Oil-Cooled Power Electronics: Heat Sink Design, Modelling and Validation

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FLANDERS MAKE — DRIVING INNOVATION IN MANUFACTURING

GHENT UNIVERSITY

Single Motion

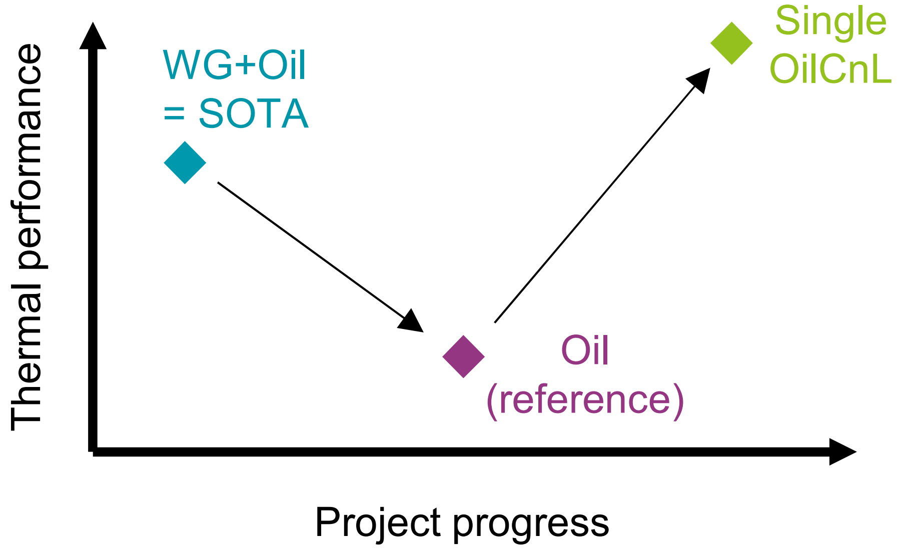
CORELAB EEDT-MP

Goal

The goal of this research is to reduce the thermal resistance of a power module heat sink by 15% compared to a benchmark pin fin design with oil cooling, at equal or lower pumping power.

Motivation

- Moving from a separate cooling (water-glycol) and lubrication (oil) circuit to a combined circuit can increase a drivetrain's power density (SingleOilCnL ICON).
- Oil has inferior heat transfer properties when compared to water-glycol mixtures, making cooling of the power electronics challenging.



Approach

Improve thermal performance through:

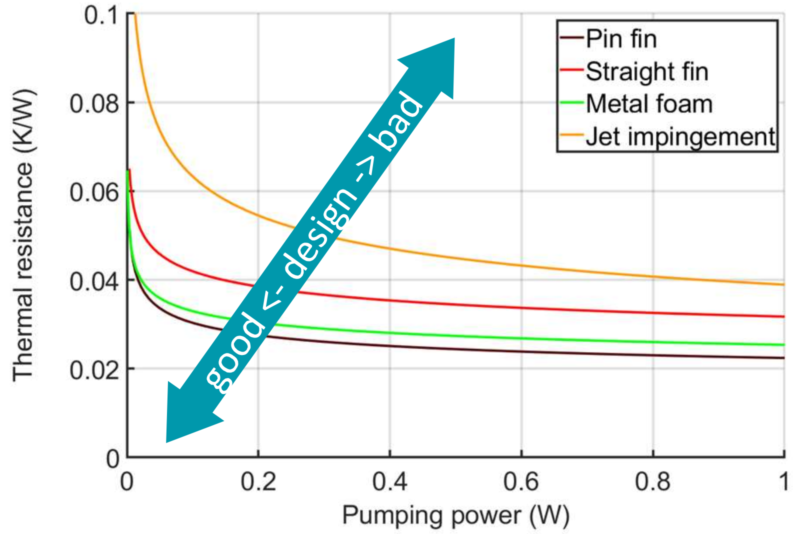
- Modelling
  - Design
    - Validation

Using an iterative approach:

- Reference heat sinks
  - Advanced heat sinks
    - Innovative heat sinks

Reference heat sinks

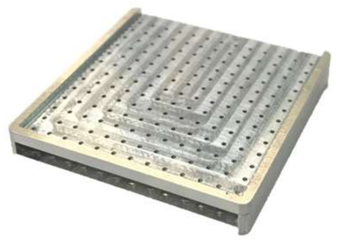
- Modelling (lumped parameter) [1]



