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Regulation and temperature dependency of the light sources

Jiri Vincenec[1,a] and Martin Zalesak[1]

[1] *Tomas Bata University in Zlin, Faculty of Applied Informatics, Department of Automation and Control Engineering, Nad Stranemi 4511, Zlin, Czech Republic*

Abstract. The paper focuses on the regulation effect on the photometric properties of the artificial light sources generally used in administrative and residential buildings. If energy consumption is one of leading areas of usage, there is an area for improvement and energy savings. There are several approaches how to achieve this aim. This attempt for energy saving is limited by standards which regulate the quality of the luminous environment; for example, illuminance level, uniformity illuminance, the colour rendering respectively colour temperature or glare requirements.

1 Introduction

Nowadays, when electric energy is used almost in all areas, higher efficient is required from electric devices. One of the leading areas of usage is Illumination. According to Şahin, 19 % of total amount of energy consumed is for illumination [1]. This quantity of energy encourages for improvement of the lighting solutions installed in buildings.

For example, Şahin described the usage of artificial neural networks for calculating the efficiency of the used lighting solution and the uniformity of its illuminance and as a result of these calculations optimal period of maintenance can be decided [1]. Another approach is optimisation of interior lighting as described Madia, in this solution, genetic algorithms were used for optimising illuminance and uniformity with no interventions to a building [2].

On the other hand, several studies compare different control approaches. Pandharipande described two architectures for lighting control centralised and distributed [3]. Roisin deal with individual daylight dimming system, movement detection switching, movement detection dimming and its combinations [4].

During daytime is appropriate using daylight. Han describing new developments in illuminations; for example, solar tubes or Mini-dish optical-fiber solar system for indoor illumination [5]. The shading control of daylighting through windows is described in several studies; for example, the subdivided window design with light shelves, which divide window to two parts, one with static light shelves and the second part with light shelves controlled by the occupant is presented by Sanati [6].

Due to this approach, our intention is to discover the effect of regulation on the photometric properties of the light sources. Because, no matter what approach is chosen, the light environment must fit the standards; for example, CSN EN 12464-1 [7].

2 Methods

This study was performed for common light sources used in residential buildings. Every light source was measured in a climatic chamber for several temperatures, specifically 0, 5, 10, 15 and 20 °C. Temperatures below 0 °C were not chosen due to impossibility measured photometric properties with provided measure head.

The measurement began with a time period when the light source was switch on with 100 % regulation level and the climatic chamber was set on one of the temperatures. This period lasts minimally 25 minutes.

Figure 1 shows inside of the climatic chamber. Due to stainless steel walls inside the climatic chamber, these walls were covered with paper.

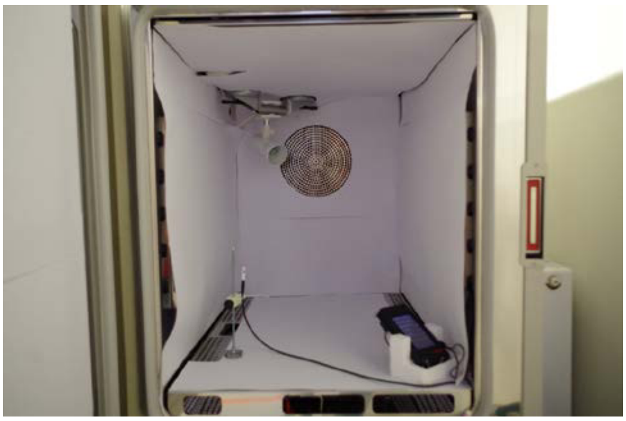


Figure 1. Climatic chamber with modification

During the measurement were recorded illuminance levels, colour temperature, spectral luminous efficiency,

[a] Corresponding author: vincenec@fai.utb.cz

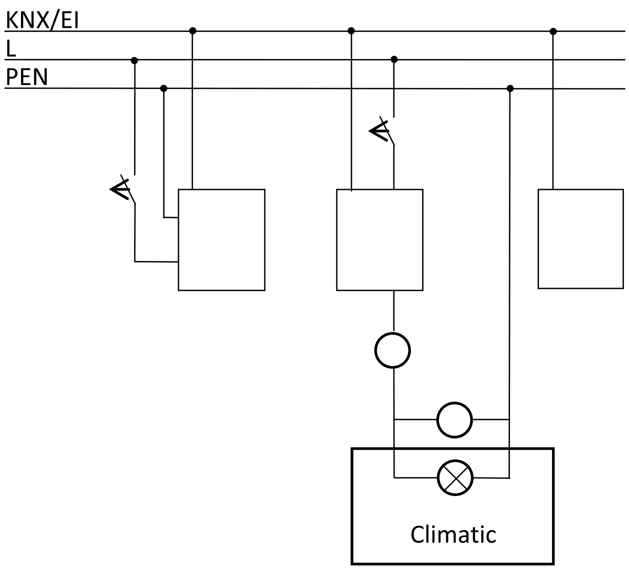
voltage, current and for verification temperature inside the climatic chamber. Those parameters were measured for the possibility to describe temperature effect on the photometric properties.

