PRESS RELEASE

Interview with Dr. Konrad Steiner on Foam Expo Europe 2024

Innovative Simulation Tools for Optimizing Foam Production

The perfect foam is not only important for drinks such as beer and coffee or for the airy consistency of chocolate mousse at Christmas dinner. Foam is also used for insulation in cooling devices or batteries as well as in seat cushions, prostheses or shoe soles. From December 3 to 5, 2024, the Fraunhofer Institute for Industrial Mathematics ITWM will be presenting its contributions to the future of foam production for lightweight construction at Foam Expo Europe 2024 in Stuttgart.

Dr. Konrad Steiner, Head of the »Flow and Material Simulation« department, provides insights into the latest development of the FOAM simulation tool. This tool helps to improve foam expansion for industrial applications, for example in the automotive, aircraft, refrigeration, construction and packaging industries. At our booth H1-250, researchers from the »Flow and Material Simulation« department will also be demonstrating the FeelMath software for predicting thermomechanical foam properties.

Dr. Konrad Steiner, Head of the »Flow and Material Simulation« department, answers questions about the FOAM and FeelMath software tools:

Konrad, the FOAM software simulates the foam manufacturing process. What makes the FOAM software solution so special?

The foam expansion process is a major challenge, especially when filling complex components: You need to know exactly how the foam material behaves, as it is highly reactive and therefore highly temperature-dependent. We have developed an automatic parameter identification process such that users only have to carry out a few simple foaming experiments. The necessary material parameters of the PU foam are then determined and are available for all calculations with the same foam. FOAM simulates the expansion process of foams in any geometry and offers the possibility of calculating the foam formation process and the resulting foam density in closed molds in advance.

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Companies therefore save time and money if they use simulations instead of constantly trying out new settings during the ongoing process. What else makes FOAM so interesting for users?

FOAM offers a user-friendly interface, pre-processing tools for CAD data, automatic parameter identification from foaming experiments to determine the dynamic material properties and supports various foams. It enables the optimization of foam components as well as the design of foaming tools and even the simulation of processes such as RIM infiltration of foam. With FOAM, very complex mold filling requirements can be predicted, including venting, injection nozzle path and material quantities.

For which applications is FOAM interesting and why?

Due to their low density, foams are attractive for a wide range of applications. They are used as shock absorbers or for sound and heat insulation and can be found as seat structures in vehicles of all kinds, for example in wheelchairs, automotive or airplane seats. In all these applications, the aim is to keep the weight of structures and components low without compromising the required strength and functionality.

In which applications has the FOAM software already been used?

Refrigerators and freezers are filled with polyurethane foam. The highest possible thermal insulation of refrigerators is achieved by filling as many cavities of the refrigerator as possible with PU foam. We were able to determine both the filling process and the foam density distribution completely digitally with FOAM. Additional insulation elements such as vacuum insulation panels are also taken into account in the calculation.

Another example: cells in a battery module must also be thermally insulated from each other and mechanically fixed. Cylindrical cells are often arranged next to each other and the spaces between them are filled with foam. We can simulate how the foam spreads and expands and use the results to examine in advance whether all areas that need to be filled are reached and whether the foam distribution is homogeneous. For large battery packs with hundreds of cells, we have also implemented a highly efficient homogenization method to make the calculation fast and sufficiently accurate.

Let's take a closer look: What is the FOAM digital twin?

We create a complete digital image for the foam components. The digital twin starts with the simulation of the foaming process to determine the local density and pore size distribution of the foam component. Based on this, a foam database is dynamically created for different densities and pore sizes. This step relies on microstructure simulations to determine the effective mechanical behavior of the foam, which we perform using FeelMath software. Finally, using the results from FOAM and FeelMath,

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the part design of the foam components can be optimized using a standard FE tool, taking into account the local material properties and process conditions.

You mentioned the FeelMath software. It will also be presented by your colleagues at the booth. What benefits does this software offer?

FeelMath is an extremely fast analysis tool for calculating the effective mechanical and thermal properties of microstructures that are given by volume images or analytical descriptions, such as foam models. It does the preliminary work for the component simulations, so to speak, by creating the necessary material model for all density ranges of the foam components.

You will be giving a presentation at the trade fair entitled »Accelerating and Optimization of Foam Production Using Fast and Accurate Digital Prediction Tools«. What can visitors look forward to?

In the presentation, I will show how the FOAM tool can be used to identify suitable model parameters as well as foam filling in demanding applications such as the highly efficient simulation method for large battery packs mentioned above and how it can also be used in other applications. Participants will learn a method for calculating very large and complex parts quickly and accurately, while still being able to account for small details with sufficient accuracy. They will learn more about the possibilities that foam simulation offers as a tool for process optimization.

Thank you for the background information and good luck at the fair!

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In an interview, Dr. Konrad Steiner provides insights into the latest development of the FOAM simulation tool. © Fraunhofer ITWM

More Information online: https://www.itwm.fraunhofer.de/PM_FOAM-24_Interview-EN

About the Fraunhofer Institute for Industrial Mathematics ITWM

The Fraunhofer Institute for Industrial Mathematics ITWM in Kaiserslautern is one of the largest research institutes for applied mathematics in the world. We see it as our task to further develop mathematics as a key technology and to provide innovative impulses. Our focus is on the implementation of mathematical methods and technology in application projects and their further development in research projects. The close cooperation with partners from industry guarantees the high practical relevance of our work.

Their integral building blocks are consulting, implementation and support in the application of high performance computing technology and the provision of customized software solutions. Our various areas of expertise address a wide range of customers: the automotive industry, mechanical engineering, the textile industry, energy and the financial sector. This also benefits from our excellent networking, for example in the Simulation and Software-based Innovation Center.

About the Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft, based in Germany, is the world's leading organization for application-oriented research. With its focus on future-oriented key technologies and the utilization of results in business and industry, it plays a central role in the innovation process. As a guide and driving force for innovative developments and scientific excellence, it helps to shape our society and our future. Founded in 1949, the organization currently operates 76 institutes and research facilities in Germany. More than 30,000 employees, most of whom are trained in the natural sciences or engineering, work on the annual research volume of 2.9 billion euros. Contract research accounts for 2.5 billion euros of this total.

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