
Case Study on Airflow Analysis for Improving the Working Environment in Large Factory

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Key words: Air flow simulation, Energy conservation, Heat stress Index, WBGT, Thermal environment, Worker safety

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In large-scale automobile manufacturing plants, heat generated from production equipment frequently leads to elevated indoor temperatures. The deterioration of thermal conditions increases safety and health risks for workers and reduces their work efficiency. In some cases, excessive heat exposure may also result in operational constraints, posing potential risks to stable plant operation. To manage these risks, thermal stress is commonly quantified and monitored using the Wet Bulb Globe Temperature (WBGT) index. Accordingly, improving the thermal environment in production facilities is recognized as a critical task for ensuring worker safety and maintaining stable operation in large-scale manufacturing plants.

To improve the thermal environment of large factories, JATCO has secured the reliability of its HVAC(Heating, Ventilation, and Air Conditioning) simulation model by incorporating the following elements.

1)Field-Based 3D Factory Modeling:

The arrangement of equipment, exhaust and ventilation fans, cooling systems, and the open/closed states of openings (doors and windows) were reproduced to match actual summer factory conditions, thereby enhancing analysis accuracy.

2)Implementation and Verification of the Cooling Performance Model for HVAC Equipment:

The actual specifications and Pressure-Flow rate performance curves of cooling equipment such as fans and air conditioners installed in the plant were directly applied to the model. Through a verification process, the reproducibility of cooling performance was confirmed.

3) Improvement of Reliability through Direct Measurement of Equipment Heat Generation:

Using thermal imaging camera, the actual heat-source data of each piece of equipment was measured and applied to the model, improving the realism of heat-source conditions.

Final model validation was conducted by comparing measured WBGT values at worker locations with the simulation results. By applying correction factors optimized for Japanese factory environments—based on the WBGT reference tables of the U.S. National Weather Service (NOAA)—the model achieved a prediction accuracy of 91%. Additionally, after implementing heat-environment improvement measures, the difference between actual and simulated temperatures remained within $\pm 1^{\circ}\text{C}$.

This study presents the development and validation process of JATCO's HVAC simulation model for large factories and introduces practical thermal-environment improvement cases within JATCO facilities using this model. Going forward, JATCO expects to utilize this simulation model not only to improve the thermal environment but also to achieve energy-saving effects by optimizing HVAC equipment layout and operating strategies, thereby reducing unnecessary system operation.