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Numerical investigation on thermal effects by adding thin compartmental plates into cooling enclosures with heat-leaking walls

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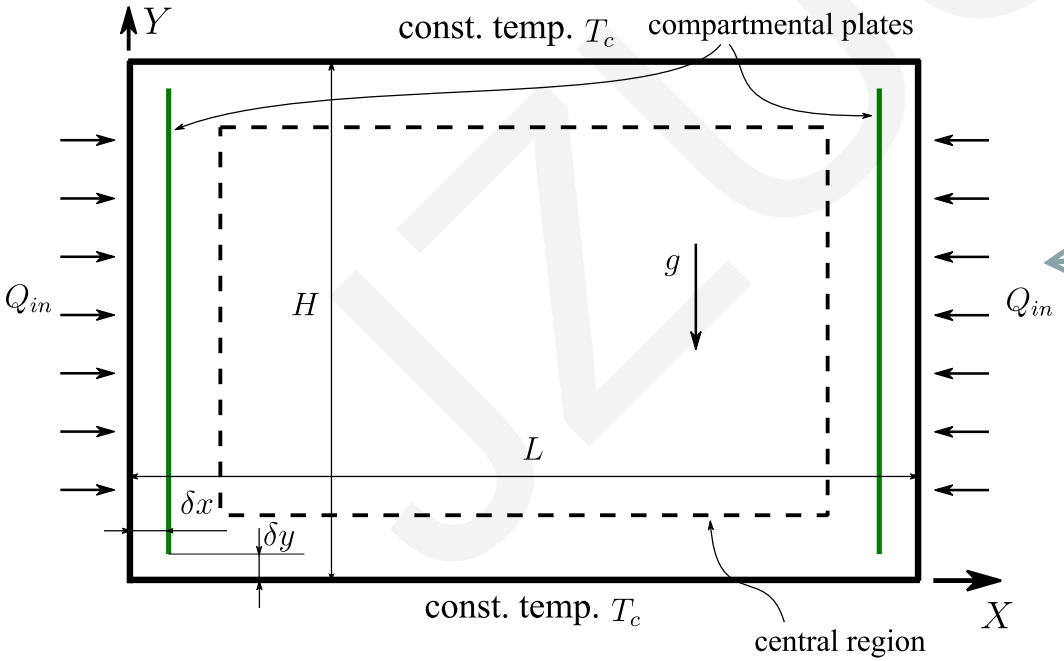
Background and Model Introduction

Heat leak

- Lower cooling rate
- Non-uniform temp.
- Waste of power

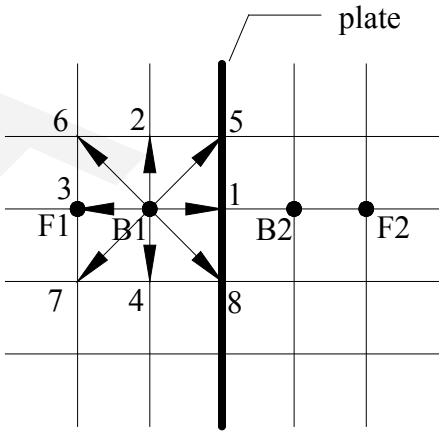
- Insulation
- Compartmental plate???

