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Applications of Domain Decomposition Method to Industrial Thermal Convection Problems

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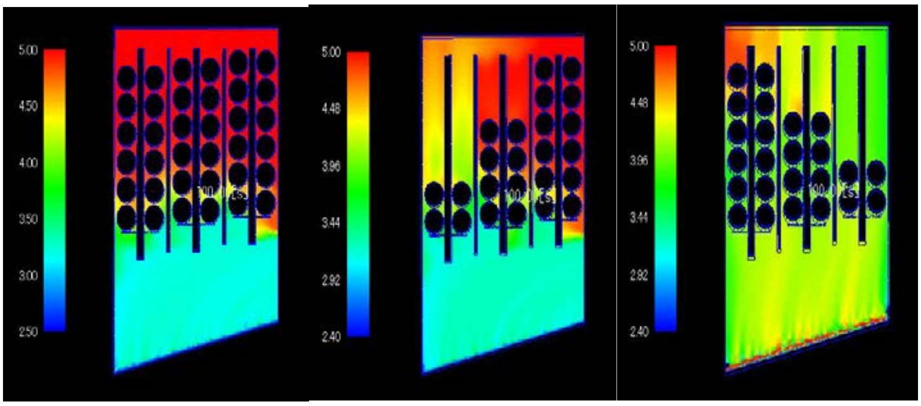
A coupling analysis of thermal convection problems is performed in this work. By approximating the material derivative along the trajectory of fluid particle, the characteristic curve (CC) method can be considered. The most attractive advantage of this method is the symmetry of the linear system, which enables some classic symmetric linear iterative solvers, like the conjugate gradient (CG) method or the minimal residual method (MINRES), to be used to solve the interface problem of the domain decomposition system. Applications to industrial problems are demonstrated to show the effectiveness of our approach.

A new parallel coupling thermal convection solver [1] has been developed. Based on a CC method [2], the scheme can provide solvability for non-stationary thermal convection problems. The new solver can reduce memory consumption compared with solvers of product-types. The computation speed is also improved, as is expected. The reliability and accuracy of numerical results have successfully been validated by comparing with the exact solution [1]. Comparisons of our numerical results with results of other recognized solvers or available benchmarks also convince us that the application of the characteristic curve method to thermal convection problems has been a success. Accompanied with several new features, the new solver is speedy and worthy to be expected. As one member of the ADVENTURE system [3], it will be published as an updated version of ADVENTURE_sFlow on the homepage after the in-house testing.

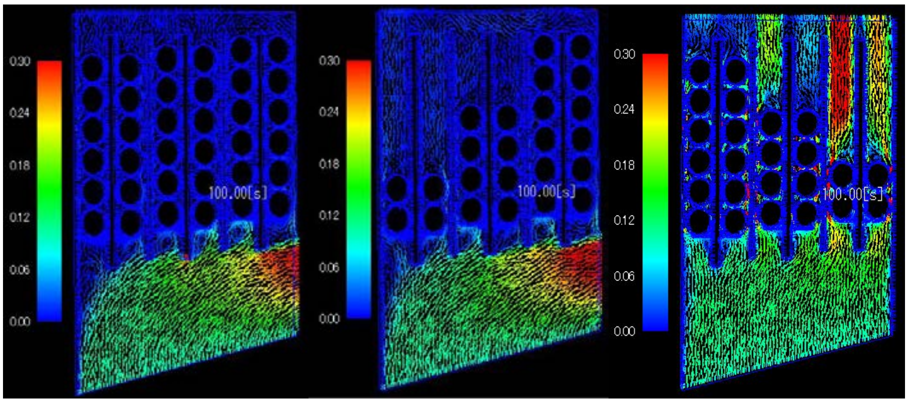
In recent years, energy conservation has become an important topic in Japan. One focus of current research is the use of numerical analysis techniques to control cooling and heating systems in vending machines to improve their efficiencies and reduce their electric power consumptions. In this study, we report results of analyses using the ADVENTURE_sFlow parallel solver to study problems of thermal convection in mechanical components inside a vending machine [4].

Here, we consider several summer cases. Namely, different number of cans are considered for each column. Case (a) in Fig. 1 is a fully occupied case, and Case (b) and Case (c) consider stairs. In all cases, many cans produce high temperature because cans become obstacles of the air flow. It is specially noted that Case (b) relatively shows high temperature, compared with Case (c).



(a) full; (b) stairs; (c) stairs;

Fig. 1 Temperature distribution after 100 [s].



(a) full; (b) stairs; (c) stairs;

Fig. 2 The temporal velocity variation of stream diagram after 100 [s].

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