INFLUENCE OF AIRFLOW ON TEMPERATURE CHARACTERISTICS OF FLUORESCENT LAMPS

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Abstract: The aim of the investigations was to study the temperature characteristics of fluorescent lamps in airflow. The characteristics of the large majority fluorescent lamps were found to be much lower than those given in the catalogues especially at a temperature of below 5°C. This is probably due to the fact that the catalogues give the results of measurements made in stationary air.

1. Introduction

The use of fluorescent lamps for exterior lighting in countries with a temperate climate is limited owing to the considerable loss of luminous flux of such lamps in a low ambient temperature. The data given in the catalogues on the relation between fluorescent lamp flux and ambient temperature are sparse and do not usually indicate the conditions under which the measurements were made [1]. The movement of air, or its absence, has a particularly marked effect on the results of measurements. It is obvious that with more rapid airflow, there is a greater heat exchange resulting in a tendency of the temperature curve to fall. The aim of this work was to study the temperature characteristics of fluorescent lamps in airflow.

2. Material and methods

Fluorescent lamps of different types: tubular with a diameter of 26 mm, and integrated and non-integrated with a ballast compact lamps were studied. Frost-proof fluorescent lamps in which this property was achieved by the methods given below were also studied:

- placing the tubular lamp of a diameter of 26 mm in a transparent glass shield of a diameter of 38 mm (Narva -LT-ET 36W/010),
- application of amalgamate in a fluorescent coating (Philips PL*Electronic/T 23 W),
- application of amalgamate and a shield of thick glass (Philips SL*Primatic 18W).

The investigation were made in a climate chamber produced by Heraeus VÖTSCH, type VUK08/1500 in a temperature range of from -25°C to +40°C every 5°C. The airflow with a velocity of 3-5 m/s was created by a built-in fan. The fluorescent lamp with its supply system and luxmeter photometric head was placed in the chamber. The integrated compact fluorescent lamps were positioned vertically with cap downward and the other lamps horizontally. The air could flow freely around the lamps. The accuracy of the temperature stabilisation in the climate chamber was ±0.7°C. All the photometric heads consisted of a silicon element with spectral correction preliminarily tested in the climate chamber with a tungsten halogen lamp. Variation of the readings during this test was ±2.0%.

3. Results

The results of the measurements and data from the literature [1] are presented as the relation between the lamp flux and ambient temperature in the climate chamber for: tubular fluorescent lamps of different power (Fig. 1), frost-proof fluorescent lamp with a tubular shield (Fig. 2), various compact fluorescent lamps (Fig. 3).

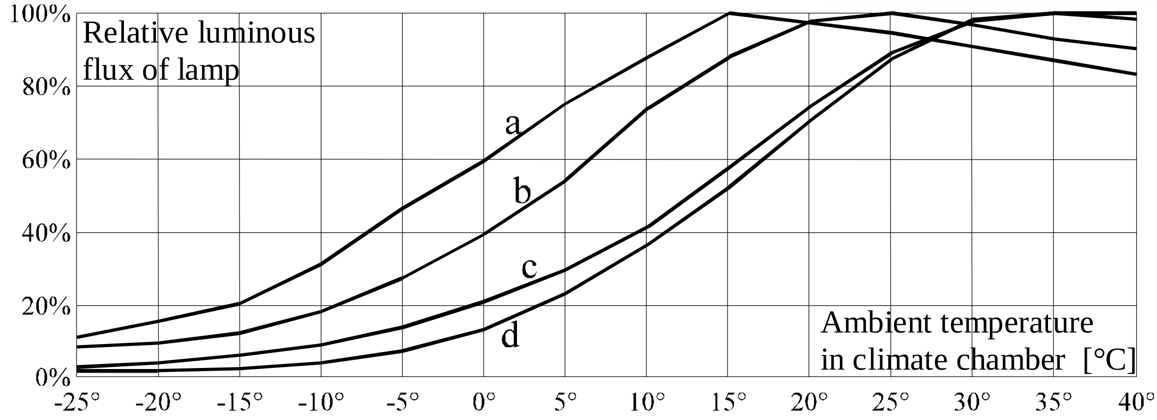

Fig. 1. The relation between the lamp flux of tubular fluorescent lamps of different power and ambient temperature

a) Osram L58W - catalogue data
b) Osram L36W - catalogue data
c) Philips TLD 58W - results of measurements
d) Philips TLD 36W - results of measurements

