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NUMERICAL STUDY OF THE COOLING AIR FLOW IN A HYDRO GENERATOR WITH VARIOUS VENTILATION SCHEMES

***Stephan Klomberg[13], Ernst Farnleitner[2], Gebhard Kastner[2] and Oszkár Bíró[13]**

[1] Christian Doppler Laboratory for Multiphysical Simulation, Analysis and Design of Electrical Machines, Inffeldgasse 18, A-8010 Graz, Austria, stephan.klomberg@tugraz.at
[2] Andritz Hydro GmbH, Dr.-Karl-Widdmann-Strasse 5, A-8160 Weiz, Austria, ernst.farnleitner@andritz.com, gebhard.kastner@andritz.com
[3] Institute for Fundamentals and Theory in Electrical Engineering, Inffeldgasse 18, A-8010 Graz, Austria, biro@tugraz.at

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INTRODUCTION

The cooling of large hydro generators is an important part of the whole generator system. Even if the losses are only a few percent of the nominal power of the generator, the dissipated thermal power will be in the range of some MWs. Therefore an appropriate cooling has to be guaranteed. This paper describes the investigation of the fluid flow around the end winding bars of large hydro generators. It shows the advantages and disadvantages of different ventilation schemes. The main topics are the flow through the end winding and the heat transfer at the bars.

The calculations have been done with ANSYS CFX 13.5. A steady-state approximation using multiple frames of reference (mixing plane model, see [1]) along with a reduced geometrical model has been used to carry out the numerous numerical simulations. Geometry, mass flow rate, inlet swirl and rotational speed are varied. Basic research for the development of the reduced model has been presented in [2], including discretisation, mesh density, turbulence models and fluid properties.

GENERATOR MODELS

The geometries used are shown in Figure 1. The end winding region and the inlet area are part of interest in this work. Nevertheless, the reduced fluid model extends over every component of the generator. These are the casing, end winding bars, poles, stator ducts and outlet area. The idea behind the reduced model is the reduction of every component to its minimal required circumferential angle. This reduces the number of elements of the mesh and the calculation time.

An important value for the calculation of the heat transfer is the dimensionless distance from the wall y^+ [3]. The used y^+ is about 8 at the end winding walls to have a stable simulation with converged results. The recommended y^+ of 1 would require a too fine and large mesh increasing the calculation time enormously [3]. The fluid flow is calculated in steady-state and the Reynolds Averaged Navier Stokes (RANS) equations are solved by the finite volume method. Further extensive investigations have shown that the shear stress transport (SST) turbulence model is the best choice for heat transfer calculations [3].

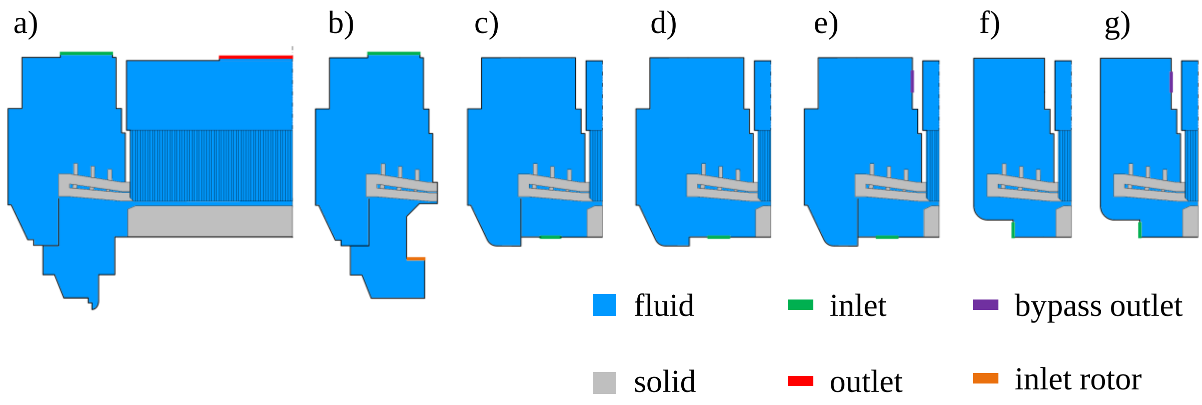

Figure 1: Various investigated ventilation schemes: a) external fan, b) external and radial fan, c) radial fan and guiding plate, d) radial fan without guiding plate, e) radial fan, guiding plate, and bypass opening, f) axial fan, g) axial fan and bypass opening.

RESULTS AND CONCLUSION

The results show the different distributions of flow, velocity and pressure in the end winding region. Figure 2 presents an example of a comparison of the results obtained by the investigated models for the top bar. The support rings (r1-r3) and the synthetic space brackets (sb1, sb2) are not considered for these simulations. The influence of the different schemes on cooling and heat transfer will be discussed too.

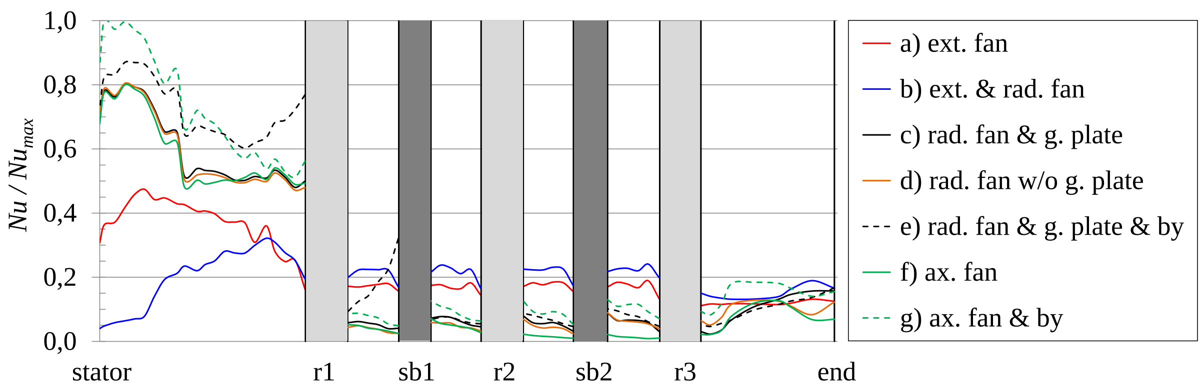

Figure 2: Distribution of the normalized *Nu* number along the top bar.

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