Megawatt Engines need Mega Cooling

By Boris Marovic, Mentor Graphics

The thought of a 20 megawatt electric engine is mind blowing; especially when you consider most road car engines are a mere 120 kW. A 90 ton, 20 meter long Eurosprinter that is capable of reaching speeds of up to 230km/h only uses 6.4 MW in its four electric motors. So when considering a 20 MW engine, in an oil or gas compressor for instance, one has to marvel at its power. An engineer however must concern himself with how to keep this monster cool.

E-Cooling GmbH in Berlin is an engineering consultancy founded by Karim Segond. Their expertise lie in providing 3D thermal and flow analysis, enhancement and development supporting electronics, electric engines, and power electronics. When E-Cooling began working on 20 MW motors it was evident that traditional CFD was not up to the job of meshing their complex geometries. Karim undertook the task of finding an approach that could handle complex geometries, wasn't too laborious but still delivered quality results, "The pre-processing with traditional CFD tools is much too slow for the simulation of large complex machines. I decided to look for a better solution that would solve my problems faster. I was specifically looking for software that can mesh such models with a Cartesian mesh and found FloEFD™. "E-Cooling's ethos is to provide detailed, accurate data to their clients at a reasonable cost, therefore the amount of man-hours used to mesh complex geometries is a big factor to consider for Karim. "The biggest benefits I got from FloEFD was that it was embedded, I

Figure 1. Rotor of a Hydro Generator. Photo courtecy of Hydropower Consult

With thanks to Karim Segond at E-Cooling GmbH
www.e-cooling.de

"The accuracy of FloEFD was always good. It is not easy to measure electric motors that run at very high speeds but FloEFD provided good results when compared to the measurements we received from our customers. FloEFD helped me to work on contracts that involved very complex geometries, such as a stator coil end turn support system, which I wouldn't have been able to do with other CFD software."
Karim Segond, E-Cooling GmbH

