The application of the Radiance system for calculation of luminous intensity distribution of car high-beam headlamp

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Abstract: Application of a Radiance system permits simulations of basic values of luminous dimensions necessary for calculated of luminous intensity distribution of cars projectors. The applied method of modelling allows of elimination of many reductions which are usually done in standard methods in relation to the shape of the reflector and also other parts of the lamp. In this report the results of calculations have been shown concerning the car projector equipped with a clear globe and a basic optical system. Moreover, both analysis of the obtained results and evaluations of usefulness of the proposed method have been presented.

Introduction

Radiance system has been commonly used for creation of photorealistic visualization of interiors [5]. However, it allows also determining distribution of luminous intensity of car's headlamps using specific calculation algorithm [3]. The common aspiration to reach the highest efficiency of the car's headlamps involves still new ways of studies. Therefore, for formation of luminous intensity distribution a mirror reflector of a complex shape is proposed, instead of prismatic globe, in all kinds of optical systems studied. The proposed method allows both for improvement of illumination, and for keeping all demands of United Nations Economic Commission for Europe (ECE) regarding car's headlamps

II. The choice of a model system.

An optical system of car headlamps, HL-133 H3 MSR, used in VW Golf I/II, was chosen as a subject of the present studies. The main beam headlamps were fitted with a tungsten halogen lamp with PK 22s holder. The 55 W lamp with a 12 V lamp voltage and total flux 1450 lm. Basing components of the headlamps and their dimensions are shown in Figs. 1 and 2. A simple reflector is a main component, which shapes the distribution of luminous intensity. It is composed of a smooth paraboidal part and four vertical belts. The belts cause that the light spot is stretched out horizontally.

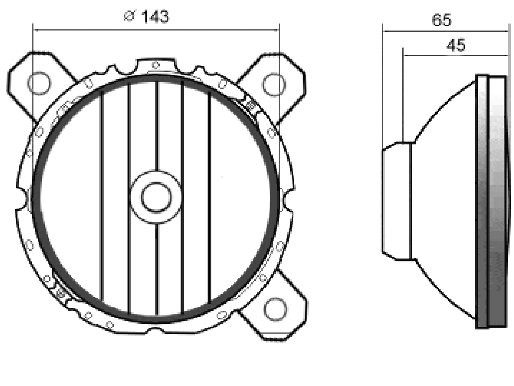

Fig.1. Dimensions of the headlamp [7]

Fig.2. Basic optical elements of the headlamp
1 – holder, 2 – tungsten halogen lamp, 3 – shutter of tungsten, 4 – reflector, 5 – clear globe

III. Geometry.

In order to carry out the simulation using a method of detection of the light beam in the Radiance surroundings, it was necessary to form a tri-dimensional copy of all optically active parts of the headlight. Numbers of components, kinds of materials and reflection coefficients, used for the headlight reproduction in the Radiance surroundings, are shown in Table 1.

In a given method the assumed number of the elements depends on the element actual size and on degree of element complexity. Moreover, the expected influence of a given element on the route of the light beam is also of importance. Active surfaces of the reflector and division of the surfaces into flat elements are shown below, see Fig.3.

Table I
Elements of headlamp

Elements	material	numbers of components	reflection coefficients [1]
paraboidal reflector	mirror	1296	0,7
vertical belts	mirror	192	0,7
shutter of tungsten	mirror	81	0,7
holder	mirror	108	0,5
tungsten	light	16	0

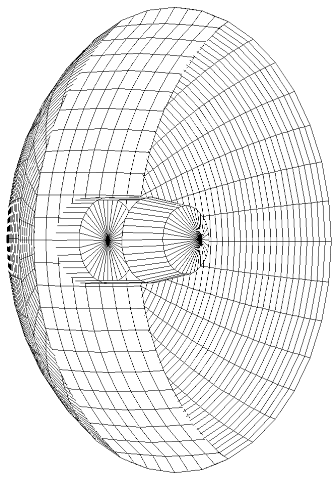

Fig.3. Discretisation of headlamp

The presented in Fig.4 luminous element was reproduced by flat elements of uniform luminance, which formed luminous filament having dimensions 5x1 mm.

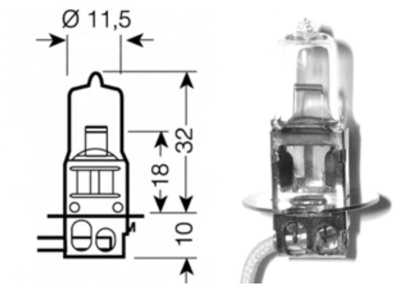

Fig.4. Tungsten halogen lamp H3 [6]

Restrictions of the Radiance system cause that the elements, which play the role of the light source, possess zero reflection coefficients [4].

IV. Results of the measurements

In order to verify the obtained results of simulation, comparison with the measured values in real system was done.