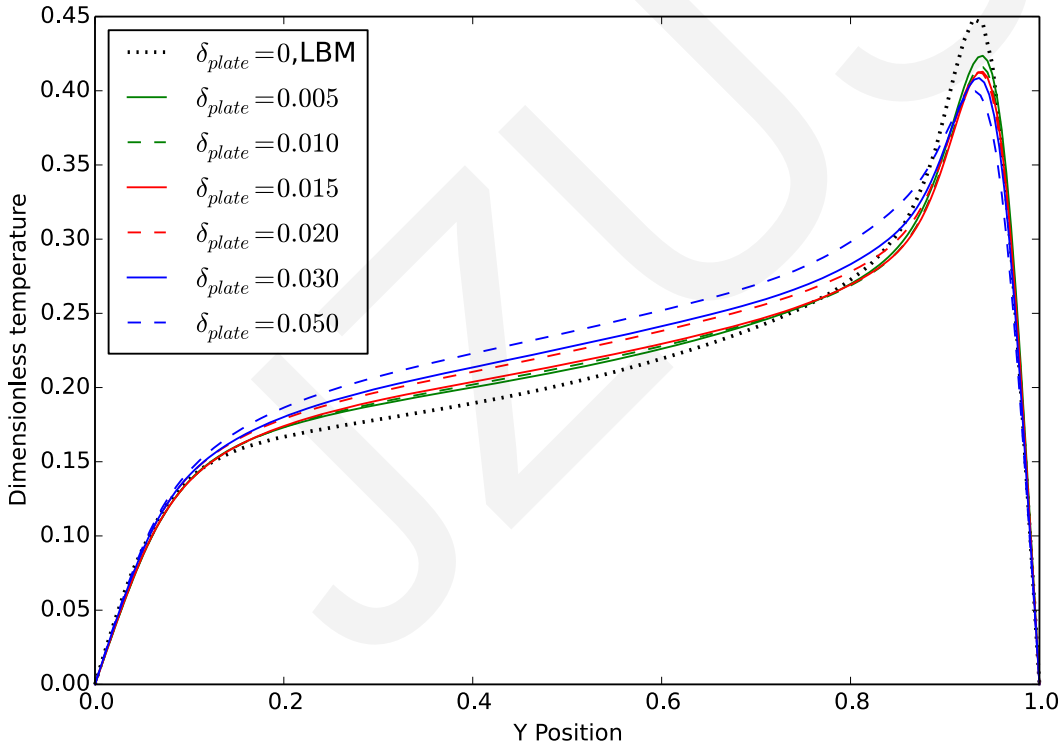
Simplified model



Thermal Boundary for Thin Plate

- Modified extrapolation scheme for the thin plate: interpolate from nearby nodes to obtain unknown temperature.
- The scheme is verified by comparing with a series of cases with different plate thicknesses.





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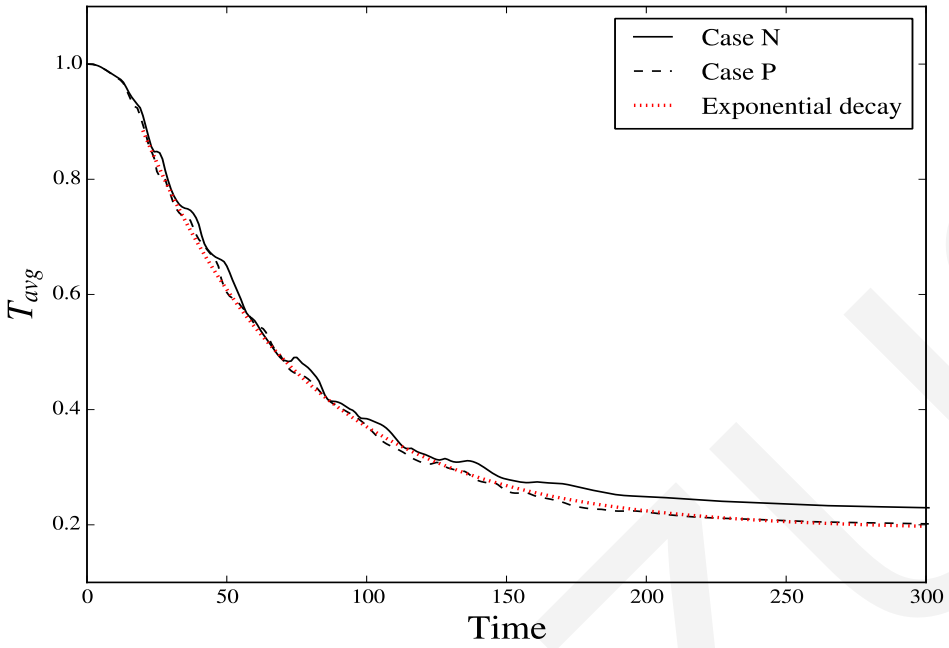
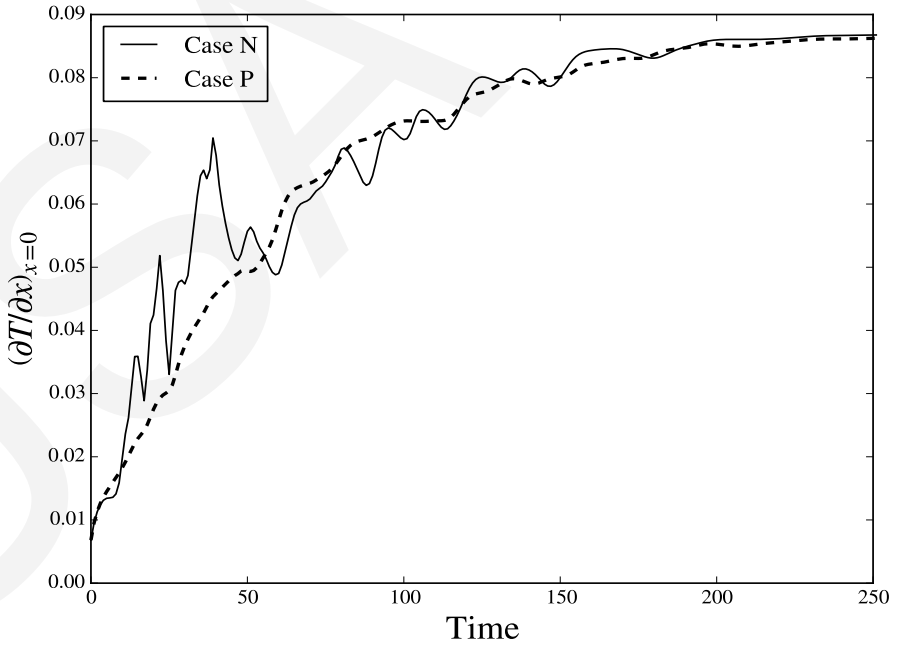
Results (I)



