Aalto University
School of Engineering

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Optimization of row-and-rack level airflow management in data centers

Title of the dissertation	Optimization of row-and-rack level airflow management in data centers
Contents of the dissertation	This thesis firstly conducts a literature review about the cooling system and data centers (DCs). Considering the current huge market share of air-side cooling and its high cooling reliability and normalized model matching design compared with liquid-side cooling, this thesis proposes row-and-rack level airflow management is worth further studying. Then, 4 different row-and-rack level methods are proposed and studied to optimize the thermal environment through experimental & numerical studies and model validation. The numerical models are validated by the experimental results, and the results of both experimental and numerical studies are presented and analyzed as well as energy saving potentials. Finally, the literature review is conducted again based on phase change cooling (PCC), and PCC is recommended for future study. The results show that the numerical results are in good agreement with the experimental results, and the reliability and feasibility of numerical models are validated. All the row-and-rack level airflow management methods can improve the thermal environment in DCs to varying degrees. The rack hotspot temperatures can be decreased by 1.5-2.5 K with different methods, which reduces the risk of servers' down-time and extends lifespan. Some of these methods can also achieve considerable energy savings (98-146 kWh electricity use per day) under the premise of safe operation. The proposed methods (server terminal baffles and tilted server placement) can be used directly in the operation phase of DCs, and only need simple modifications (e.g., adding baffles and adjusting server angles) for thermal environment improvement, while the rest (in-rack UFAD and step-like server placement) are applicable in the DC design phase, which also just needs simple modifications (e.g., changing the positions of perforated floor and server rack, and rack length).
Field of the dissertation	Energy Technology
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