汽车在环境风洞内流场的数值模拟与实验研究㊀㊁

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【摘要】 为研究汽车在环境风洞内的流场特性，建立了环境风洞和整车数值模型，考虑了风洞喷口和收缩段的阻塞效应、边界层抽吸以及试验设施等对汽车流场的干扰效应，对环境风洞内汽车前方、车身和车轮周围、冷却模块以及机舱内的流场进行了数值模拟。对车身表面的静压以及车身周围和车底部的风速等进行了测试，通过数值模拟结果与实验结果的对比，表明数值风洞能准确预测汽车在环境风洞内的流场特性。研究结果显示：汽车前端气流的速度分布沿着气流方向发生显著变化，越接近前端冷却模块时风速的均匀性变差；汽车底部气流受地面、车底和轮胎旋转等的共同影响呈现规律性的变化，车底风速沿车身纵向先增大后减小。本方法对研究汽车在环境风洞内的热气动性能以及开发数值风洞提供了新的思路和参考。

【关键词】 环境风洞，流场特性，冷却模块，数值模拟，风洞实验

Numerical Simulation and Experimental Research on the Flow Field of Automobile in Climatic Wind Tunnel

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Abstract：In order to study the flow field characteristics of the vehicle in a climatic wind tunnel，the numerical models of the climatic wind tunnel and the vehicle were established. The blocking effect of the nozzle and contraction section of the climatic wind tunnel，the boundary layer suction and the interference effect of the test facilities on the vehicle flow field were considered. The flow fields in front of the vehicle，around the vehicle body and wheels，in the cooling module and cabin were numerically simulated. The static pressure on the surface of the vehicle，the wind speed around the vehicle body and the bottom of the vehicle were tested. Comparison of the numerical simulation results with the experimental results shows that the numerical wind tunnel can accurately predict the flow field characteristics of the vehicle in the climatic wind tunnel. The results show that the velocity distribution of the front-end airflow of the vehicle changes significantly along the airflow direction，and the uniformity of the air velocity deteriorates as it gets closer to the front cooling module. The air flow at the bottom of the velocity changes regularly under the joint influence of the ground，the bottom of the velocity and the rotation of tires. The air velocity at the bottom of the vehicle increases first and then decreases along the longitudinal direction of the vehicle body. This method provides a new idea and reference for studying the thermal aerodynamic performance of vehicles in the climatic wind tunnel and developing the numerical wind tunnel.

Key words：climatic wind tunnel，flow field quality，cooling module，numerical simulation，wind tunnel experiment

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