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Effects of free surface on flow energy harvesting system based on flapping foils[1] LUBAO TENG, JIAN DENG, XUEMING SHAO, Department of Mechanics, Zhejiang University, Hangzhou 310027, People's Republic of China — Here, we consider a flapping foil based energy harvester, which is modelled by a 2D NACA0015 foil performing coupled motions of pitching and heaving. Volume of fraction(VOF) method is employed to capture the free surface. We fix the Reynolds number at $Re = 900$, and the Froude number at $Fr = 0.32$. We fix the non-dimensional flapping frequency at $f = 0.16$, the pitching amplitude at $\theta_0 = 75°$, and the heaving amplitude at $h_0 = 1c$, where c is the chord length. With these parameters, the harvester has been proved to reach its highest efficiency of $\eta = 0.34$ in a single phase flow. By varying the submergence d, which is defined as the distance between the calm free surface and the highest position of the pitching pivot of the flapping foil, we find that the free surface affects pronouncedly the energy harvesting efficiency η. As d decreases from $24c$ to $0.5c$, η increases from 0.34 to 0.41, getting a 20% promotion of the efficiency. To reveal the underlying physical mechanism of the effects of free surface, we examine the time histories of hydrodynamic forces on the foil. We find that due to the existence of the the free surface, the lift force and pitching moment experience asymmetric time histories during the upstroke and downstroke of the foil.

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