

LED Design Case Study: Improving the Thermal Performance of a LED Replacement Light Bulb

In conjunction with experimental techniques, ATS Europe used Future Facilities' 6SigmaET electronics simulation software to analyze various designs for LED replacement light bulbs. Recommended modifications were then evaluated using the simulation package. When modifications were proven by 6SigmaET to provide an improvement, the best designs were experimentally verified. Through numerous design steps combined with the industrial design changes, the new lamp showed its potential.

How Difficult Can LED Lighting Be?

In recent years, the consumer lighting market has had a rapidly increasing offering of LED base light bulbs to replace the traditional incandescent light bulbs. The challenge for a replacement market is to have the light colour which the consumer expects, a form factor which is comparable to the traditional incandescent light bulbs and a thermal solution which is orientation independent whilst aesthetically fulfilling customer desires.

How Small Can You Go?

Traditionally, to decrease the LED temperature, one would have to increase the size of the heat sink. But how low can you go without increasing the size of the light bulb heat sink? With one of the design constraints being the form factor of a traditional light bulb, Lemnis Lighting B.V. asked its partner ATS Europe, B.V. to design a thermal management solution that can have the lowest possible heat sink temperature. To do this with simulation, one needs to have a simulation tool which can accurately predict the thermal performance of a complex natural convection phenomenon of extremely curved 3D solid objects.

The original LED replacement light bulb (right) and its surface temperature plot (bottom)



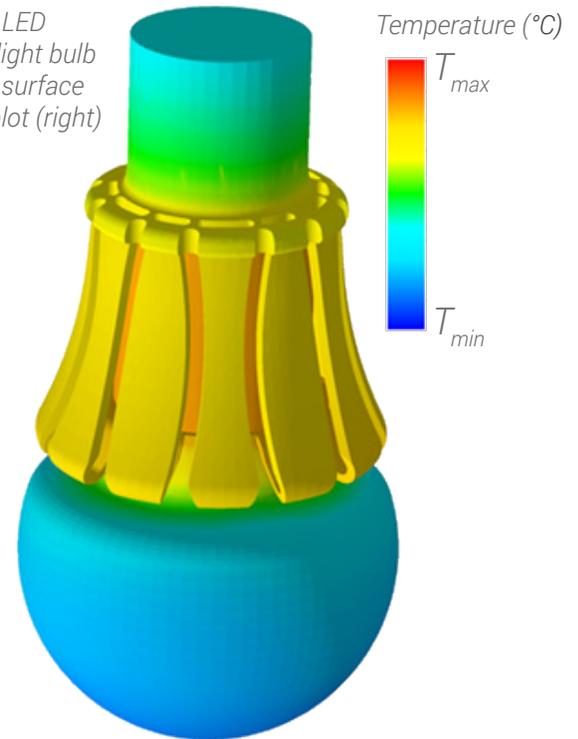
6SigmaET, a computational fluid dynamics (CFD) simulation tool, brings new levels of productivity to electronics cooling design. Thanks to its ease-of-use, it overcomes many of the problems that have plagued analysis tools from the beginning. Boasting substantial automation and intelligence, 6SigmaET is already being used by a global community of design engineers.

"6SigmaET allows for the rapid thermal evaluation of different designs... this is critical to the short term and long term success of our LED product."

Norbert Engelberts
Director
ATS Europe
Optimal Thermal
Solutions BV



The new LED replacement light bulb (left) and its surface temperature plot (right)



The Results

Experimental testing of the initial design showed that there was a maximum of just 5% difference between 6SigmaET's predicted temperatures and the actual experimental values. Similarly for the new design, 6SigmaET's predicted temperatures were within 5% of the experimental temperatures.

The use of 6SigmaET to test and evaluate the light bulb designs reduced the requirement for physical prototypes, allowed the accurate assessment of the performance, suitability and effectiveness of each design modification, and therefore aided the development of the new and improved light bulb design significantly. At the end of the process, it was found that there was a 14% improvement in the light bulb's performance overall, as a result of the changes to its design.

ATS Europe provides leading-edge thermal management solutions to its European partners. ATS and ATS-Europe engineers have over 100 years of collective thermal management experience, 35 patents, over 70 professional publications, and receive continual requests for technical presentations at international and national conferences. Their engineers from across the globe collaborate to provide next-generation products and custom solutions to meet growing thermal management and packaging needs.

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