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Experimental study on the hydrodynamic processes of wake attenuation of tidal turbine rotors

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A series of flume experiments were carried out to investigate the hydrodynamic processes of wake attenuation of tidal turbine rotors arranged into a single row and staggered rows. The horizontal axis rotors were represented by porous discs. The time-varying velocities were measured by an Acoustic Doppler Velocimeter at eight cross-sections over the distance of 10 diameters downstream, and the three-dimensional structures of wake flow and turbulence fields were obtained. The velocity decreased sharply as the flow passing through the turbine rotor. Wake turbulence mainly occurred in the shear layer, caused by flow separation at the outside edge of the rotor disc. In the process of wake attenuation, there appeared to be a certain order for the wake velocity recovery and turbulence dissipation. Wake expansion and turbulence dissipation were limited until the shear-induced turbulence reached the wake centre. Compared to a single turbine, the locations of significant wake mixing moved downstream for turbine rotors in a single row. Further downstream, wake merging happened and the length of wake recovery was enlarged. Due to wake superposition, the velocity deficit increased gradually as turbine rotors were added to the staggered array along the flow direction, while the turbulence intensity decreased after two staggered rows.

Keywords: Tidal turbine rotor; Turbine array; Velocity deficit; Turbulence dissipation; Wake mixing