The unsteady respiratory airflow dynamics within the human tracheobronchial network under resting condition, maximal exercise condition and high-frequency ventilation (HFV) condition was investigated utilizing Computational Fluid Dynamics (CFD) technique based on a finite volume method (FVM). For the resting condition, peak Reynolds number (Re) number of 1.75×10^{3} and Womersley number (α) of 2.37 were used, this corresponds to the tidal volume (VT) and the breathing frequency (f) of 0.5L and 0.2Hz, respectively. The Reynolds number of 4.66×10^{4} and Womersley number of 4.47, corresponding to the tidal volume of 3.33L and breathing frequency of 0.8Hz, were selected for the maximal exercise condition. While the Reynolds number of 4.37×10^{3}, the tidal volume of 0.05L, the Wormesley number of 11.87 and the breathing frequency of 5Hz were used as a condition for HFV condition.

A three-dimensional single asymmetric bifurcation model of the upper airway based on morphological model proposed by Horsfield et al. (1971) has been used. The simulation results for both inspiration and expiration phases agreed with experimental results given by

Nishida et al (1997). It was found that during the high-frequency ventilation (HFV) the flow is dominated by the unsteadiness effect, while the respiratory flows at resting condition and maximal exercise condition are dominated by the convective effect. It also was found that the respiratory flow under the high-frequency ventilation behaves in the similar way as in the straight tube. Hence the geometry effect becomes less important in such flow condition.

Keywords: Oscillatory flow, Respiratory flow, CFD, Numerical, Asymmetric bifurcation

(คำหลัก)