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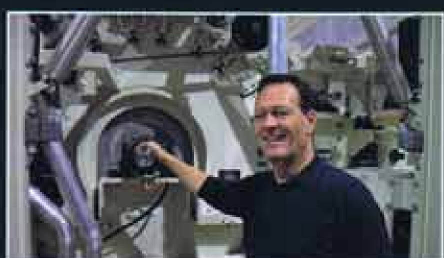
ROLLERS & SLEEVES



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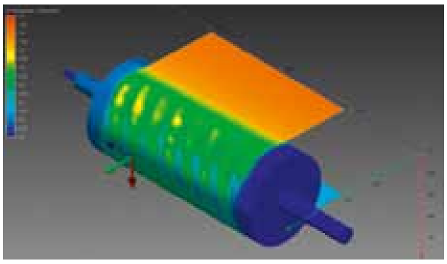
Everything flows

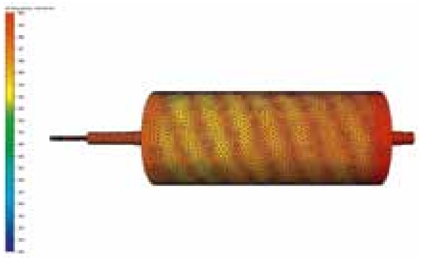
Menges Roller uses computational fluid dynamics to design improved heat transfer rollers

In today's converting industry, engineers and OEMs constantly push materials and machines to the limit in an effort to develop more advanced processes and manufacture materials with superior features. Efficient heating or cooling of substrates is often the key to optimising the quality and cost of these operations. Heating and cooling processes, however, are usually not simple tasks, especially since today's adhesives, coatings and substrates require very specific and consistent temperature ranges.

The responsibility of delivering this hot or cold energy usually falls upon a liquid-filled double-shelled roller. Modern thermal rollers – whether cold 'chill rolls' or hot 'heat transfer rollers' – must maintain their target temperature (with little or no variation across the roll face), even over long production runs. Hot spots, cold spots and uneven thermal transfer to the substrate result in problems such as poor laminating or uneven cooling of blown film.



An illustration of variations in thermal transfer as a thin layer of film moves across a cold roller



Thousands of nodes along the roll face note exact temperatures externally and inside the fluid cavity of the roller

Critical design questions

"Many OEMs and converters are burdened with continually improving or modifying their heat transfer rollers in order to accommodate innovations in processes and materials," explains Jeffrey E. Awe, marketing director at the American-based Menges Roller Company.

"Fortunately, CFD technology can be utilised to answer such critical design questions." CFD stands for computational fluid dynamics – a concept that has traditionally been used by highly advanced organisations such as NASA, which uses CFD models to simulate the re-entry of spacecraft into the atmosphere. Their models show the details of heat, friction and molecular augmentation as shuttles plunge earthbound at 27 600km/hr.

Now, the experts at Menges Roller are using CFD models to simulate converting processes and design better heat transfer rollers. "It is now possible to use CFD thermal models in order to generate accurate predictions of a roller's temperature profile as it performs within a converting operation," states Awe.

Predictable performance, excellent results

"Additionally, engineers can use CFD to visualise the effects and reactions these hot or cold rollers will have upon materials or substrates. Thus, we are not only able to design better rollers, but we can also potentially optimise the actual converting processes in which these rollers operate!"

"The use of CFD thermal modelling technology has enabled our engineers to reduce the number of unknown factors that go into designing a thermal roller. Performance is much more predictable, and excellent processing results are achieved by the converter in a shorter amount of time."

For converters that have taken advantage of these state-of-the-art technologies, the results have been exceptional, claim the American experts. "Since incorporating computational fluid dynamics into our design and engineering process, we are manufacturing heat transfer rollers that we absolutely know will achieve very specific temperatures with very small tolerance windows," says Matthew Menges, president of Menges Roller Company.

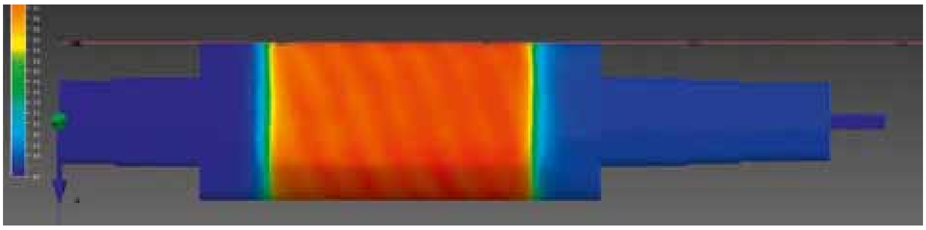
"Converters using our newly-designed rollers will see better laminating results and higher levels of quality in their films. Consequently, they are often able to increase line speeds and reduce waste material."

Preventing costly design errors

The new technology is especially useful, when new equipment is being configured and new processes are tested. Obviously, it is much less costly to run several predictive CFD simulations on a computer compared to experimenting with multiple chill roller designs in a real-world setting. "Can you imagine rebuilding a €3M machine, only to discover the heat transfer rollers are too small to accomplish the task? CFD modelling prevents these types of costly design errors," underlines Awe.

For double-shelled heat transfer rollers, one of the most important factors that determine a roller's thermal signature is the spiral baffle wrap (which is welded or machined onto the outside surface of the inner shell). The angle of this spiral wrap helps determine the amount of time a thermal fluid circulates inside the roller and this can have a strong effect on the roll's temperature signature.

As all parts are connected, a change in spiral baffle angle might then mandate another change in outer shell thickness or modification to the inner cavity's fluid volume. "The 'relatedness' of so many factors accentuates the need for a technology that can handle thermal, physical, rotational, chemical and reactive factors – as CFD models do," affirms the American expert. CFD models also generate detailed, colour-coded images that completely map the roll from one end to the other. These images show precisely how much hot or cold energy the roll will generate, how much of that energy will be distributed to the substrate, and the final temperature changes the substrate will undergo. Temperature variations, which can be shown in tenths or even hundredths of a degree, are noted across thousands of data nodes along the roll face and web surface. This makes it very easy to spot any potential cold spots, hot spots or temperature variations falling outside the tolerance range.



This image – generated using CFD thermal modelling – shows the temperature profile of a heat transfer roller

Playing with ideas

"The use of 'CFD thermal modelling technology for heat transfer rollers' helps converters 'play with ideas'," emphasises Awe. "Engineers are perhaps less afraid to test new processing ideas and machine designs, knowing that thermal and reactive results can now be accurately simulated, eliminating the spending of resources on experimental equipment and elaborate 'trial and error' tests."

Moreover, CFD technology can also be tied to secondary applications such as FEA (finite element analysis) and 3D CAD applications. Finite element analysis is a stress testing application that helps engineers test the load bearing capacities of rollers. After a group of CFD modelled design options has been selected, each option can be run through an FEA testing process to verify the roller's strength. The FEA model will show areas of stress and predict zones that might require thicker steel or larger journal shoulders.

After all design modifications have been made and the roller is ready for production, final designs are outputted to a 3D CAD programme or a standard CAD schematic generator. By tying the CFD modelling capabilities to a recognised CAD application, shop-ready prints of the final design can be easily generated. This ensures every measurement and specification relating to the final design is incorporated into the actual fabrication plans. ■