Computational Fluid Dynamic Analysis of the Tesla Turbine

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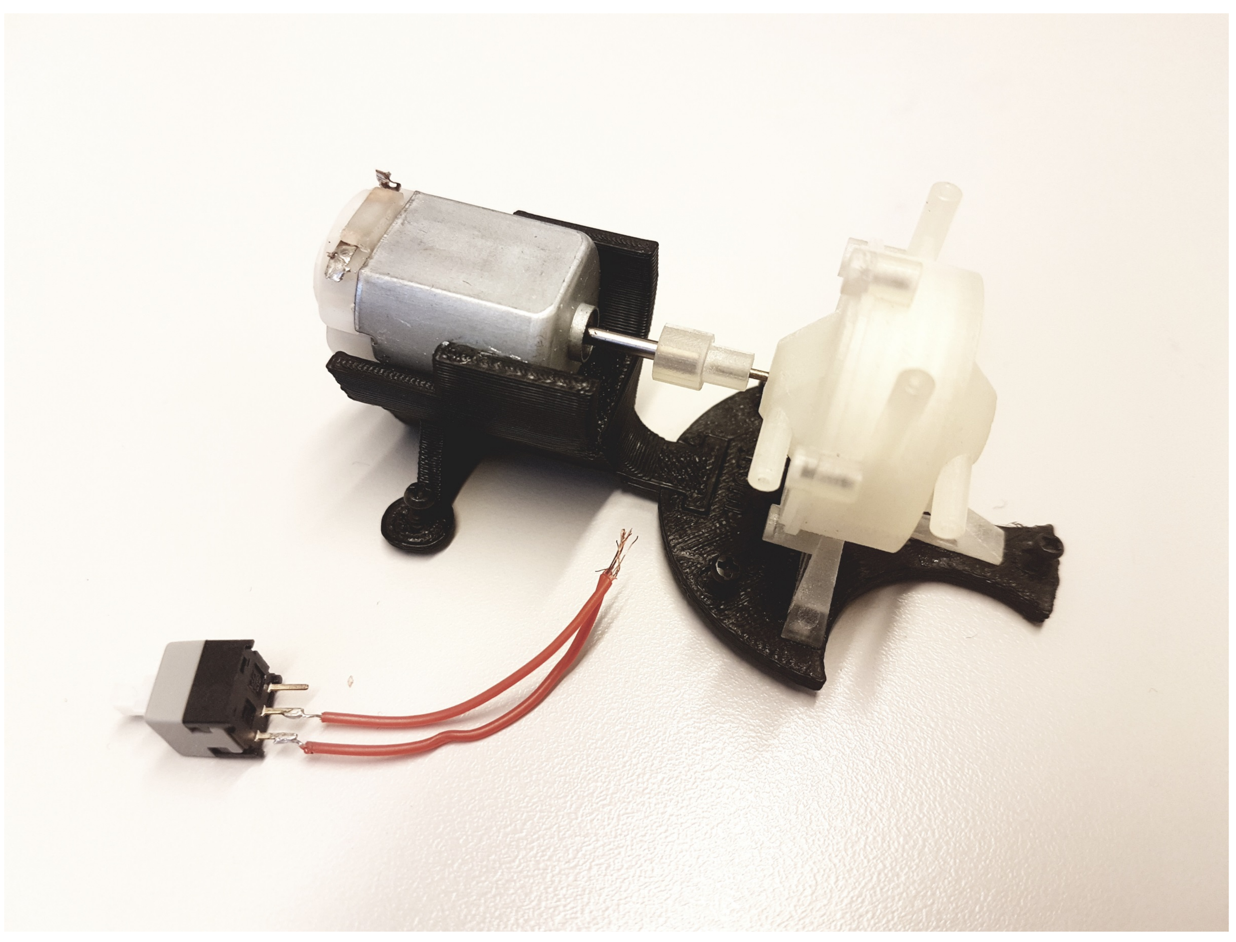
Abstract

Serbian-born inventor Nikola Tesla invented the Tesla turbine and patented it in 1913. The Tesla turbine is unique in the sense that it does not have any blades, also referred to as “bladeless turbine”. The working was based on the establishment of the fluid boundary layer.

