FLUENT - Unsteady Flow Past a Cylinder - Step 7

Step 7: Validate the Results

For steady case, to validate the accuracy of the result, we have to check whether the mesh is refine enough. For unsteady case, we have another parameter that we have to take note of, which is the time step size. The smaller the time step size, the more accurate the representation of the physical flow.

Time Step Size Investigation

We will reiterate the solution using time step size of 0.2s follow by 0.1s. Increase the number of time steps accordingly to capture 10 shedding cycles. If you don't capture enough shedding cycles after initial iteration, just continue the iteration. The reason we need at least 10 sustained shedding cycle is that we would want to calculate the shedding frequency.

No reinitialization is needed because since previous solution should give us a good approximation of current solution with smaller time step. Another advantage of not reinitialize the problem is that, we can keep all our C_L data in a single file name: "cl-history".

Using method taught in Step 6, calculate the Strouhal Number for time steps size of 0.2 and 0.1. Following table summarizes the result.

Time Step Size (s)	0.1	0.2	0.4
Strouhal Number	0.188	0.182	0.172
Difference (%)	3	6	0

As can be seen, the Strouhal number difference get smaller as we move to a smaller time steps. We can conclude that time steps size of 0.1s will give us a fairly accurate representation of physical flow in term of time parameter.

Do note that with time step size of 0.1s, we have exceeded the experimental Strouhal value of 0.183. However, we have only investigated the time parameter. We will have to investigate other parameters such as grid convergence, residual, unsteady formulation, etc, before we can conclude on the accuracy of our model.

Grid Convergence Investigation

To determine the effect of grid convergence, a finer mesh with double the original mesh density was created. Using the time steps size of 0.1s and a refine mesh, we solved the problem in FLUENT again. With the finer mesh, we obtained Strouhal value of 0.186. As can be seen, the value is much closer to the experimental value. Further refining mesh will get us to more accurate solution.

Conclusion

For steady case, we need to check grid convergence to validate the accuracy of our result. For unsteady case, we have to validate both time parameters (time step size) and grid convergence.

Reference

C.H.K Williamson and G.L. Brown, *A Series in to representat the Strouhal-Reynolds number relationship of the cylinder wake, J. Fluids Struc. 12,1073 (1998).*

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