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Passive Propulsion in Vortex Wakes

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Synopsis

Making energy efficient transportation is always a need. Drag reduction is one way to reduce fuel consumption in many modes of transportation. One thing that is observed is vortex formation on these bodies. Vortexes are formed on boundaries of objects due to boundary layer separation. One way is to use passive devices to avoid vortex formation and decrease the amount of drag induced by them. The second way is to extract some of the energy from these vortexes and put it back into the system. This can be done by placing additional aerodynamics structures in the wakes. This particular problem is being investigated in this study. The performance of NACA 0012 airfoil placed in vortex wakes of a cylinder is studied through simulations in OpenFOAM 7. Based on the work by Jonathan et. al in [1] and Beal et. al in [2], 2 cases have been investigated - allowing heave and rotational movement of the airfoil and rigidly fixed airfoil. Variations with angle of attack has also been studied with the rigidly fixed wing. It is shown that there is a propulsive force on the airfoil in both cases. PimpleFoam solver was used for transient and moving mesh simulations.

Figure 1: Domain

References

[1] Lefebvre, Jonathan N. and Jones, Anya R., Experimental Investigation of Airfoil Performance in the Wake of a Circular Cylinder, AIAA Journal, 10.2514/1.J057468

[2] BEAL , D. & HOVER , F. & Triantafyllou, Michael & LIAO , J. & Lauder, George. (2006). Passive Propulsion in Vortex Wakes, Journal of Fluid Mechanics, 10.1017/S0022112005007925.