- Designs

Pin fin

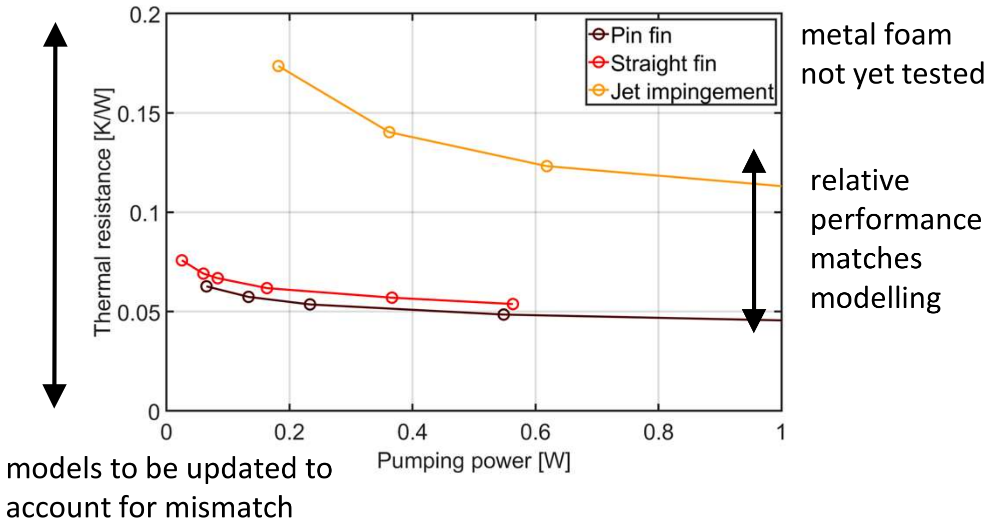
Straight fin



Jet impingement

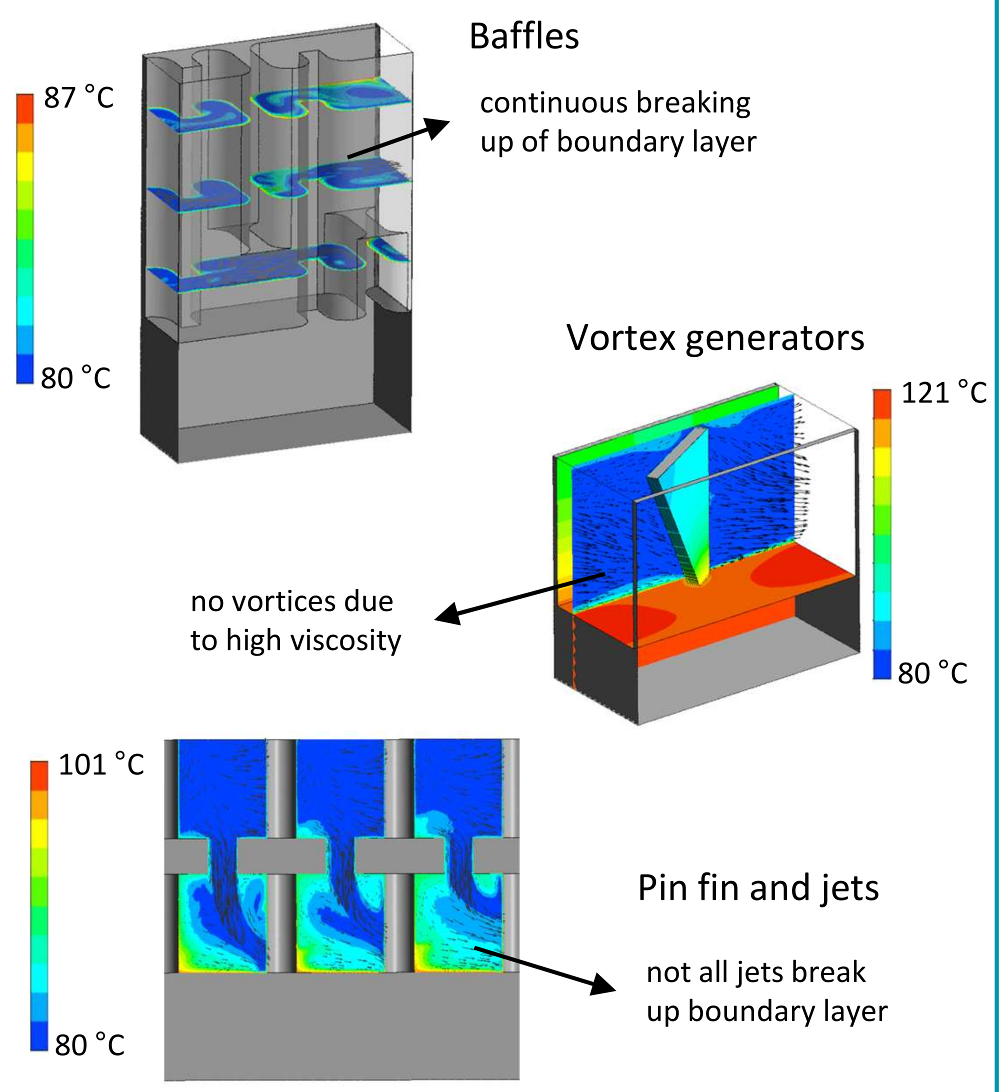
Metal foam

- Validation



Advanced heat sinks

- Modelling (computational fluid dynamics)



Key takeaways

- Of the reference designs, pin fin heat sinks perform better than impinging jets, metal foam and parallel channel heat sinks when optimized for oil cooling.
- Advanced baffle designs for oil cooling can outperform pin fin heat sinks.
- Future work: validation and optimization of (innovative) heat sink designs.

Further reading

- [1] doi: 10.1109/THERMINIC52472.2021.9626484