INFLUENCE OF DISCHARGE LAMPS SUPPLY VOLTAGE ON CHROMATICITY TEMPERATURE

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ABSTRACT

This paper deals with colour features of light sources in relation to the amount of supply voltage. Particular attention is dedicated to discharge tubes, especially metalhalide discharge tubes. The paper includes analysis of chromatic temperature as the key property describing colour features of light, and methods that enable measurement of the colour of light emitted by light sources. The concluding chapters provide and assess results of measurings related to the dependence of chromatic temperature on supply voltage. These measurements were conducted in the laboratories of lighting technology.

1. INTRODUCTION

Today, lighting engineering is inseparably linked with human life in modern civilized society. It creates conditions for appropriate work environment at places and times where the needed light intensities cannot be provided from natural resources. Apart from trichromatic coordinates, chromaticity temperature may also be used to describe colour or identify colour properties of light.

2. CHROMATICITY OF LIGHT SOURCES

Light sources for general lighting generate electromagnetic energy mainly in the visible spectrum part. It then depends on the energy distribution how we will perceive the energy thus emitted as energy of light, e.g. the colour of light and intensity [1]. The light emitted by the light sources is influenced by a number of factors. Ambient temperature, length and placement of wolfram fibre, pressure and chemist of the mixture in the discharge area, size of discharge area, arrangement of electrodes and many others.

The most commonly used characteristics describing the service properties of light sources include the relationship of selected parameters to applied voltage of the source. They are called cross characteristics and show the sizes of changes of the displayed quantities through the size of supply voltage deviation from the rated value. However, these characteristics normally do not include the relationship of chromaticity temperature to voltage, although this is an important parameter in particular for the assessment and selection of light source for different applications.

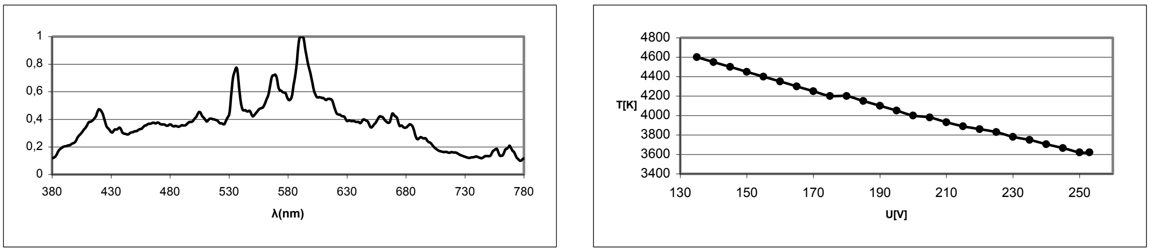
As a result of voltage drop, the temperature in the discharge area and the pressure of gaseous mixture decrease. Also the power supplied to atoms is reduced and the amount of emitted power decreases, resulting in the spectrum depletion. The change in spectral distribution of the light emitted is shown through the changed chromaticity temperature of the light source.

3. MEASUREMENT OF RELATIONSHIP OF CHROMATICITY TEMPERATURE TO VOLTAGE

The measurements whose results are presented in this study, were carried out in the lighting engineering laboratory at the Department of Electrical Power Engineering of FEEC VUT in Brno. The discharge lamp spectral characteristics were obtained from an AvaSpec spectrophotemeter – 2048 and chromaticity temperature was measured by Minolta XY – 1.

3.1. MEASUREMENTS RESULTS

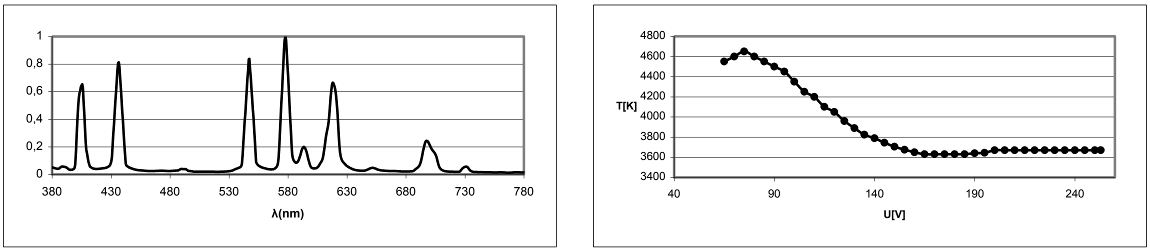
HQI-E 150W Power Star OSRAM halide lamp with luminophore. In Fig. 1a) spectral lines of thalium can be seen, powerfully emitted in the green area at 535 nm wave length, and of sodium with spectral lines 589 and 589.6 nm. Fig. 1b) shows an almost linear relationship of chromaticity temperature to supply voltage.



a) b)

Fig 1: a) Relative spectral density of HQI-E 150W OSRAM discharge lamp emission, b) chromaticity temperature relationship to HQI-E 150W OSRAM supply voltage.