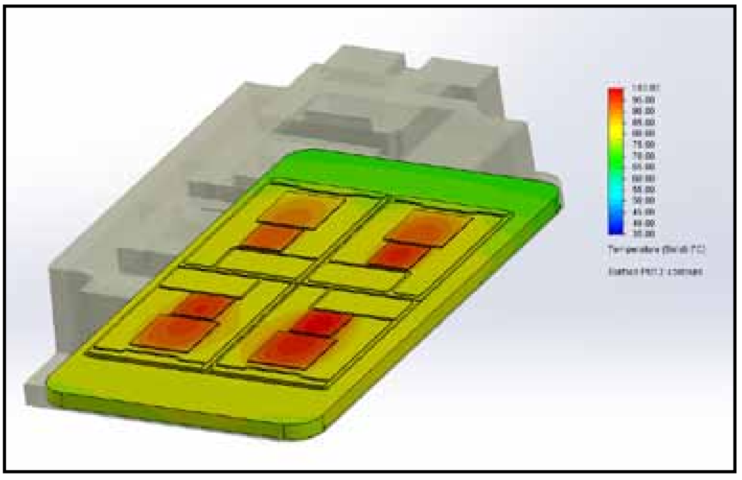

Figure 2. Surface temperatures in an IGBT casing

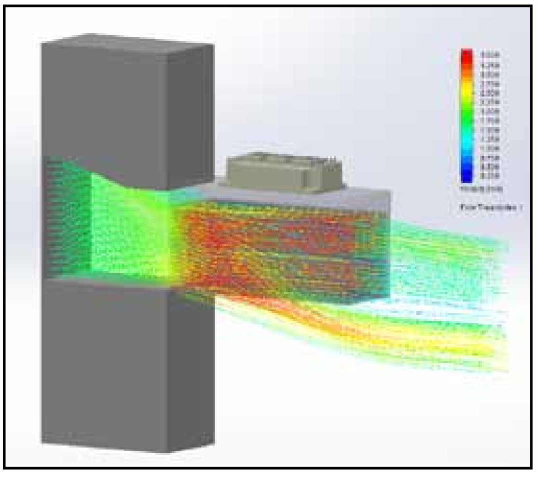

Figure 3. Streamlines through the heat sink of a power module

could work within a CAD system and use parametric CAD models. This made it easier to change any geometry and therefore run several variants very easily. Another point that lifted a heavy burden for me is the automatic meshing, so basically the meshing as I knew it became obsolete and I could spend my time with other things than manually mesh the geometry."
Karim is supported by his business partner, Guenter Zwarg, for the thermal management of these mega engines; the expertise of Günter covers almost all types of large electrical motors and hydro generators. According to Karim, his customers were always very satisfied with his work and the accuracy of the results has not suffered from the comfort of automatic meshing.

Karim is also investigating the thermal management of the power electronics components used to drive such large engines. Karim says "The cooling of power electronics is very important and should be considered as early as the concept stage of the design. Here CFD can be leveraged to optimize the design and ensure the best possible cooling for the components."

Besides simulations of IGBTs E-Cooling has turned their attention to the overall cooling of a system. Such cooling systems are too big and too complex to simulate with 3D CFD software. Therefore it is necessary to analyze them using a 1D thermal and fluid flow circuit that is modeled in a 1D CFD tool such as Flowmaster®. This combined solution then enables Karim to provide the qualities of both tools and provide the ultimate cooling solution to his customers.

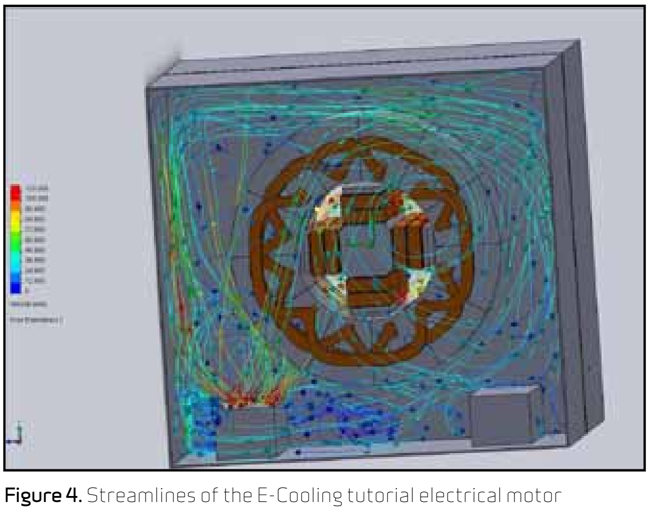

Figure 4. Streamlines of the E-Cooling tutorial electrical motor

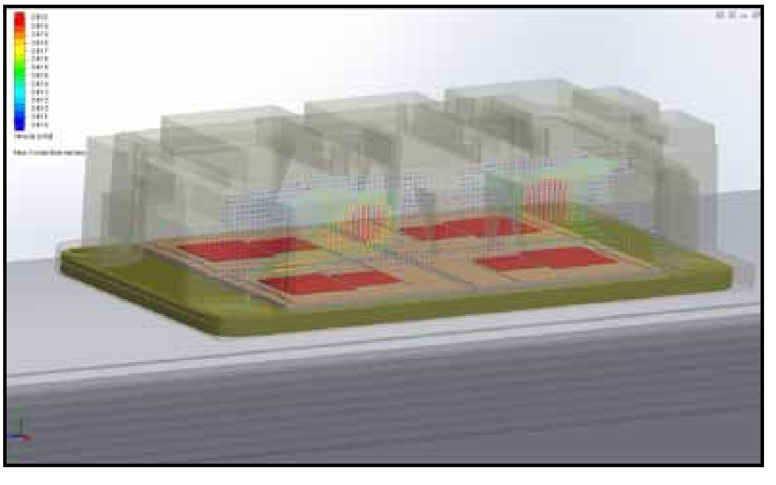

Figure 5. Flow vectors of free convection in the casing of a power module