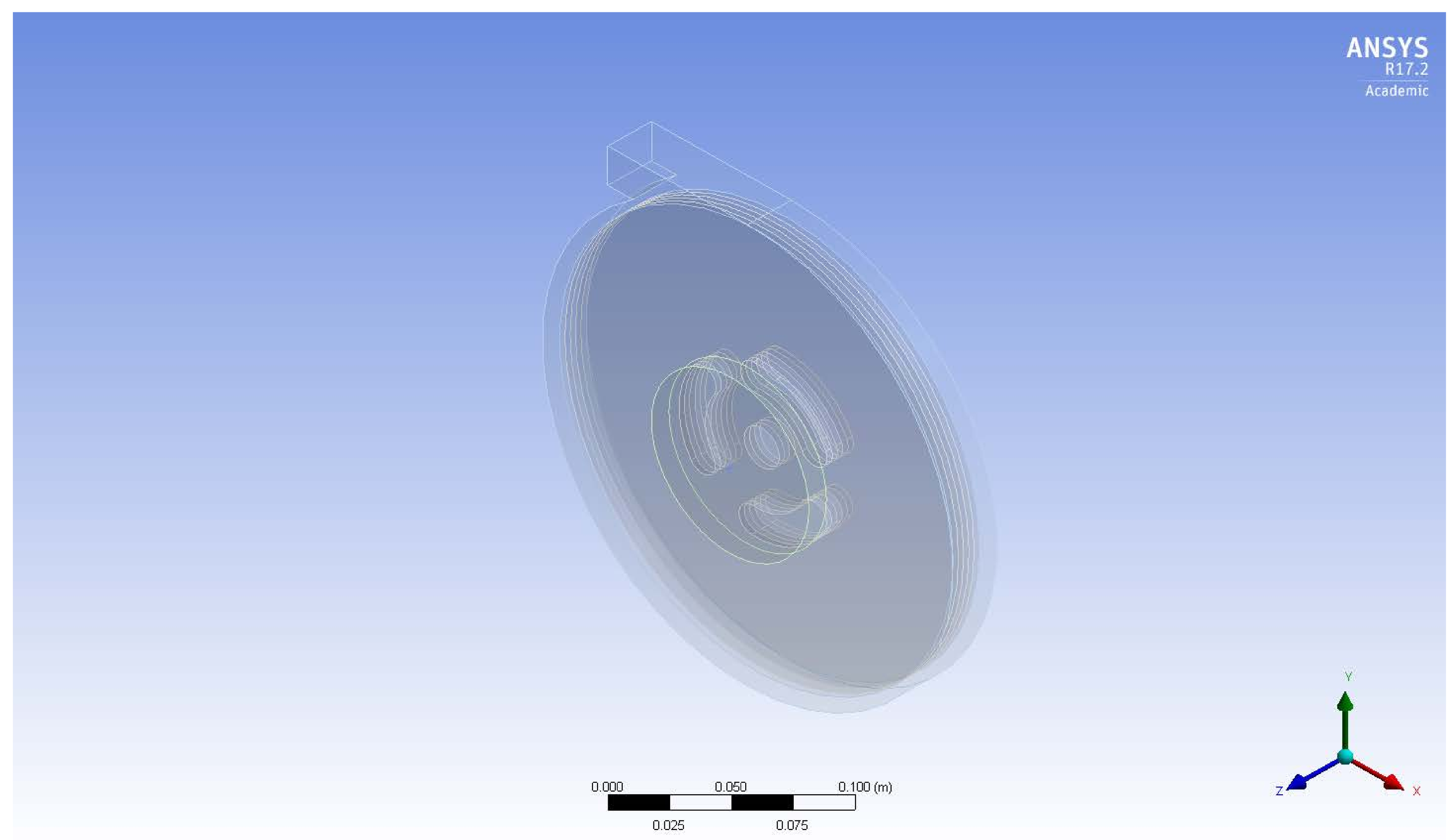
The original Tesla turbine consisted of multiple smooth discs. With the passage of flow, a boundary layer establishes and skin friction drag provides necessary force for rotation. Since the discs are relying primarily on skin friction drag, this type of turbine can function effectively under low-pressure differences. Another advantage of the Tesla turbine is that it can achieve very high rotational speeds ‘rotations per minute (RPM)’. Hence it is ideal for applications where high speeds are required.