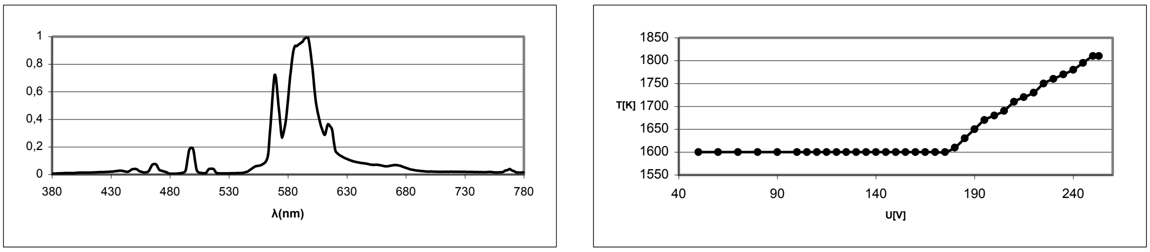
HPM-RVLX 80W Tesla high-pressure mercury lamp. As shown in Fig. 2a), the main share in emitting is generated by four very intensive lines in the visible area of the spectrum (404 - 407, 436, 546 and 577 nm). Fig. 2b) shows that the mercury lamp maintains a constant chromaticity temperature even under great voltage drop.



a) b)

Fig 2: a) Relative spectral density of HPM-RVLX 80W Tesla discharge lamp emission, b) chromaticity temperature relationship to HPM-RVLX 80W supply voltage.

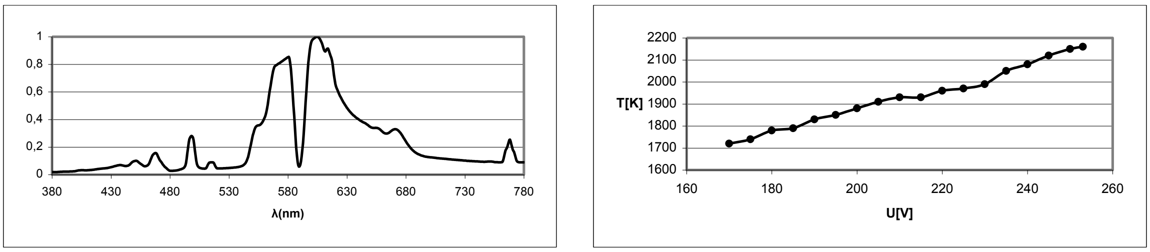
High-pressure sodium lamp NAV-T 70W Vialox OSRAM. A very distinct part of the spectrum between 580 - 595nm is characteristic of a sodium lamp. Sodium is characterized by an intensive resonance doublet in the yellow part of the visible spectrum at 589.0 – 589.6 nm wave lengths, which nears a maximum spectral sensitivity of human eye. The sodium lamp chromaticity temperature drops linearly with the voltage down to the value of 1600K at 170V and stays constant at that level.



a) b)

Fig 3: a) Relative spectral density of HPS-NAVT 70W OSRAM discharge lamp emission, b) chromaticity temperature relationship to HPS-NAVT 70W OSRAM supply voltage.

High-pressure sodium lamp SHL 50W Tesla with a milk bulb. The lamp's spectrum is similar to the previous sodium lamp, but unlike the previous one it produces insignificant emissions on the sodium-specific wave lengths, i.e. 589 to 589.6 nm. In this area the spectrum is considerably suppressed. Chromaticity temperature continuously drops over the whole measured voltage range.



a) b)

Fig 4: a) Relative spectral density of SHL 50W Tesla discharge lamp emission, b) chromaticity temperature relationship to SHL 50W supply voltage.

4. CONCLUSION

The measurements described in this study may be used in practice for completing the cross characteristics of light sources with the relationship of chromaticity temperature to the supply voltage of the relevant light source. The identified relationships may also help in deciding about and designing the lighting in the regulated networks with discharge lamps. For a certain type of application it is advantageous for the chromaticity temperature to change continuously with the voltage, which requirement is satisfied by the halide lamp whose chromaticity temperature rises while the voltage decreases, or the high-pressure sodium lamp whose temperature decreases. On the other hand, for a different kind of use it is needed that chromaticity temperature stays constant even under voltage drop. An example of such an application may be the use of discharge lamps in public lighting, especially for the road network lighting. Here, when the chromaticity temperature is changed, colour presentation might be impaired and in consequence drivers' vision and some elements of the traffic signs distorted, which negatively impacts the traffic safety.

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