DEVELOPMENT OF AN OUTDOOR LUMINAIRE USING SPEOS SOFTWARE

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Abstract

The task of the paper is the development of a luminaire using induction light sources and aluminum mirror surfaces for outdoor lighting purposes. We designed the luminaire with a professional light-modeling and simulation software called OPTIS SPEOS which is used at the Budapest University of Technology and Economics (BUTE), Department of Mechatronics, Optics and Engineering Informatics (MOEI). The aim of the development was to design reflective surfaces to achieve the required light distribution. The luminaire had to create the illuminance prescribed by standards, using 2x15 W induction light sources (~700 lm luminous flux each) from 5 m height, considering also economical operation. There was no available simulation input for the applied light source, thus we had to generate the exact luminous intensity distribution database too.

Keywords

Luminaire, induction lamp, simulation, SPEOS

1 Introduction

The modern induction light sources have many beneficial characteristics (long life, high luminous efficacy, low heat emission, rapid re-ignition). However these lamps have typical light-distribution due to the special build (Fig.1), which sometimes restricts their use, and makes the luminaire design difficult. This is the reason why although induction light sources are suitable for outdoor use, they are not so popular.

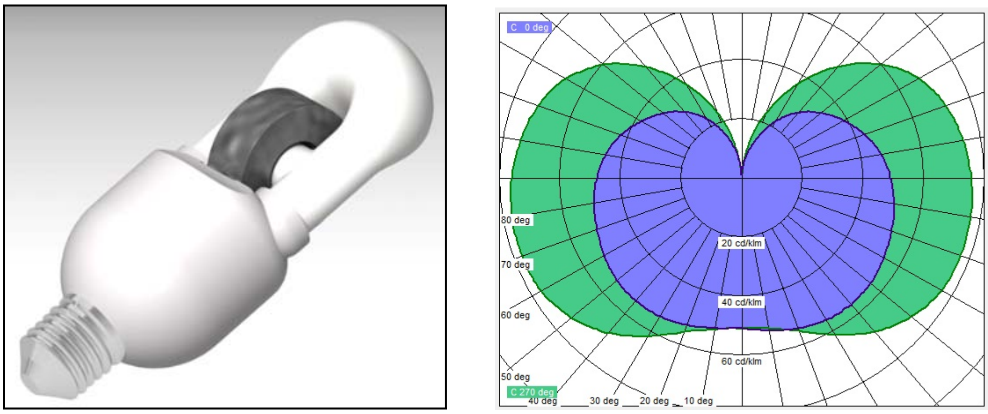

Fig. 1 Structure and luminous intensity distribution of the used induction light source

2 Generating the luminous intensity distribution database

The first step was to build-up the simulation environment. The applied inputs had to be accurate in order to get exact simulation results. The luminous intensity distribution data file was only available for the 23 W type of the luminaire, however the correct 15 W luminous intensity distribution file was important for the simulation. The manufacturer informed us, that the luminous intensity distributions of the two lamp types are similar to each other, only the maximum intensities are different. Therefore, with illuminance measurements, and with the simulations of these measurements using the 23 W database, the required luminous intensity distribution file can be created for the luminaire development.

The main steps can be seen below:

1. Illuminance measurements from discrete distances (X = 2,3 and 4 m) with the **15 W** light source, using a calibrated photodiode;

