CFD analysis of the regenerator performance of cryocooler under different accelerations

Yuzhe Lin , Jiuce Sun, Holger Neumann, Shaowei Zhu

Corresponding Author:
Yuzhe Lin, yuzhe.lin@partner.kit.edu, Institute for Technical Physics/KIT, Germany

High temperature superconducting (HTS) technology is a promising enabling technology to allow the offshore wind turbines (WT) scaling up to 10 MW and beyond by radical reduction of the head mass. In order to provide adequate magnetic field, the HTS coils are supposed to work at a low temperature of 20-40 K, thus a cryogenic cooling system is required. Comparing with cooling by means of cryogenic liquids, the cryogen-free method which adopts conduction cooling with regenerative cryocoolers leads to certain advantages such as smaller size, simple structure and elimination of safety issues related with cryogens. These advantages are particularly valuable in superconducting WT operating in offshore condition, and thus the cryogen-free cooling system attracts more and more attention in demonstrating HTS WT projects.

The cold head of the cryocooler linking to the superconducting filed coil rotates together with the rotor. The resulting centripetal acceleration and oriental variation may introduce streaming inside the regenerator and lead to performance degradation. However, up to now the influence of acceleration on the oscillating flow and heat transfer inside the regenerator has not yet been investigated.

As a response to the demands of performance stable cryocooler system, in this paper we will study the impact of the gravity and centripetal acceleration on the regenerator performance. Two dimensional numerical model of the regenerator will be established by Ansys Fluent. The temperature and pressure distribution of the regenerator will be illustrated and the dependence of operating frequency, acceleration and regenerative material will also be discussed.