It is proposed in this work to conduct computational fluid dynamics analysis of a Tesla turbine. The study will help in revealing its working principles and hence allows us to optimize its parts for various applications, such as harnessing tidal energy, geothermal energy, etc.

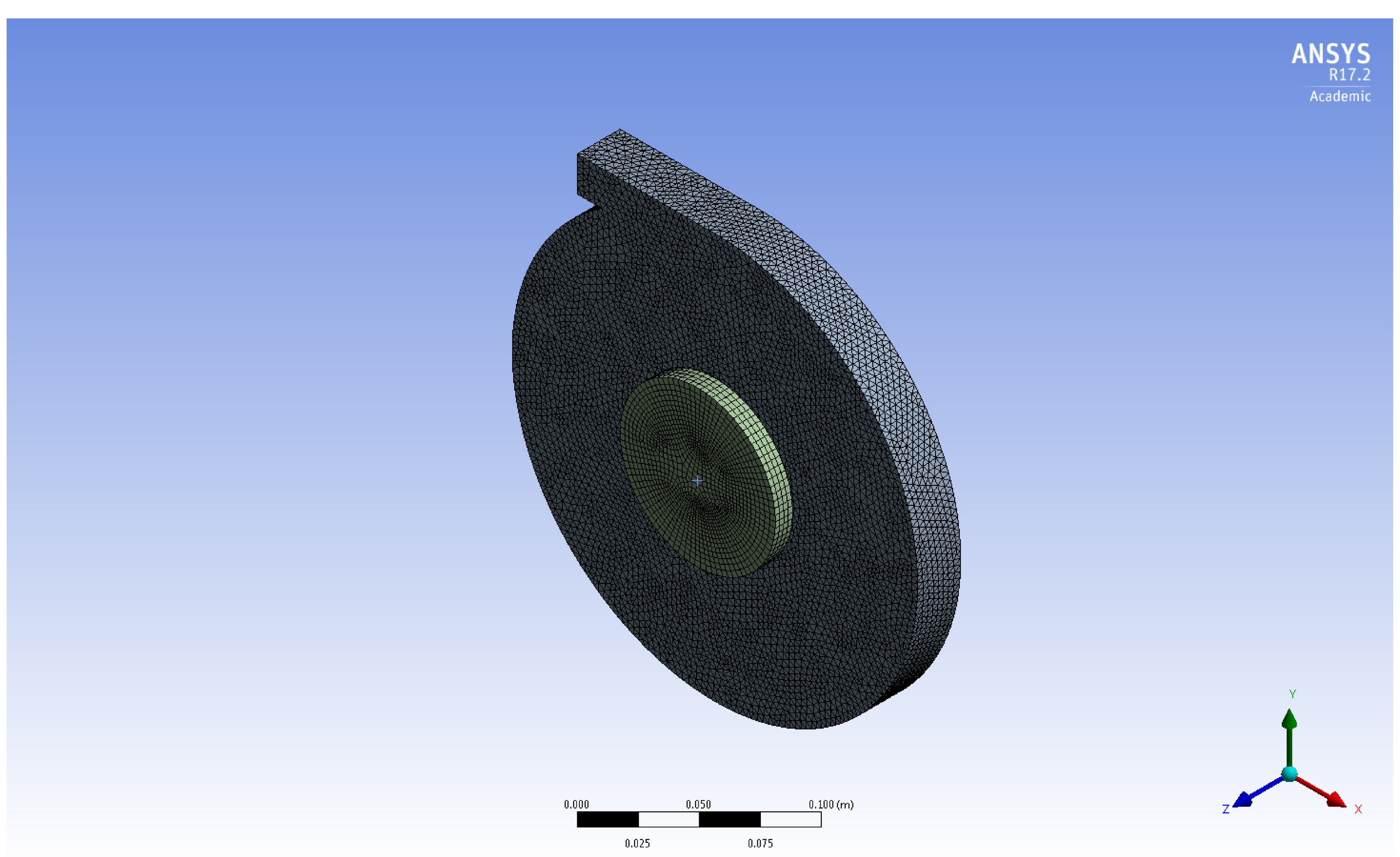
Experimental Setup of Tesla Turbine (epicphysics.com)



