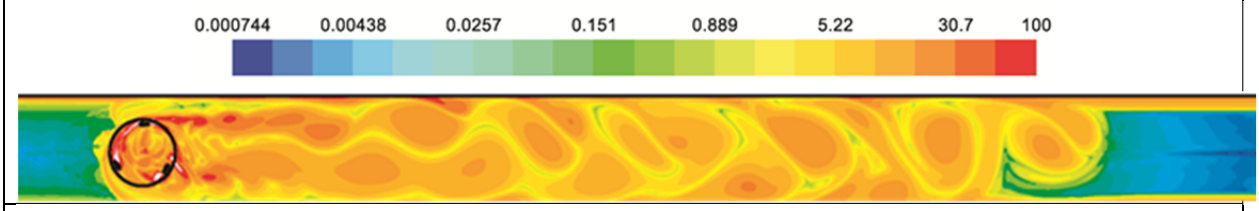
ENE 505 – Applied Computational Fluid Dynamics in Renewable Energy Technologies

WEEK 11: CFD PROBLEM RESULTS

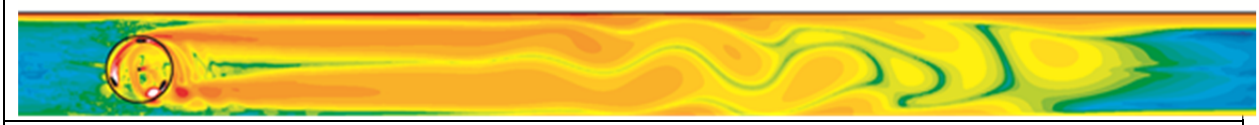
RESULTS:

- **Vorticity Contours**

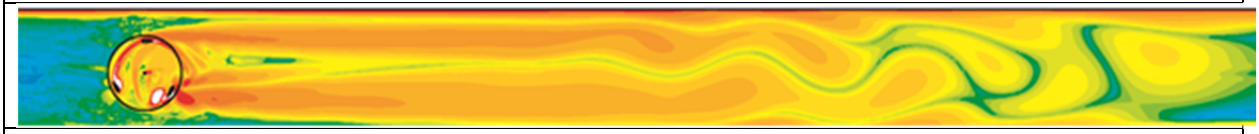
➢ Figures 1(a) to (c) clearly illustrate the differences in occurrence of the vortex street behind the rotating sub-domain for each turbulence model case [1].



(a) RNG k-ε turbulence model



(b) Standard k-ε turbulence model



(c) Standard k-ω turbulence model

Figure 1 Instantaneous vorticity contours on the wake for different turbulence models for inflow wind velocity of 5.07 m/s and TSR of 2.15 at 0-degree design angle of attack [1].

➢ The less elongated separated shear layer in case of the RNG k-ε model leads to stronger and more discernible vortex patterns in the wake compared to those for the other two standard turbulence model cases, which reproduce more elongated separated shear layers rolling into very weak and less discernible vortex patters as seen in Figs. 1(b) - (c) [1].

- **Velocity Contours**

➢ Figures 2 (a)-(d) on the other hand provide information regarding the wake flow patterns i.e. coherent vortical structures of the rotating sub-domain in the stationary zone at different equally distributed time intervals of T/4 again during the last revolution of the turbine [1].

➢ There is a strong influence of wall constraint in the evolution of the separated shear layers from the rotating sub-domain. Their rolling up into vortex patterns in the near wake region is significantly affected and there is a strong convection mechanism between the wake and the separated free shear layer flow further downstream of the flow [1].

