HEATING VIA VENTILATION AIR WITH A DYNAMIC DIFFUSER

Villiam Jensen & Jonas Spanggaard

INTRODUCTION

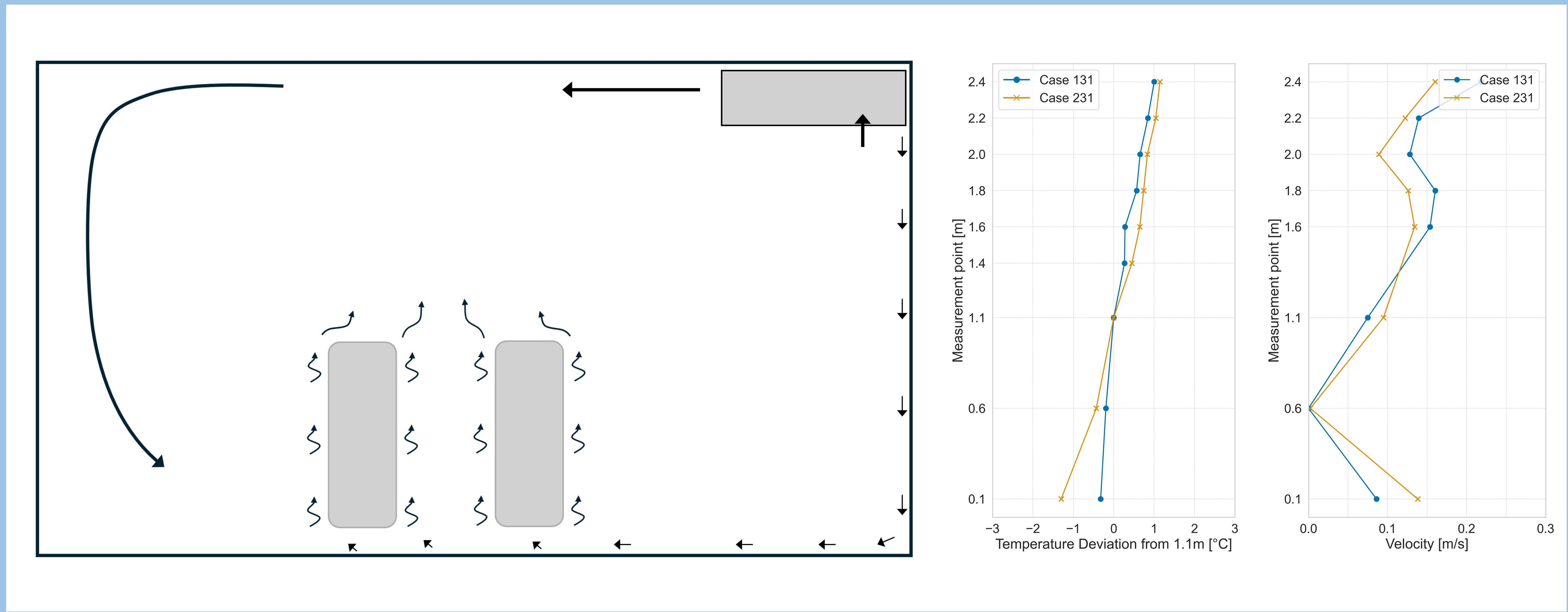
Effective heating in modern buildings is crucial for occupant comfort and productivity, but air-based systems can cause thermal stratification. Decentralized air handling units (AHUs) like the Airmaster AMX4 offer a flexible solution. This research investigates optimizing the AMX4's heating performance to reduce stratification and improve indoor comfort by determining how supplied air can be mixed.