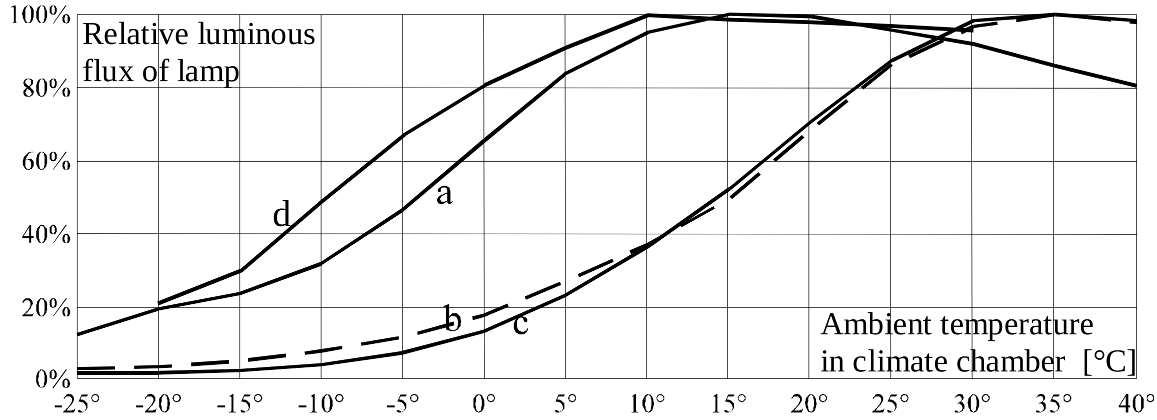

Fig. 2. The relation between the lamp flux of frost-proof fluorescent lamp with a tubular shield and ambient temperature

a) Narva -LT-ET 36W/010 - results of measurements
b) Narva -LT-ET 36W/010 without shield - results of measurements
c) Philips TLD 36W - results of measurements
d) Aura Thermo-LL 36 W - catalogue data

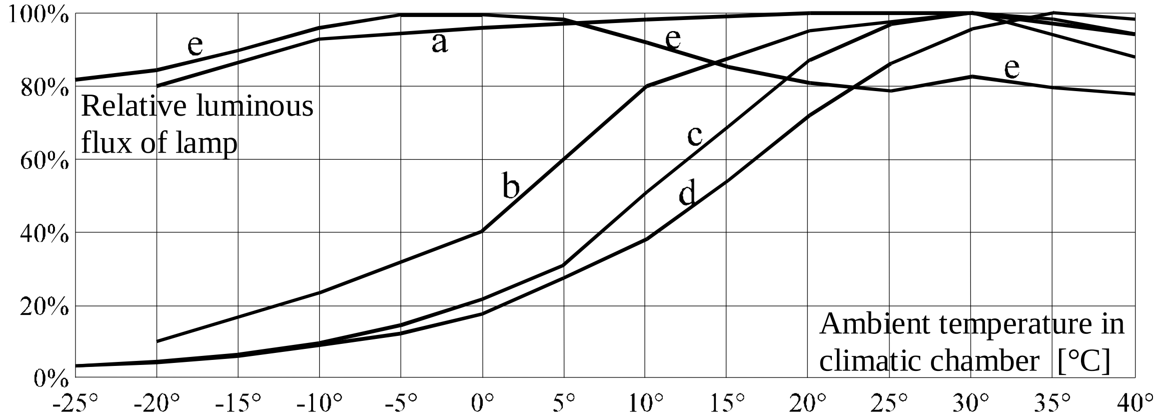

Fig. 3. The relation between lamp flux of different compact fluorescent lamps and ambient temperature

a) Philips PL*Electronic/T - catalogue data
b) Philips PL*Electronic/E - catalogue data
c) Philips PL*Electronic/T 23 W - results of measurements
d) Philips PL*Electronic/E 20 W - results of measurements
e) Philips SL*Primatic 18W - results of measurements