Faster cool down rate
(lower equilibrium temperature)



Steadier heat flux input
(almost identical heat flux)

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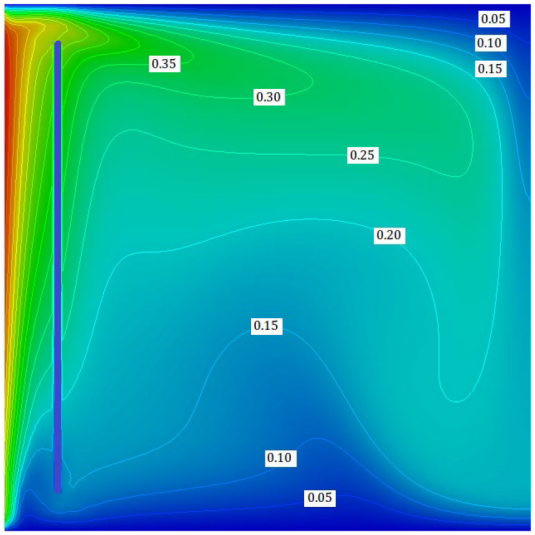
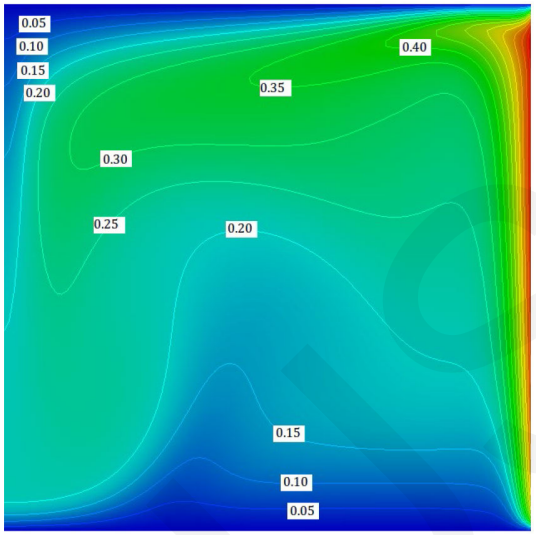
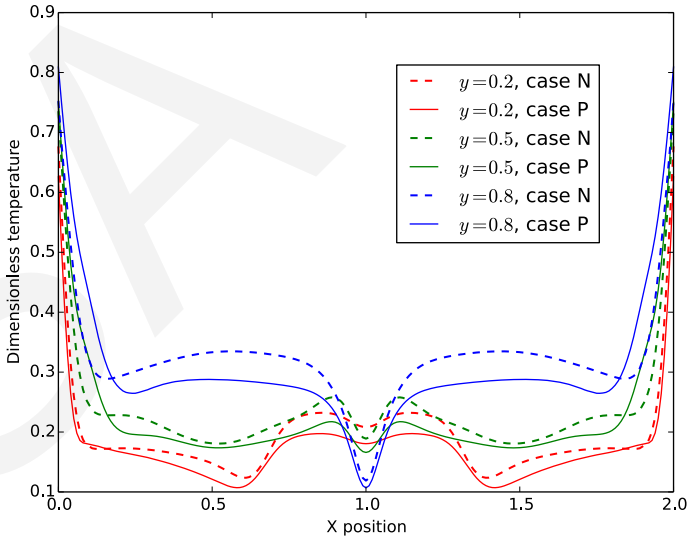
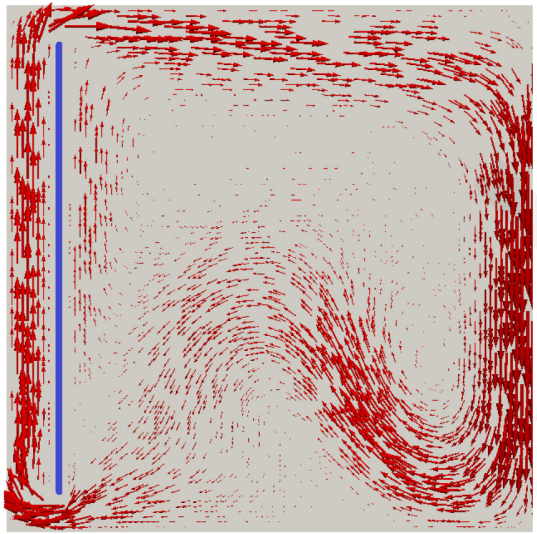
Results (II)

