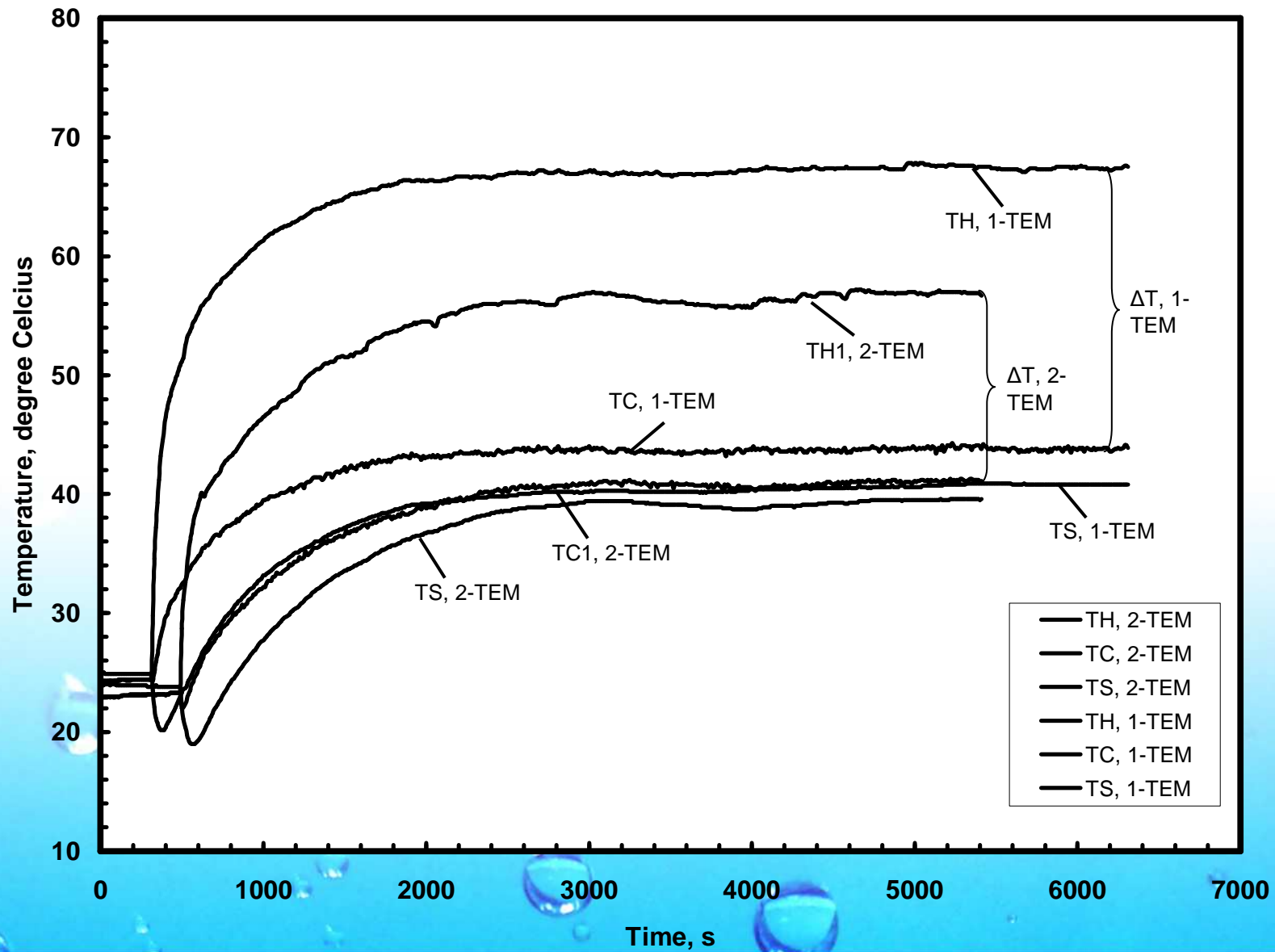
Optimum current

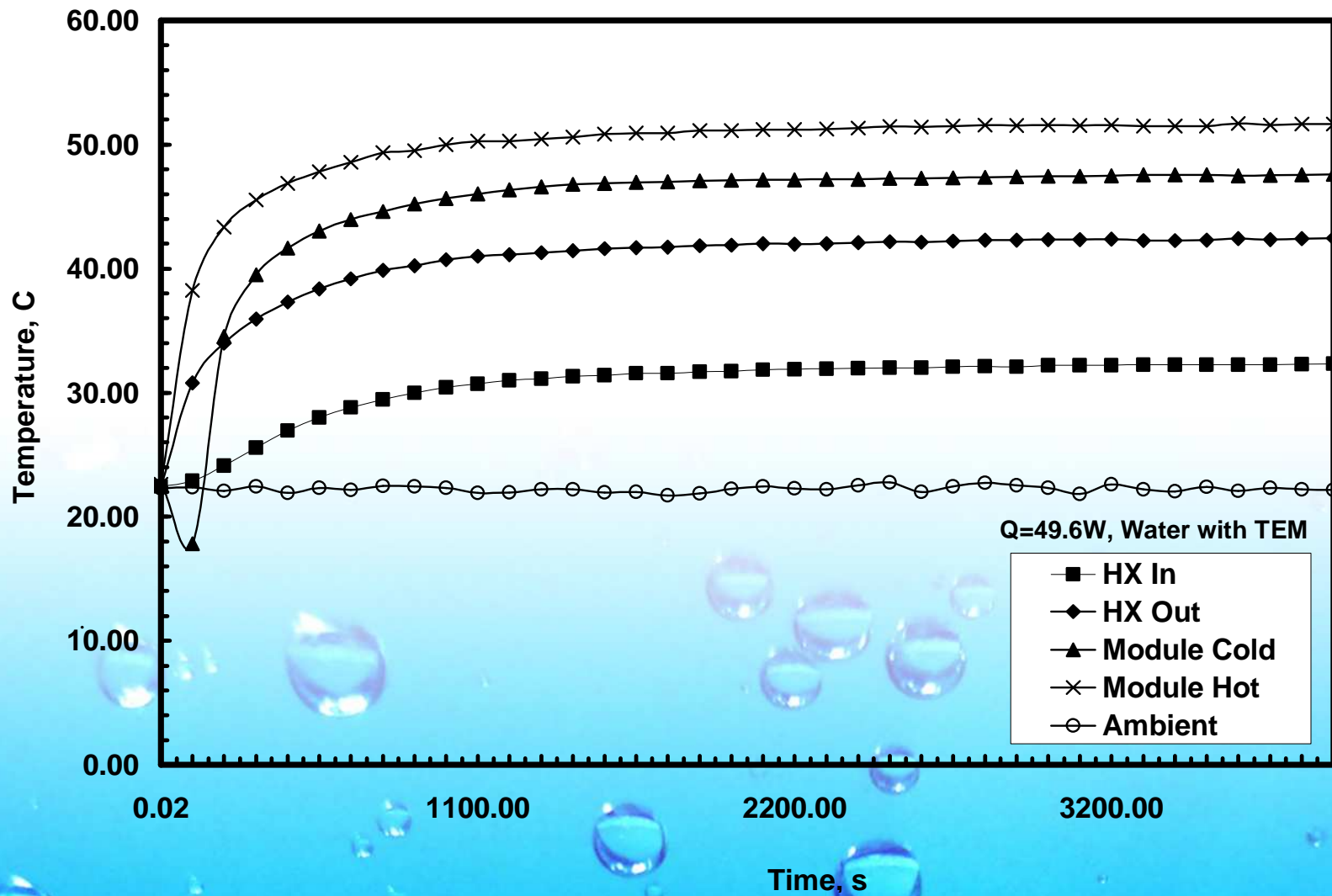


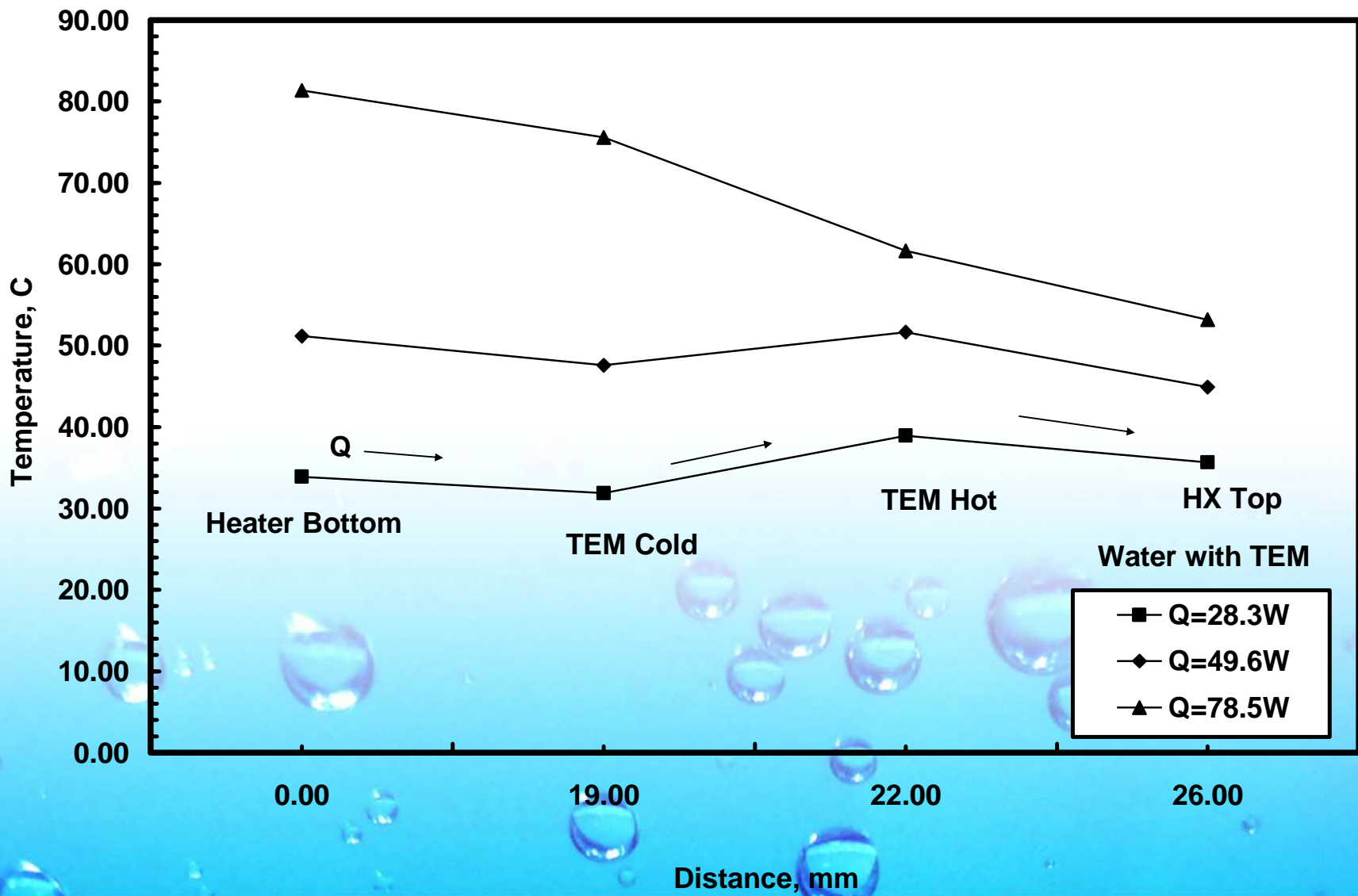
$$Q_C = \left(I\alpha T_c - .5I^2 R - k\Delta T \right)$$











Conclusions

- ▶ Experimental evidence shows that liquid cooled heat exchanger is most effectual compared to air-cooled or cascaded thermoelectric
- ▶ Cascaded thermoelectric lead to decrease in junction temperature when compared to single thermoelectric module
- ▶ Thermoelectric devices are effective for short transient heating
- ▶ Thermal contact resistance remains a major issue in thermoelectric cooling systems