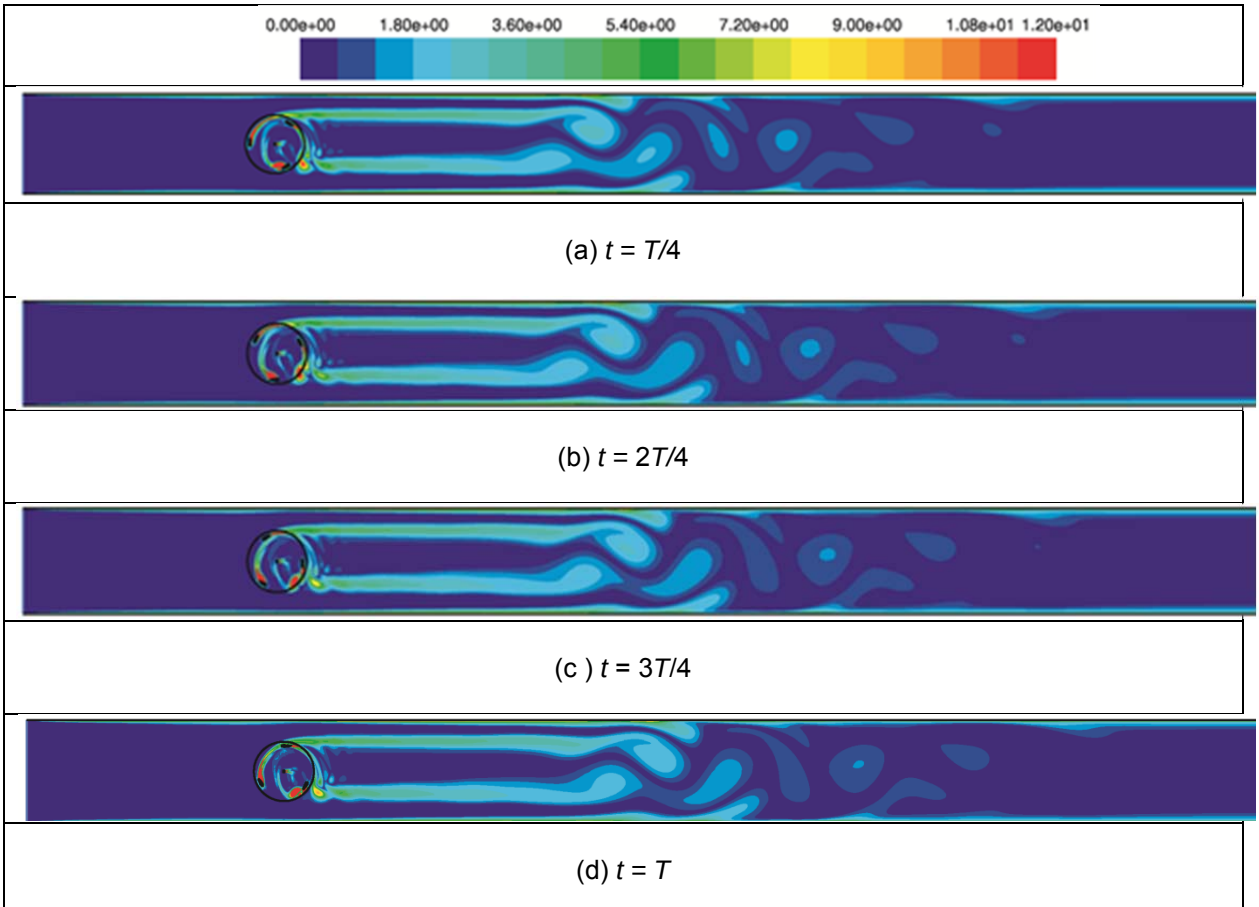


Figure 2. Velocity contours at turbine wake at different time periods for inflow wind velocity of 5.07 m/s and TSR of2.27 at 0-degree design AOA [1].

- **Pressure Contours**

➢ The time dependent local pressure distribution in the rotating sub-domain is also studied at equally distributed time intervals of T/4 shown in Figs. 3(a) to (d). As seen in these figures, the rotor blades have a large effect on the local pressure field in the rotating sun-domain, and the highest pressure distributions is observed at the windward faces of the blades [1].

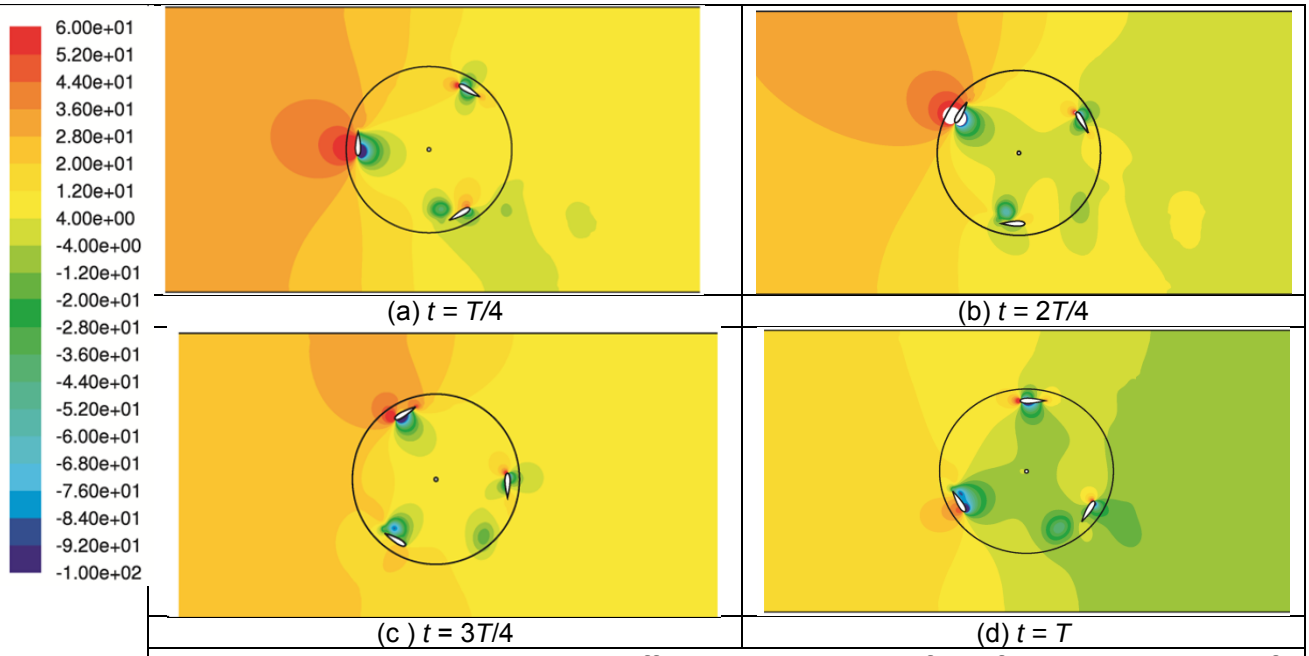


Figure 3. Pressure contours at different time periods for inflow wind velocity of 5.07 m/s and TSR of 2.27 at 0-degree design AOA [1].

References:

1. Aresti, L., Tutar, M., Chen, Y., and Calay, R. K., "Computational study of a small scale vertical axis wind turbine (VAWT): comparative performance of various turbulence models" Winds and Structures, Vol. 17(6), pp. 647-670