INFLUENCE OF THE PREMISES SIZE ON THE VALUE OF THE DAYLIGHT FACTOR AT THE REFERENCE POINT

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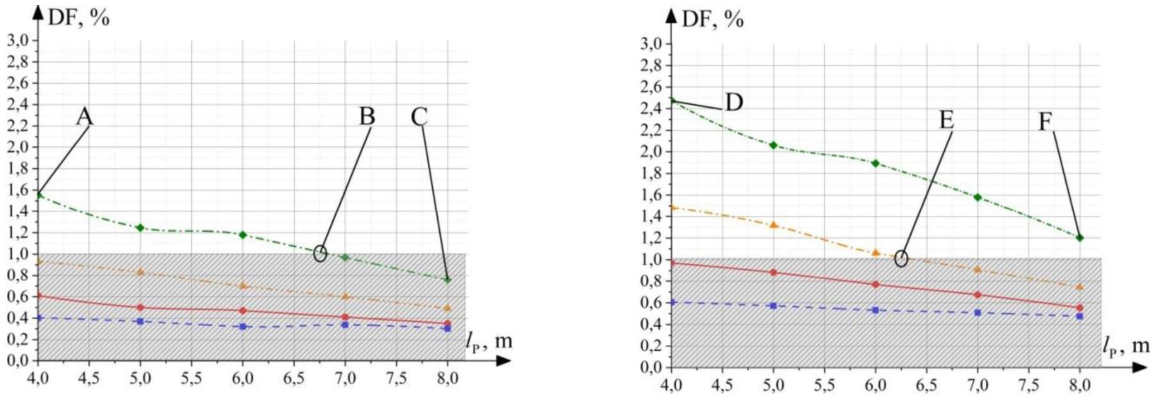
The issues of increasing the energy efficiency of premise's lighting, as a rule, are solved by increasing of the artificial lighting's efficiency. According to the International Energy Agency, it consumes about 2650 TWh of electricity per year (≈19% of global production), exceeding its total production by all nuclear power plants in the world [1]. In Ukraine, lighting consumes for about 16% of total electrical energy production. That is why the lighting system is a significant consumer of electricity, especially in office buildings (up to 80%).

Nowadays, the building sector plays a very important role in making significant changes in future energy use. This is because buildings consume about 40% of their electricity, producing nearly 45% of their CO_2 emissions. In Japan, this figure has already exceeded 50%.

The use of sunlight is one of the obvious ways to save electricity not only on lighting, but also on heating and air conditioning. According to DBN B.2.5-28-2006, which complies with European standards DIN EN 12464-1: 2011-08, lateral daylighting is normalized to the minimum value of the daylight factor (DF) at a reference point (RP) on a work surface (WS). Therefore, the RP for its determination selected in the most remote place of the WS, which is located at a distance of 1 m from the wall opposite the translucent structures of exterior wall envelope (TSEWE) and at a distance of 0.5 m from side external enclosing structure. Calculations of the DF value in RP for premises of selected sizes were carried out in the Relux program with the same data as in [2].

In [2], are present the results of studies to determine the minimum glazing area of TSEWE to provide the required value of DF. In this paper, the issue of the influence of the premises width and depth on the DF value in the RP is considered in more detail. This is necessary in order to be able to determine the effect of the number of individual TSEWE which in the premises, by the DF value in the RP and come to the conclusion about the possibility of using the calculation method [2] when analyzing premises with the several TSEWE's. When calculating the DF value, such TSEWE parameters sizes as the profile and foaming thickness were also taken into account, they were determined according to the equations given in [3].



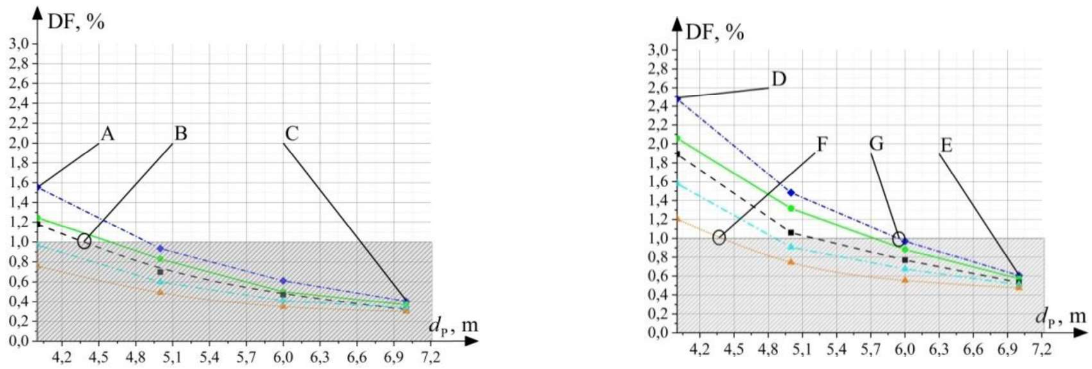
а) б)

– DF values below the norm.

Premise depth (m): – d_P=4; – d_P=5; – d_P=7; – d_P=7;

Fig. 1. Dependence of the DF value on the premises width with the TSEWE with the area: a) 4 m^2 and b) 6 m^2

According to the fig. 1 width of the premise 6,5 m is the maximum at which a standardized DF value is provided in case of one-side illumination through the TSEWE with the area of 4 m^2, with a premise depth of 4 m or more (Fig. 1, a, p. B). With an increasing of the TSEWE area, the DF value changes in a dependence close to linear (the A-C section in Fig. 1, a). When the width is doubled (from 4 m (Fig. 1, b, p. D) to 8 m (Fig. 1, b, p. F)), the DF value also decreasing almost by half (from 2.47% to 1.20%). With an increasing in the depth of the premise, the dynamics of the DF value fall in case of a decreasing of the premise's width.