The attributes of the measured light sources are given in Table 1, those attributes were read out from the wrapper.

Table 1. Attributes of the light sources

Light source	Power [W]	Colour temperature [K]	luminous flux [lm]
Bulb	75	2700	940
Classic ECO halogen	53	2700	840
LED Premium	14	2500	995

Figure 2 illustrate a diagram of the regulation circuit used for measurement. As could be seen only light source and measurement heads were inside the climatic chamber, regulation elements were stated out of the chamber.



L	-	Phase	V_1, V_2	-	Voltmeter
PEN	-	Protective earth, neutral	A	-	Ammeter
REG	-	Regulation element			

Figure 2. Diagram of the regulation circuit used for measurement

3 Results

This article provides relative illumination in selected regulation levels, colour temperature and spectral composition of artificial lighting at different temperatures.

3.1 Bulb

The first artificial light source was the bulb. Figure 3 summarises relative illumination in selected regulation levels and temperatures. From this figure conclude no obvious dependency on temperature. In several regulation levels, there is a small difference between relative illuminance but this difference is probably caused by measurement error.

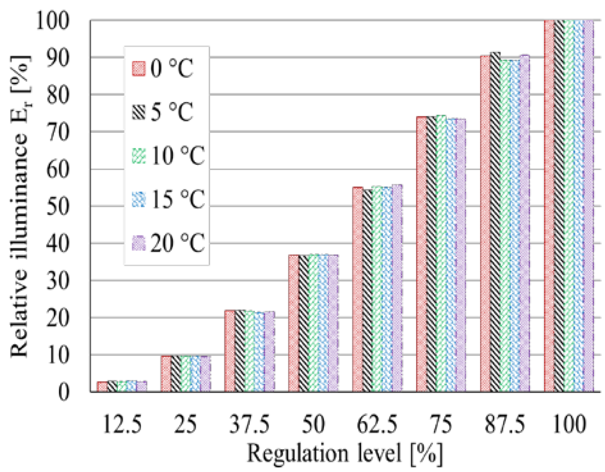


Figure 3. Relative illumination in selected regulation levels and temperatures (Bulb)

Following Figure 4 colour temperature dependency on regulation levels and temperature shows difference at the lowest regulation levels, when the light source provides the lesser colour temperature at the lower temperature. Higher regulation levels, above 37.5 %, provide the equal colour temperature at all measured temperatures.

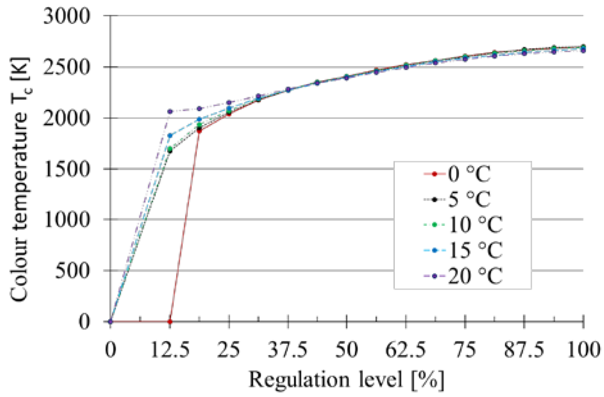


Figure 4. Colour temperature dependency on regulation levels and temperature (Bulb)

Figure 5 shows the spectral composition of artificial light (Bulb) at different temperatures and V(λ). This figure provides us only with the spectral composition at 50 % and 100 % regulation level. As can be seen there in no difference in spectral composition, the difference is only when the regulation level is changed.