4. Analysis of the results

The results obtained for typical tubular fluorescent lamps of a diameter of 26 mm differ considerably from the catalogue data [1] (Fig. 1). This is probably because the catalogues give the results of measurements in stationary air. By way of example, at the temperature of -10°C in the catalogue, the luminous flux of a 58 W lamp falls to 30%, in our measurements to 5%, for a 36 W tubular fluorescent lamp the fall is to 18% and 3% respectively. This means that the luminous flux in a flow of air is approximately 6 times lower than in stationary air. In the catalogue the temperature curve of 58 W tubular fluorescent lamp (Fig. 1a) is considerably higher than the curve of the 36 W lamp (Fig. 1b). The characteristics for similar lamps measured in airflow (Fig. 1c,d) do not differ so considerably, from each other.

A frost-proof fluorescent lamp composed of a primary tubular and transparent tubular shield has considerably better temperature characteristics (Fig. 2a) since at a temperature of -10°C it still has 33% of luminous flux, and at -20°C - 20%. The temperature curve is far higher than that of the typical tubular lamp of the same power (Fig. 2c). Measurement of the frost proof lamp with the shield removed was made in order to study the possible influence of the fluorescent coating on the temperature characteristics (Fig. 2b). This curve is in concurrence with the curve of a typical tubular lamp of the same power (Fig. 2) indicating that the effect of frost proof is only brought about by the glass shield. There were no catalogue data on the temperature characteristics of the Narva-LT-ET 36W frost-proof lamp so that in order to compare it with the characteristics measured (Fig. 2a) in this study the catalogue characteristics of the AURA-Thermo-LL 36W lamp [1], which is of a similar construction (Fig. 2d) was used. The curve given in the catalogue is above the measured curve, but the differences are not so great as those noted in the case of the typical tubular lamps. At a temperature of -10°C the catalogue states that such lamps should have about 50% of the maximum luminous flux whereas the value measured was 33%, and at -20°C the values were practically the same.

The characteristics of the typical and frost-proof compact fluorescent lamps are illustrated in Fig. 3. The catalogue data of a frost proof compact fluorescent lamp with amalgamate shows that such fluorescent lamps at a temperature of -20°C should have 80% of the nominal luminous flux (Fig. 3a). The results of the investigation show that the application of amalgamate (Fig. 3c) ensures a considerably higher luminous flux than that of a lamp without amalgamate (Fig. 3d) but only in a range of temperatures from 5°C to 35°C. For temperatures of from -10°C to 5°C fluorescent lamp with amalgamate has only a slightly higher luminous flux. Below -10°C the difference between the luminous flux of a fluorescent lamp with amalgamate and that of such a lamp without is negligible. It is significant that the curves obtained from compact fluorescent lamps both with and without amalgamate when measured in airflow were far lower than the curves of lamps without amalgamate given in the catalogue (Fig. 3b) [1].

The greatest frost-proof effect was noted in the fluorescent lamp with both amalgamate and shield (Fig. 3e). Its compact structure and the shield of thick glass ensure that even at a temperature of -25°C and in airflow the luminous flux is 80% of the maximum value. Therefore only the results of such a fluorescent lamp in a rapid flow of air are similar to or even better than the catalogue data [1].

5. Conclusions

Rapid airflow has a significant effect on the temperature characteristics of fluorescent lamps. The curves measured are far lower than those given in catalogues, which are probably measured in stationary air. In the case of the typical tubular fluorescent lamp in the flow of air the loss of luminous flux is approximately 6 times greater than in stationary air and the characteristics are independent of the lamp power. In airflow, of the two methods of frost proofing studied, the application of transparent shields is clearly better than the addition of amalgamates to the fluorescent coating. It is only when both these methods are combined that the results of the measurements are in agreement with the data given in the catalogue containing measurements made probably in stationary air.

References

Catalogues of firm: Osram, Philips, Aura

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