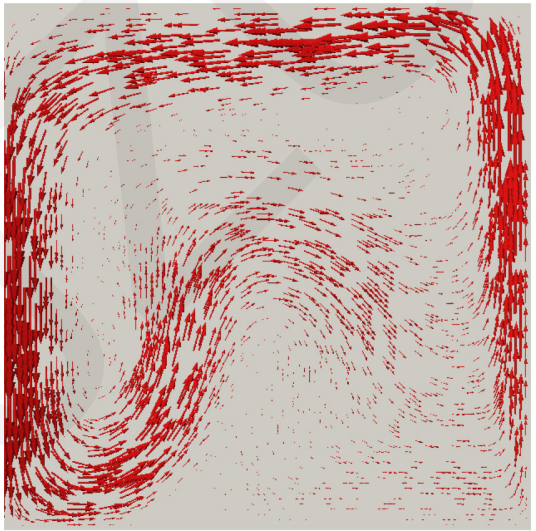






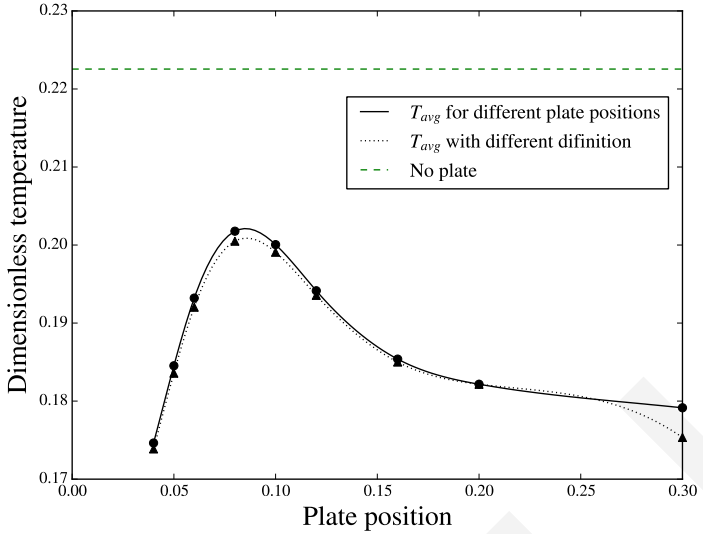
More uniform temperature





Natural convection and pre-cool effect help improve thermal performance

Results (III)