а) б)

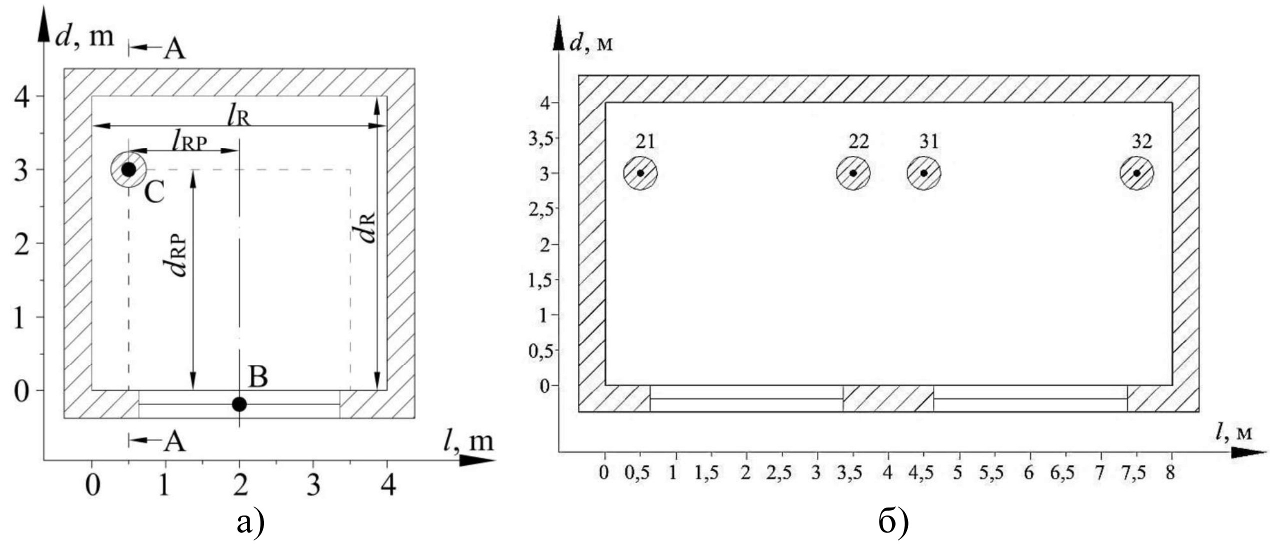
– DF values below the norm.

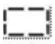
Premise width (m): – l_P=4; – l_P=5; – l_P=7; – l_P=7;

Fig. 2. Dependence of the DF value on the premises depth with the TSEWE with the area: a) 4 m^2 and b) 6 m^2

As can be seen from fig. 1 and 2, the depth of the premise has a greater influence on the DF value, rather than its width. With an increase in the width of the premise 7/4 = 1.75 times from 4 m (Fig. 1, b, p. D) to 7 m (Fig. 1, b, p. E) DF value decrease from 2.47% to 0 61% (2.47%/0.61% = 4.05 times) (see Fig. 2, b). While with an increase in the width of the premise in twice (from 4 to 8 m), the DF value decreases (2.47%/1.20% = 2.06 times).

It should be find out if the data obtained can be used for any premise by dividing it into several cells that form this premise. To do this, we compare DF value in premises with dimensions 4×4; 4×6, with a window opening of 6 m^2 and premises with sizes of 8×4 and 8×6, which can be divided into two cells with dimensions 4×4 in the first case and 4×6 in the second, with a similarly located TSEWE, the same sizes as in the above-described premises.




– the estimated work surface;


– the reference point on the work surface.

Fig. 3. The scheme of a premise 4×4 m in size and with a WO area of 6 m^2, which were taken into analysis: a) with one and b) with two windows

As a result of the calculations, with the above parameters, the DF value in RP is obtained, which are summarized in table. 1.

Table 1

DF value in RP on WS of the premises with width 4 m and 6 m, %

Premises depth, m	Reference point number					
	11	12	21	22	31	32
d_P=4	2,44	2,47	2,97	3,83	3,80	2,96
d_P=6	0,99	0,97	1,30	1,73	1,68	1,27

According to the obtained results (Table 1), it can be argued that dividing the premise into cells with TSEWE in each is permissible, since in RP 21 and 32 (Fig. 3), according to which DF is normalized, its value increased by 21% at a depth of 4 m and by 30% at a depth of 6 m. That is, the data obtained above can be used for premises of various sizes, dividing it into cells in which there is TSEWE.

Conclusions:

1. DF value varies inversely to the width of the premise. When the width is doubled (from 4 m to 8 m), the DF decreases by 2.06 (from 2.47% to 1.20%) (Fig. 1).

2. The depth of the premise has a greater influence on the DF value, than its width. An increase in the width of the premise by 1.75 times (from 4 m to 7 m) leads to a drop in DF by 4.1 times (from 2.47% to 0.61%) (see Fig. 2).

3. It is proved that the calculation procedure is described in [2] can be used to determine DF value in RP of premises with a large number of TSEWE by dividing the premise into separate cells with TSEWE.

References:

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АНАЛІЗ СТІЙКОСТІ ТЕХНОЛОГІЧНИХ СИСТЕМ КЕРУВАННЯ БІОГАЗОВИМИ УСТАНОВКАМИ

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