White Paper:

Cooling of LED based retrofit lamps.

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“LED based lighting is a fast growing market where the product thermal management is critical to the short term and long term success of the product. 6Sigma allows for the rapid thermal evaluation of different designs.”

Optimal Thermal Solutions B.V.

- Can simulation accurately predict the heat sink temperature of a LED based down light lighting system?
- Custom client light emitting diodes (LEDs)
- E27 60 Watt form factor

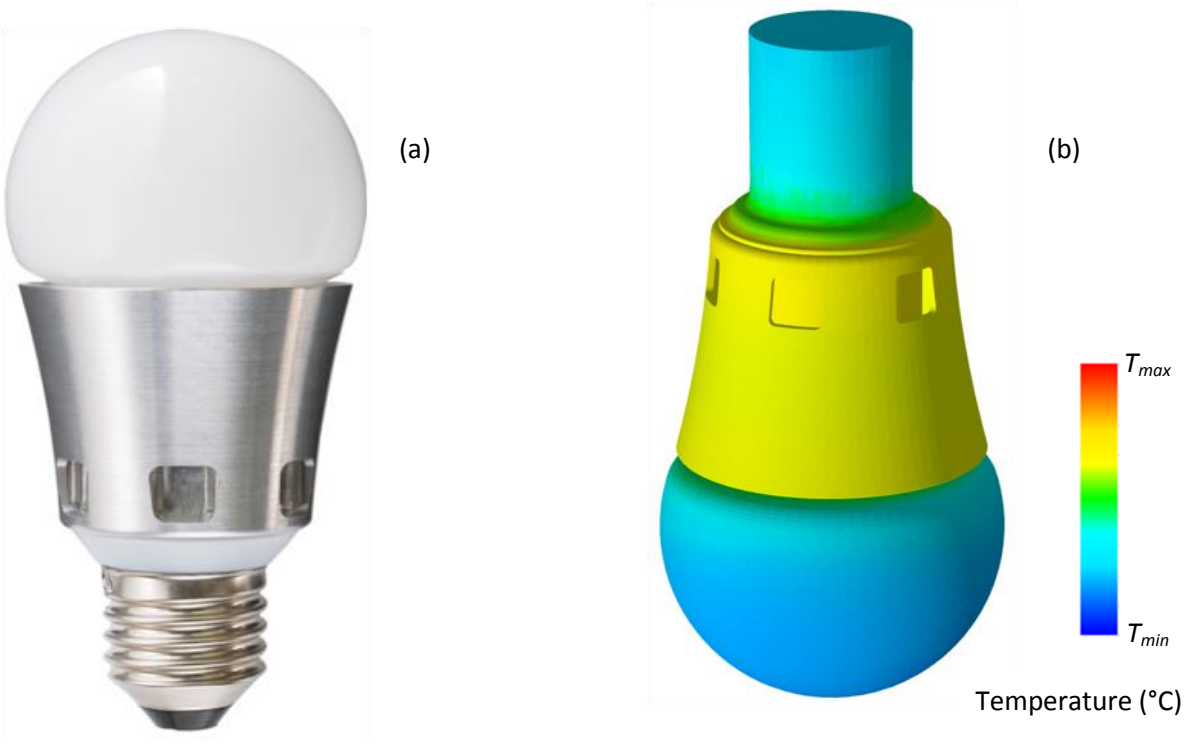

Figure 1: The original LED replacement light bulb (a) with a surface temperature plot (b).

How difficult can LED lighting be?

In recent years, the consumer lighting market has 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 best possible orientation independent thermal solution that is aesthetically fulfilling customer needs, light colour which the consumer expects and a form factor which is comparable to the traditional incandescent light bulbs.

How low can you go?

Traditionally, to decrease the LED temperature, one would have to optimise the heat sink. Or 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 did asks its partner Optimal Thermal Solutions, B.V. (ATS Europe, B.V), to design a thermal management solution that can have the lowest possible heat sink temperature. To do this with a simulation package, one needs to have a tool which can accurately predict the thermal performance of a complex natural convection phenomenon of extremely curved 3D solid objects.

The Solution Options

In conjunction with experimental techniques, Optimal Thermal Solutions used Future Facilities' 6SigmET simulation software to analyse various designs proposed. Modifications recommended were then evaluated using the simulation package. If proven to provide an improvement by the simulation package, were experimentally verified. Through numerous design steps combined with the industrial design changes the new lamp showed its light.

The results

When physical models were made and tested, it was found that the initial design had a 6% higher temperature than the 6Sigma simulated model. When the original design was tested, it had around 5% lower temperature than the experimental value. Due to the improvements in the design, it was found that there was a 14% improvement in the lamp bulb's performance. 6SigmaET predicted a 21 % improvement.

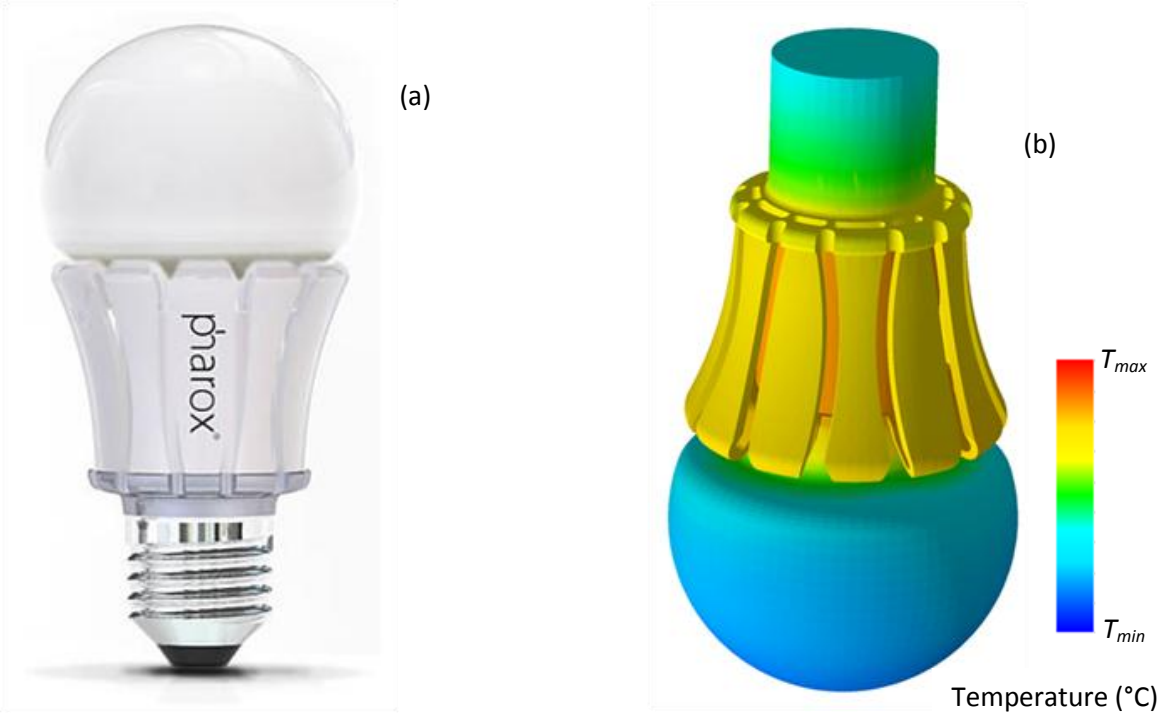

Figure 2: The new LED replacement light bulb (a) and surface temperature plot in 6Sigma (b).

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