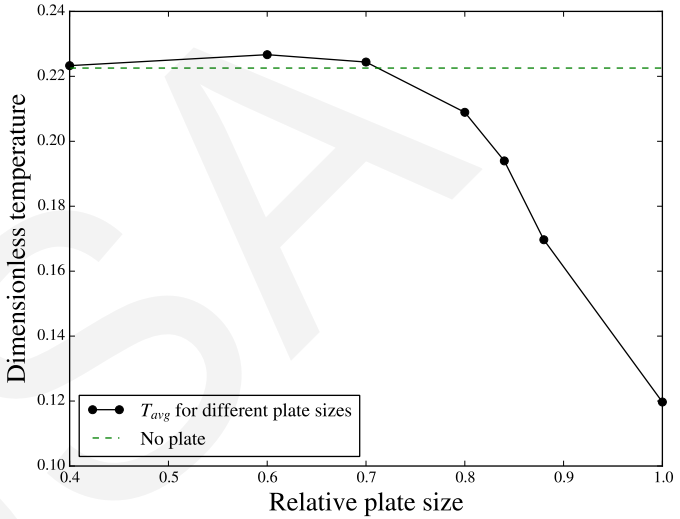
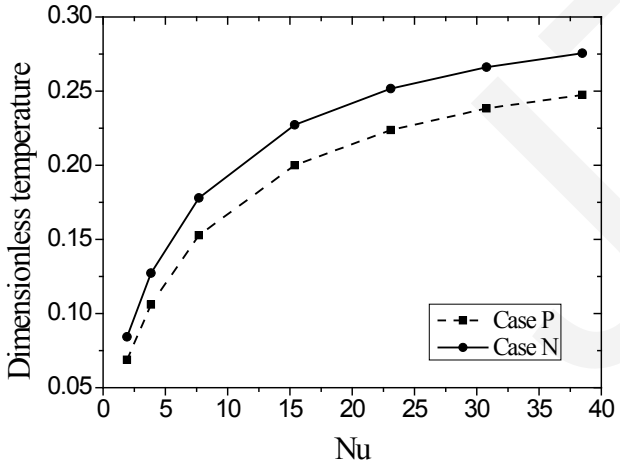


Plate should be placed as close as to the wall

Larger plate size is preferable



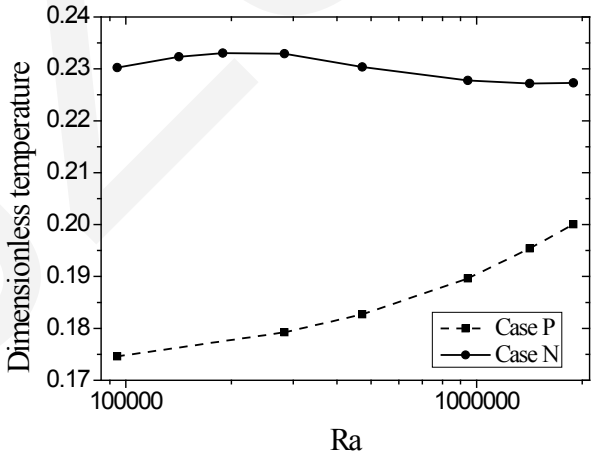


Plate effects enhanced for larger Nu and smaller Ra

Conclusions

- Adding thin compartmental plates close to the heat-leaking walls is an assistant measure to diminish the negative effects of the heat leak.
- The insertion of thin plates leads to higher average cool down rate, with 6% less time to reach the halfway point of the cool down process.
- For steady-state, it also leads to lower equilibrium temperature and better temperature uniformity.
- The plate has better effects when placed closer to the heat-leaking wall, and when it has larger size.
- The beneficial effects of adding the compartmental plate are found to be enhanced at larger Nu or smaller Ra.