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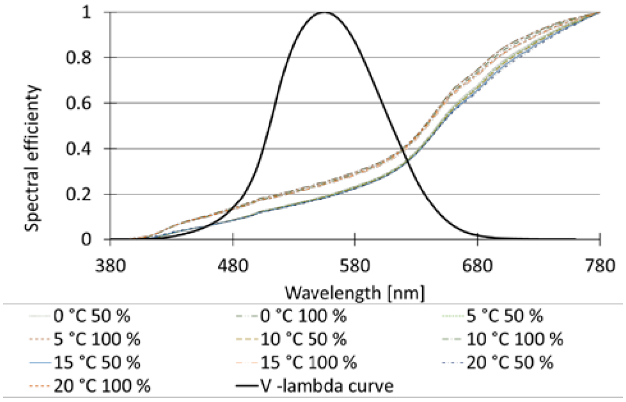

Figure 5. Spectral composition of artificial light source at different temperatures and V(λ) curve

3.2. Classic ECO halogen

The second light source was classic ECO halogen. Figure 6 presents relative illumination in selected regulation levels and temperatures. As can be seen, there is also no obvious dependence on temperature as was not which bulb artificial light source. A small difference in several regulation levels is probably caused also by measurement error.

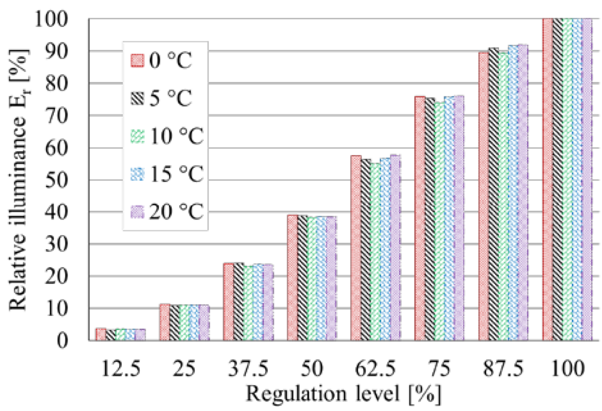

Figure 6. Relative illumination in selected regulation levels and temperatures (Classic ECO halogen)

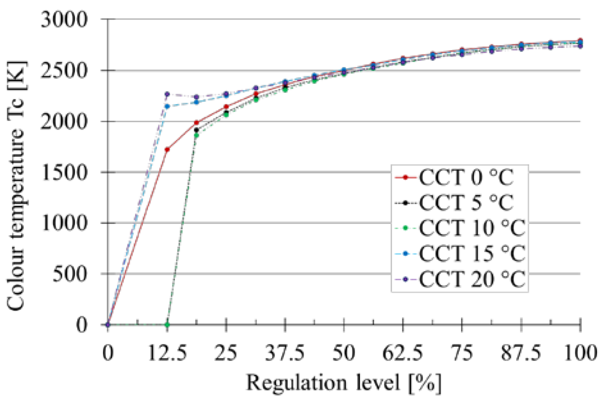

Figure 7. Colour temperature dependency on regulation level and temperatures (Classic ECO halogen)

Figure 7 illustrates colour temperature dependency on regulation level and temperature. According to the figure, the difference is only at lower regulation levels, but in this case, it is not the truth that the lower temperature provides lower colour temperature. Also higher regulation levels, above 43.75, provide the equal colour temperature at all measured temperatures.

Figure 8 shows the spectral composition of artificial light at different temperatures and V(λ) curve. This figure provides us only with the spectral composition at 50 % and 100 % regulation level. As can be seen there in no difference in spectral composition, the difference is only when the regulation level is changed.

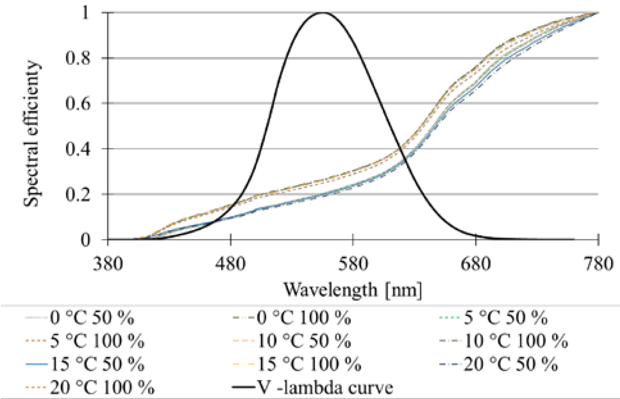

Figure 8. Spectral composition of artificial light source (Classic ECO halogen) at different temperatures and V(λ) curve

3.3 LED Premium

The third artificial light was LED premium. Figure 9 shows relative illumination in selected regulation levels and temperatures. The figure illustrates no obvious dependence on temperature as were not in previous measurements. Same as in previous measurements there is a small difference in several regulation levels which is probably caused also by measurement error.

