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Numerical Simulation on Thermophoretic Deposition of Nano Particles in Rectangular Duct with a Flat Plate

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Recently, nano particle deposition attracts much attention in various engineering fields, e.g., it is applied for the substrate coating and the fabrication of microstructures, whereas the deposition often causes energy loss and inhibition of machine functions in fluid machinery. In fluid machineries, a thermophoresis is known to play an important role in the nano particle deposition phenomena. Thermophoresis induced by temperature gradient in flow transports nano particles and results in the deposition on relatively cold wall surfaces. In 1980, Talbot et al. [1] pioneered to investigate the role of the thermophoresis in the nano particle deposition phenomenon. Until now, numerous studies on the nano particle deposition phenomena itself have been conducted.

In this study, in contrast with the previous studies, we focus on interactions between nano particle deposition layers and a three-dimensional flow field induced by a flat plate in a rectangle duct, as shown in Fig. 1. In numerical simulations, we employed the Eulerian method for flow and the Lagrangian method for nano particles motion. When the particles adhere on walls, the shape and the properties of walls are changed and, thus, the deposition layers affect the base flow in the duct.

Figure 2 shows the deposition layer thickness on the bottom wall surface of the duct, as a sample result. Here, the light color indicates the thickness of the deposition layers. The deposition layer is thicker at the side and in front of the flat plate. In the region behind the plate where a three dimensional voritcal structure is formed, the deposition layer is very thin. In the final paper and the presentation, we will discuss processes of the decomposition and interactions between the deposition layer and the flow in detail.

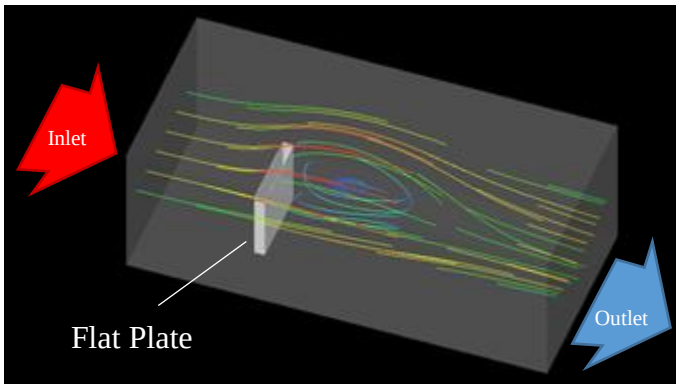

Fig. 1 Streamline in a rectangular duct with a flat plate

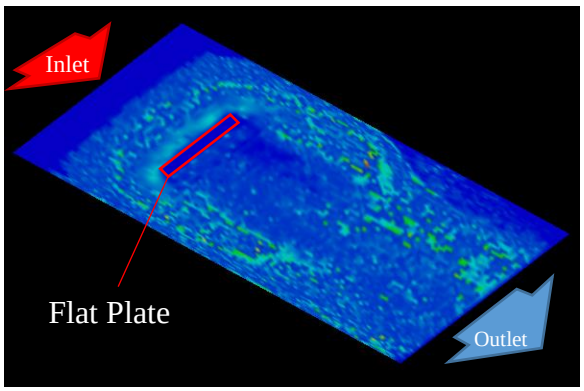

Fig. 2 Thickness of deposition layers on the bottom wall of the duct

REFERENCES

[1] Talbot, L., Cheng, R. K., Schefer, R. W., and Willis, D. R. (1980), "Thermophoresis of particles in a heated boundary layer", Journal of Fluid Mechanics, Vol. 101, pp. 737-758.