An Evaluation for Predicting the Far Wake of Tidal Turbines

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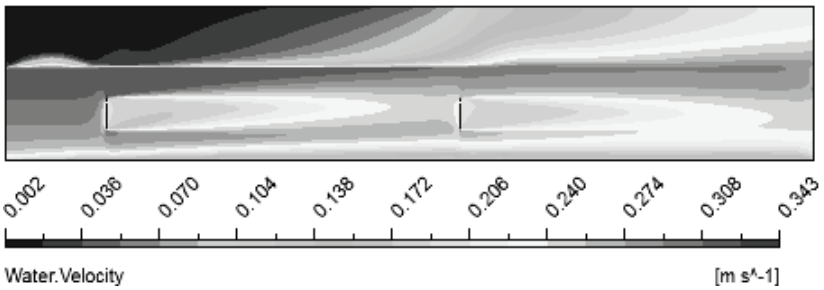
Abstract : In the modern age, as man's demand of energy is continuously grew, tidal becomes one of the sustainable energy sources that have been investigating thoroughly recently. Tidal turbine has proved high potential as a future power-generating device. To effectively capture tidal energy on site, a group of tidal turbines should be used and positioned in some formation with proper size and space so that energy can be absorbed from multiple point. Thus, the turbines together with the flow filed becomes a huge domain, a tidal farm. So, it becomes more convenient if a whole turbine farm is simulated by means of actuator discs since the time and cost for analysis can be reduced. This paper aims to evaluate the operating performance (power efficiency and energy restoration rate), mutual influence (for different longitudinal and lateral spaces), the influence of velocity profiles, turbulence intensity and the far wake characteristic of tidal turbines operating in farm formation. The results of this study help contributing to the present development of tidal turbine as the future potential energy conversion machinery.

Key Words : Tidal, Turbine, CFX, Renewable, Sustainable, Energy.

Tidal energy works from the power of changing tides. Tidal changes in sea level can be used to generate electricity. The flow of water generates enough power to turn the turbines which generates electricity. The entire process repeats with each high tide. Like solar and wind energy, there is a problem with intermittency when using tidal energy. This is a problem for communities solely dependent on these sources: It will also prove a difficulty when integrating onto the electrical grid. However, tidal energy is much more constant than either solar or wind energy. Moreover, they are completely predictable.

Currently, there are only a few locations in the world with tidal levels large enough to warrant an energy plant. Even with increasingly efficient technology, tidal energy will most likely be limited to only the most turbulent waters. A grouping of turbines used for the collection of tidal energy, typically to be distributed to the surrounding areas, is known as a tidal turbine farm. Turbine farms, usually cover significant expanses of sea bed, as the turbines can be quite large and should be properly spaced to ensure individual turbine unit's performance. Tidal farms vary in size, and there is no explicit definition of what constitutes the use of the word "farm." Sometimes, a turbine farm will contain only a handful of turbines, while other farms have several hundred.

This paper presents study on tidal turbine using actuator disc method applied for farm formation. The study is interested in positioning turbines in farm, which includes the study on the effects of longitudinal space and lateral space between turbines. Hence, a full staggered formation of seven turbines is also put in analysis.



Vertical flow pattern at 35D longitudinal spaces

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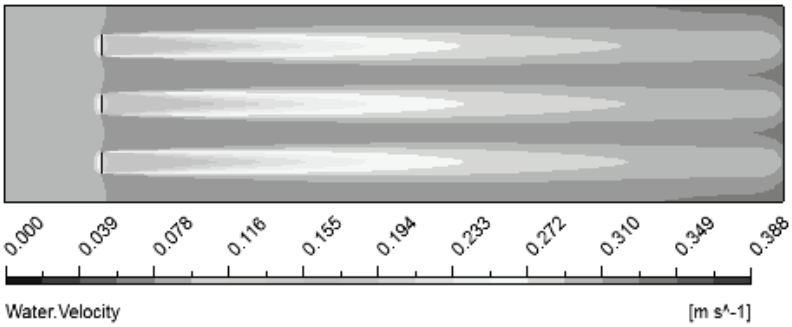
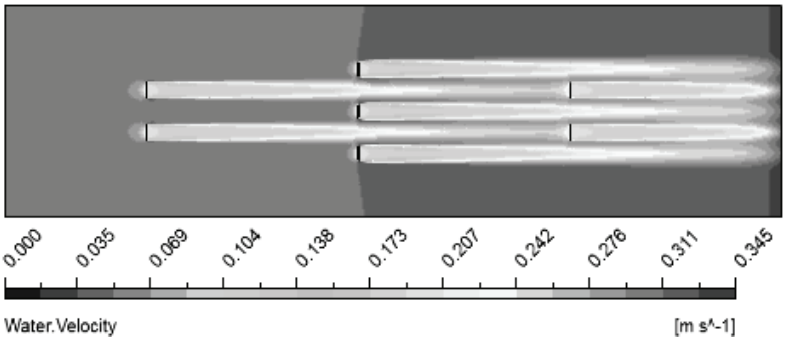
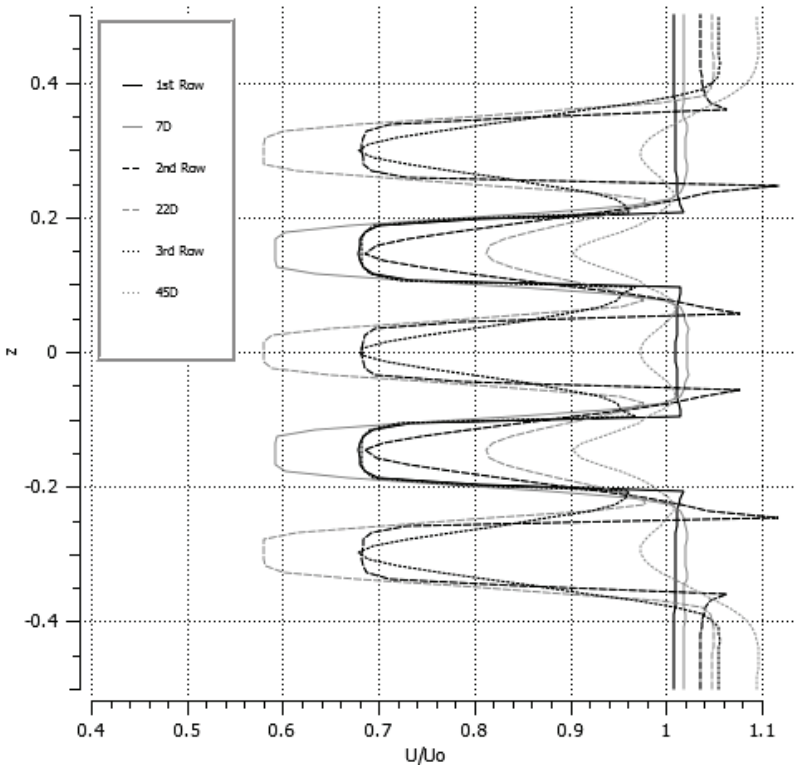


Horizontal flow pattern at 3Dlateral spaces



Staggered formation flow pattern at horizontal center plane



Downstream velocity profile in staggered formation at horizontal center plane