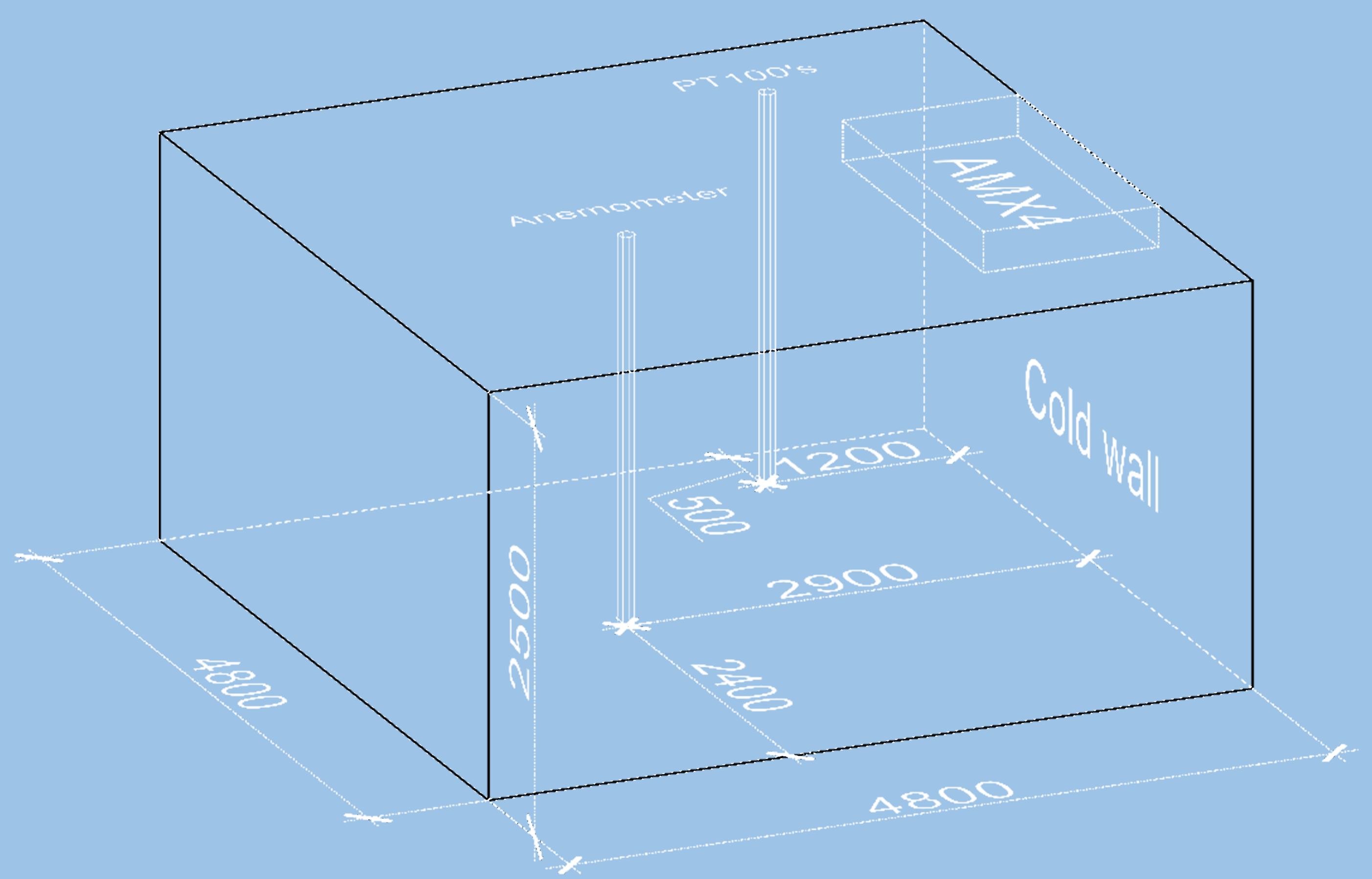
OBJECTIVE

This study aimed to determine optimal air mixing strategies for the Airmaster AMX4 during heating to reduce thermal stratification and enhance occupant comfort. The research investigated the impact of varying airflow rates (145-330 m³/h), supply air angles (0° to -60°), and inlet temperatures to identify configurations for uniform heat distribution and define practical comfort zones.

METHODOLOGY

An experimental study analyzed the Airmaster AMX4's thermal performance in controlled test rooms. Key parameters—airflow rate, supply air angle, and inlet temperature difference —were varied. Measurements included temperature, air velocity, pollutant dispersion, and Draught Rate, with the reduced Archimedes number (Ar*) used to analyze buoyancy versus inertial forces.





