Air Flow in Hydro Power Generators for Convective Cooling

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Abstract

Hydroelectric power generation plays an important role in the total electric power generation in Sweden. Almost half of the electric power in Sweden is generated by hydro electric power plants and any modifications and improvements of the system would lead to a significant contribution to the total electric energy production. Two large sources of losses in the electric generators are the thermal and ventilation losses. The electric resistance in the generator system causes heat generation in windings and coils, which decreases the total efficiency of the stator in delivering power and causes material through thermal stresses in components. The generators are thus cooled by air flowing through the rotor and stator.

The present work focuses on ventilation of axially air-cooled generators through the stator cooling channels in the stator wall. The name axial suggests that the air movement in the gap between rotor and stator is along the rotors axis of rotation. It is improtant to have a good understanding of the complicated flow field in the air passages in the generator in order to be able to design the cooling of the system. The air flow is driven by the rotational movement of the rotor and its appended poles, which will act as a fan, into the radially extended stator channels. The air thus cools the stator body and the stator coils.

The flow in the generator in the present work is modelled using ”MRFSimpleFOAM” solver, employing the low-Re ”Launder-Sharma k-ε” turbulence model. The computational domain is generated without inlets and outlets so that the volume rate of flow through the generator is determined by the solution, rather than by an imposed inlet volume flow rate. Some parts of the surrounding environment are thus included in the simulation to allow for recirculation of air in the domain. Different designs of the rotor and stator are simulated and their results are compared to each other, which will be presented.

Key words: Hydro Generators, Turbomachinery, Cooling, Axial Generators

References

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