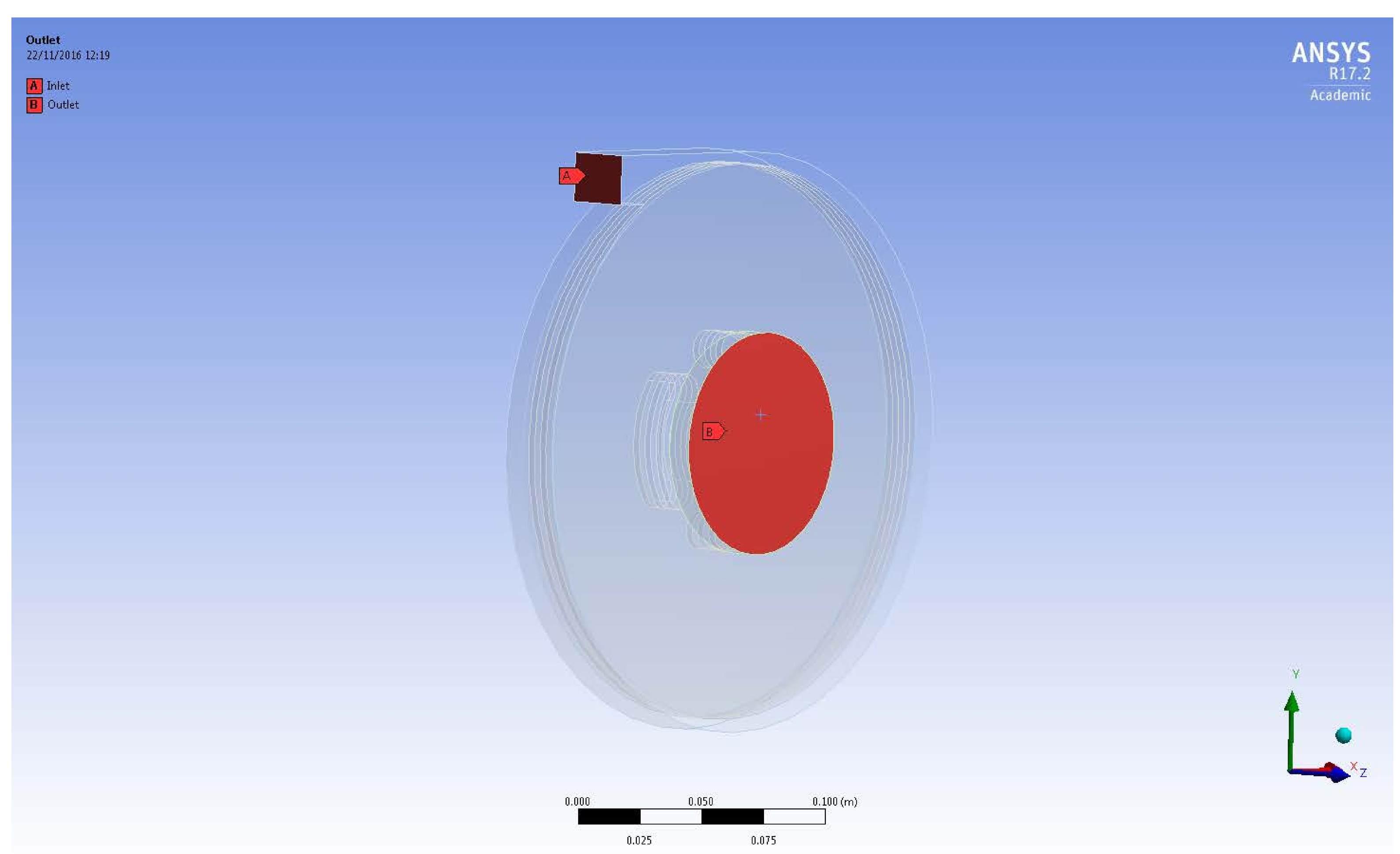
CAD Model of Tesla Turbine (ANSYS® Design Modeler)



CFD Mesh of Tesla Turbine (ANSYS® Fluent)



Applied Boundary Conditions (ANSYS® Fluent)



Challenges

In order to model the tesla turbine, multiple domains were created. The domain interacting with the discs was setup to be a rotating domain.

Appropriate meshing required attention to details. A large number of elements were needed to get reliable CFD results. This could be a limiting factor since ANSYS® Academic does not allow CFD nodes more than 512,000.

The CFD simulation was solved using pressure-based transient ANSYS® Fluent solver. This required an extraordinary amount of run-time and computational resources.

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