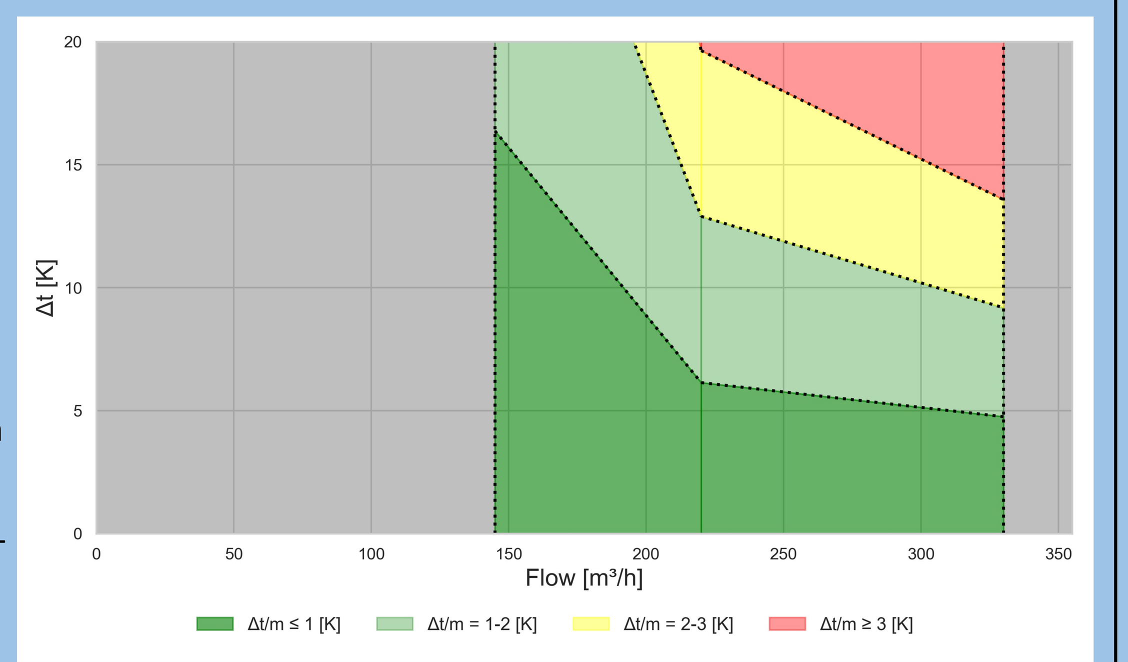
RESULTS/FINDINGS

The research established a clear quantitative link between the AMX4's operational settings (airflow, supply angle, inlet temperature Δt) and the resultant vertical thermal stratification. Higher Δt values consistently amplified stratification, often leading to inefficient heating as warm air "short-circuited" to the ceiling.

The reduced Archimedes number (Ar*) proved a critical descriptor, exhibiting a strong linear correlation with temperature gradients (e.g., between 1.1m and 2.4m), confirming its utility for predicting and potentially controlling stratification.

A key trade-off emerged: steeper downward supply angles (-40°, -60°) enhanced overall room air mixing and pollutant (CO2) distribution uniformity but increased localized draught risk near the unit, particularly at higher flow rates. However, CO2 concentrations generally remained acceptable; thermal comfort limits due to stratification were the primary constraint, not air quality.

The impact of a 400W simulated occupant load on these fundamental stratification patterns was minimal. Based on a 2°C/m stratification limit, operational comfort zones were defined, showing that permissible Δt decreased with steeper angles.



CONCLUSION

The Airmaster AMX4's air supply can be optimized to reduce vertical temperature gradients and enhance comfort during heating. Stratification depends on airflow rate, supply angle, and inlet temperature, well-characterized by the reduced Archimedes number. Findings support advanced control strategies and provide practical guidance for AMX4 settings, balancing uniform temperature with minimal draught for improved indoor environmental quality.