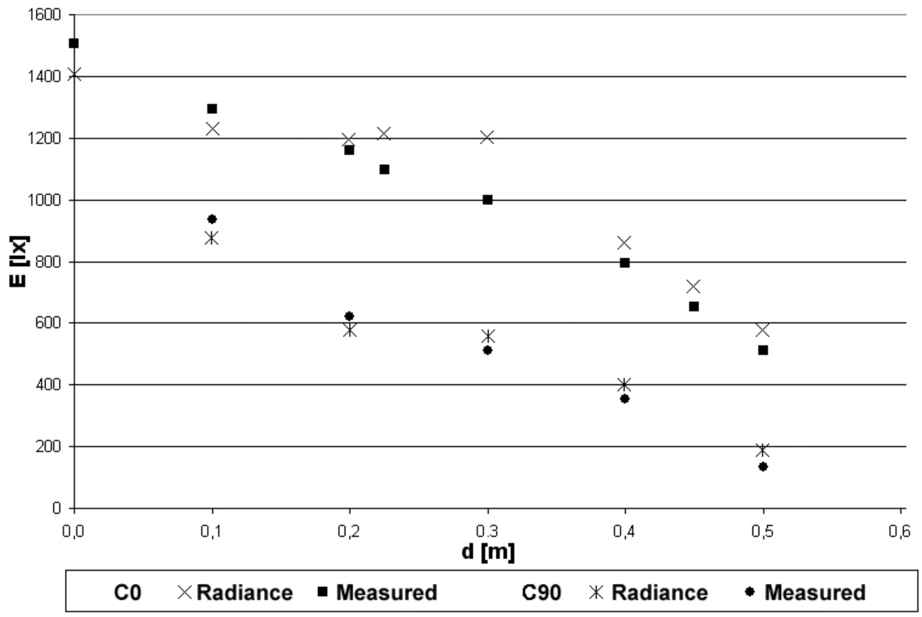

Fig.5. Illuminance E on reference surface (horizontal C0 and vertical C90)

It is the best if the measurements of distribution of light intensity are done on a measuring screen placed in a 25-meter distance from the light source. However, on account of laboratory possibilities, the screen was placed in a test distance of 5 meters. The required levels of illumination intensity for headlamps equipped with tungsten halogen lamp are collected in Table II. The presented values are related to C0 plain only. Illumination intensity and a distance from the axis of the system are conversed for the screen placed 5 meters from the lamp.

Table II
Required Levels of Illumination Intensity [2]

distance - 25m		distance (surface) - 5m	
d [m]	E [lx]	d [m]	E [lx]
0 - 1,125	≥24	0 – 0,225	≥600
1,125 – 2,250	≥6	0,225 – 0,45	≥150

One can conclude, comparing the values of the levels of illumination intensity given in Table II with these calculated from experimental data, that that the studied reflector fulfils all principal requirements.

V. Summary.

The presented method of examination of car's headlamps allows to determine their luminosity curves. Therefore, in enables comparison of the obtained values with the demanded ones. Divergences between the values of illumination intensities measured in a real system and these determined using the above described method, see Fig.5, are probably on account of approximate reproduction of the reflector, the main moulding element. It should be mentioned here, that even small changes of the reflector geometry or correction done in the location of the light source caused significant variations in luminous intensity distribution. The possibility of simulation of reflector examination at 25-meter test distance allows for application in the described model of any distance of the light source from the measuring screen. Additionally, the possibility to carry out calculations for any systems having complicated form is the other positive feature of the described method.

Literature

[1] Basics of Light Techniques, Bak J., Pabjanczyk W.: Podstawy techniki świetlnej. WPŁ, Łódź 1994, p.98
[2] Car's Light Techniques Mazur J., Żagan W.: Samochodowa technika świetlna. Warszawa, Politechnika Warszawska, 1997, s. 112.
[3] The Calculations of Luminous Frames using Desktop Radiance and Radiance Systems Wandachowicz K.: Obliczanie opraw oświetleniowych z wykorzystaniem systemów Desktop Radiance i Radiance. http://lumen.iee.put.poznan.pl/kw/oprawy/p1.2opr.pdf
[4] Calculation Techniques for Visualisation with Radiance System as an Example. The Application of Computers in Electrotechniques. Wandachowicz K., Hauser J.: Techniki obliczeniowe stosowane przy wykonywaniu wizualizacji na przykładzie systemu RADIANCE. ZKwE, Poznań 12 - 14.04.1999
[5] Determination of Luminance Distribution in Interiors Considering Directionally Distributed Reflection Characteristics of the Materials. Wandachowicz K.: Wyznaczanie rozkładu luminancji we wnętrzach z uwzględnieniem kierunkowo-rozproszonych charakterystyk odbiciowych materiałów. Politechnika Poznańska Poznań 2000
[6] http://www.osram.pl
[7] http://www.wesem.com.pl