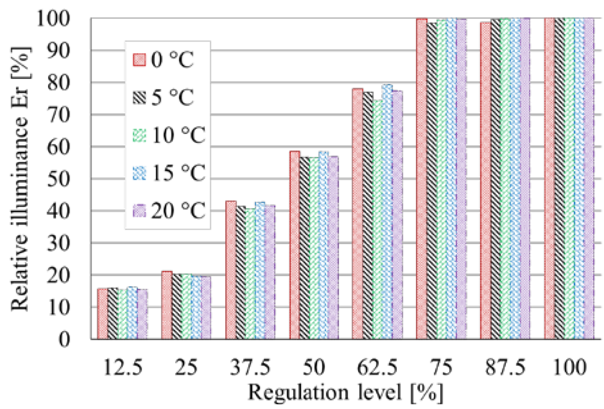

Figure 9. Relative illumination in selected regulation levels and temperatures (LED Premium)

Figure 10 illustrates colour temperature dependency on regulation level and temperature. According to the figure, there is no difference in colour temperature in chosen regulation levels and temperatures.

Figure 11 show us spectral composition of artificial lighting at different temperatures and V(λ) curve. In this case, there is no difference in spectral composition of LED Premium artificial light source. Even different regulation levels do not have an effect on the spectral composition of LED Premium artificial light source.

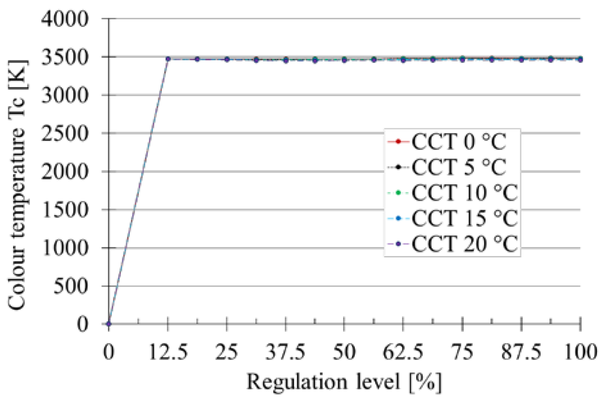

Figure 10. colour temperature dependency on regulation level and temperatures (LED Premium)

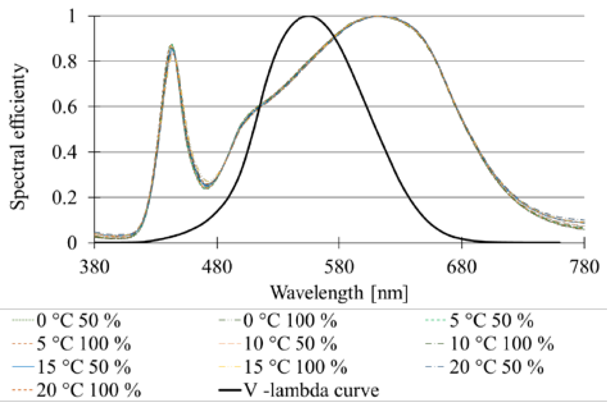

Figure 11. spectral composition of artificial light source (LED Premium) at different temperatures and V(λ) curve

4 Conclusion

This article describing. temperature effect on the photometric properties. As can be seen from Figures 3, 6 and 9 shows that the temperature in the range between 0 °C to 20 °C do not have an effect on the illumination, the small difference in regulation levels is probably caused by measurement error, due to this difference is under 2 %. Figures 4, 7 and 10 summarises colour temperature dependency on regulation level and temperature. For bulb and classic ECO halogen, there is the difference in lower regulation levels; however, due to low levels of illumination in this regulation levels, use of those regulation levels are limited. For LED premium, there is no difference in measured points and colour temperature is constant; however, the difference can be seen between value what was measured and what producer provide. The rest Figures 5, 8 and 11 present spectral compositions of the artificial light source at different temperatures. As can be seen from those figures temperature does not have an effect on spectral compositions. An effect on spectral composition have only regulation levels, but only for the bulb and the classic Eco halogen, for the LED premium the spectral composition is almost comparable to each regulation level and temperature.

As introduce above the measurement was performed for the temperatures in the range between 0°C to 20 °C, the temperatures in which those light sources will be commonly used. The measurement should be done for compact fluorescent light, but due to undefined regulation problems the measurement will be repeated shortly. In future research, the temperature below 0 °C will be measured for clarification effect on the photometric properties.

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