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Numerical Simulation of Tube Bundles by Using Immersed Finite Element Method

***Tae-Rin Lee[1], Yoon-Suk Chang[2], Jae-Boong Choi[3] and**

[1] SKKU Advanced Insitute of Nanotechnology (SAINT)
Sungkyunkwan University
tairin@skku.edu

[2] School of Mechanical Engineering
Sungkyunkwan University
yschang7@skku.edu

[3] School of Mechanical Engineering
Sungkyunkwan University
boong33@skku.edu

Young-Jin Kim[4]

[4] School of Mechanical Engineering, Sungkyunkwan University,
Suwon, Kyonggi-do 440-746 Republic of Korea
yjkim50@skku.edu, http://isel.skku.ac.kr/

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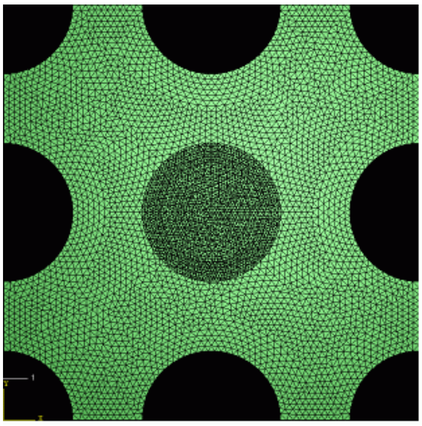
ABSTRACT

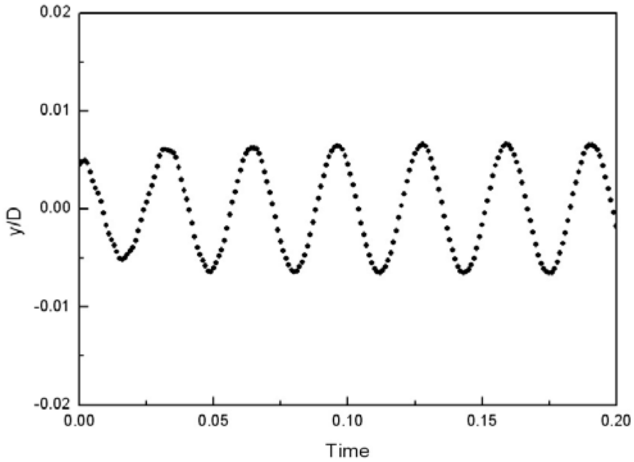
Numerical simulation of fluid-structure interaction (FSI) is one of critical issues in design of mechanical components like heat exchangers, steam generators, internals, piping and others. However, it is not easy to perform coupled analyses between fluid and solid mainly due to a time-consuming remeshing process during the simulation.

Several coupled analysis codes, concurrently solving fluid and solid domains, have been developed to overcome the limitation. The immersed finite element method (IFEM) [1, 2] is one of efficient solvers to determine the FSI behaviour, which does not require the remeshing algorithm. In this method, on the entire domain containing fluid and solid, immersed solid bodies can be solved only by fluid solver. Recently, authors developed a modified IFEM code employing directly coupled Euler-Lagrange mapping technique [3], which gives more accurate solutions than the original one for fluid-solid interaction problems.

In the present research, for industrial application, a supplementary module to estimate structural frequencies is added to the newly developed IFEM code and used to examine a flow induced vibration phenomenon occurred in tube bundles (Refer to Fig. 1). A reference domain for simulation is set to nine tubes; a movable tube and eight surrounding fixed tubes. Then, tube vibration frequencies caused by idealized incompressible viscous flow are estimated by changing initial conditions and gap velocities. Validity of the numerical simulation results in the fluid at rest is proven by comparing with the corresponding reference test data [4].



(a) FE model



(b) y-directional vibration data

Fig. 1. Numerical Analysis of elastically mounted circular cylinder around the tube bundle

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