2. Simulate illuminance values with SPEOS from the same distances using the **23 W** light-distribution file;

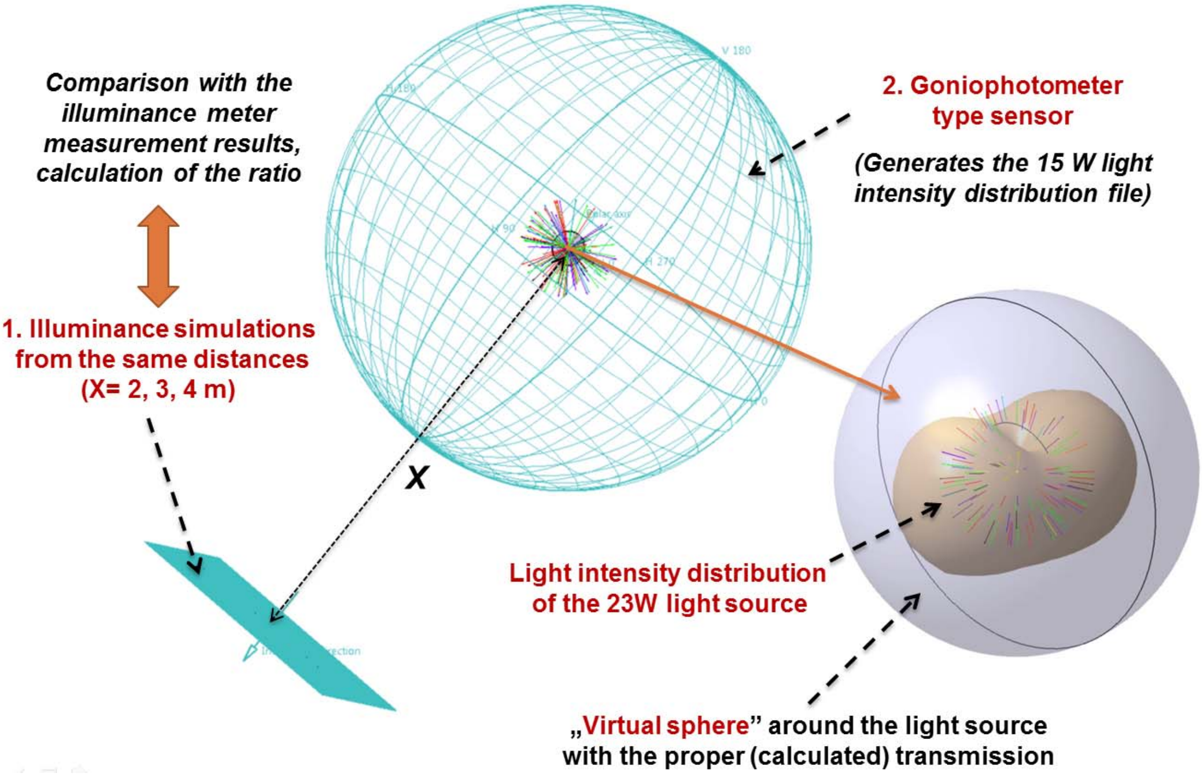

Fig. 2 Simulations with SPEOS
Results comparison and the generation of the 15 W luminous intensity distribution

Tab. 1 Illuminance measurement results

	Illuminance measurements (Light source: 15 W)		Illuminance simulations (Light source: 23 W)	
X [m]	2	3	2	3
$\bar{E}$ **[lux]**	**25,8**	**11,8**	**34,2**	**15,3**
σ [lux]	1,1	0,7	0,2	0,1

The standard deviations (σ) of the measurements and simulations were sufficiently low.

3. From the comparison (Tab.1) of the results the **ratio** can be calculated.

Tab. 2 Calculation of the ratio (transmission)

Calculated ratio (T)	
X = 2 m	0,75
X = 3 m	0,77
$\bar{T}$	**0,76**

4. Using this value, if we put a virtual transparent sphere with a known transmission (Tab.2 - 76 %) around the 23 W light source (Fig. 2), the correct light-distribution file can be created.

3 Conclusions

We made additional simulation with the new luminous intensity distribution file, to verify its accuracy. We compared the results with the measurements (Tab. 3).

Tab. 3 Accuracy check of the generated distribution file

15 W light source (X=4m)	$\bar{E}$ **[lux]**	**σ [lux]**
Simulated illuminance with the generated light intensity distribution file	4,7	0,1
Measured illuminance	4,9	0,3
Difference: 4,1 %		

The difference between the measurements and the simulations is 4,1 %, thus the accuracy of the applied model was acceptable.

We also created the CAD model of the light source, and we set the optical surface properties to each part. There is no manufacturer data from the accurate color temperature of the light source, therefore we measured its spectral-power-distribution using a spectroradiometer camera (Konica Minolta CS-1000). The measurements were implemented in the simulations to achieve better accuracy.

The developed luminaire can be seen below (Fig.5):

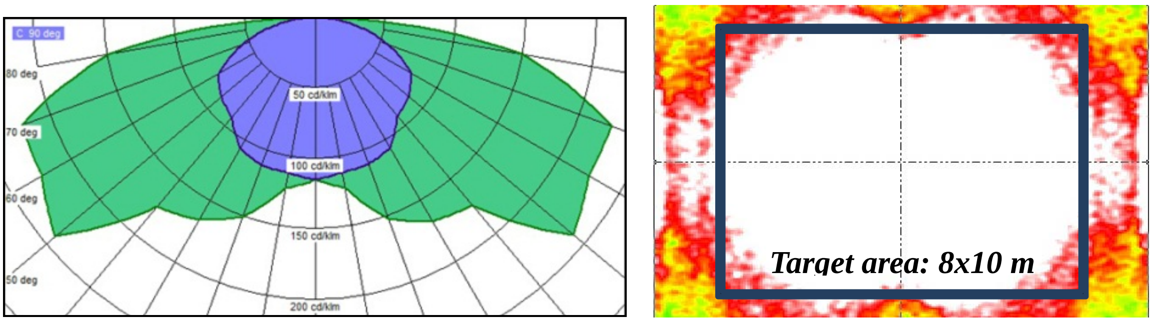

Fig. 4 Luminous intensity distribution (left) and illuminance results of the developed luminaire
In the right picture, the white area fulfills the required criteria (min. 5 lux) from 5 m height

As the simulation results show, the lamp has a typical outdoor light distribution, and the illuminance from 5 m height is appropriate almost everywhere on the target area (white areas).

Fig. 5 The developed luminaire

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