HUMAN CENTRIC LIGHTING

ASSESSMENT VARIABLES

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TRILUX – product information for conversion between photopic and melanopic assessment variables

To evaluate the melanopic effect (also called circadian or non-visual light effect) of a light source within the lighting design, conversion factors are defined in various standards.

Generally, these conversion factors are determined for a specific light source (see table). They enable the determination of e.g. the melanopic equivalent daylight illuminance (MEDI) from the vertical photopic illuminance E_v (measured at the eye and with the measuring plane perpendicular to the direction of observation).

The standards allow the consideration of further influencing factors, such as the age-dependent reduction of lens trans-mission of the eyes, the age-dependent pupil contraction and spectral changes due to reflection- and transmission properties of materials. These influencing factors are not discussed in detail here, but reference is made to the established standards for further con-sideration.

The adjacent table shows the melanopic efficiency factor $a_{mel,\,v}$, the melanopic daylight efficiency factor MDER (CIE / DIN system) and the melanopic ratio R (Well Building Standard) for the LED spectra typically used by TRILUX. A distinction is made between the colour rendering indices R_a 80 and R_a 90, special spectra defined by Oktalite, as well as TRILUX Active luminaires whose colour temperature can be controlled between 2,700 and 6,500 K. The uncertainty of the factors is approx. ± 0.04.

Colour Code	CCT [K]	$a_{mel,\,v}$	MDER	R
827 (R_a 80)	2700	0.37	0.41	0.45
830 (R_a 80)	3000	0.41	0.45	0.50
840 (R_a 80)	4000	0.57	0.63	0.69
865 (R_a 80)	6500	0.79	0.87	0.96
927 (R_a 90)	2700	0.41	0.45	0.50
930 (R_a 90)	3000	0.45	0.49	0.55
940 (R_a 90)	4000	0.60	0.66	0.73
965 (R_a 90)	6500	0.85	0.94	1.03
efficient white	3200	0.50	0.55	0.61
brilliant color	3100	0.51	0.56	0.62
efficient cool	4000	0.61	0.67	0.74
Active (R_a 80)	2700	0.37	0.41	0.45
	3000	0.43	0.48	0.53
	3500	0.52	0.57	0.63
	4000	0.58	0.64	0.71
	4500	0.64	0.70	0.77
	5000	0.68	0.75	0.83
	5500	0.72	0.79	0.88
	6000	0.75	0.83	0.92
	6500	0.79	0.87	0.96

The factors were determined based on the following standards:
CIE S 026/E:2018 System for Metrology of Optical Radiation for ipRGC-Influenced Responses to Light
DIN/TS 5031-100 Optical Radiation Physics and Illuminating Engineering - Part 100: Melanopic effects of ocular light on human beings – quantities, symbols and action spectra
International WELL Building Institute (IWBI) WELL Building Standard V2-2022

Brief description of the melanopic assessment variables

The **CIE and DIN standards** define:

$a_{mel,v}$ *melanopic factor*

$\gamma_{mel,v,D65}$ *melanopic daylight efficiency factor,*
abbreviation MDER (melanopic daylight efficacy ratio)

The melanopically evaluated quantity associated with illuminance is referred to as the *melanopic equivalent daylight illuminance*, abbreviation MEDI, the unit of which is the lux:

$E_{v,mel,D65} = \gamma_{mel,v,D65} \cdot E_v$ or colloquially MEDI = MDER · E_v

Version 1 of the **Well Building Standard** uses a slightly different system of melanopic assessment variables:

R melanopic ratio

The melanopic-assessed quantity associated with illuminance is referred to as *Melanopic Lux**
or EML *equivalent melanopic lux**, and is used both as the name of the quantity and its unit. From the photopic illuminance, which is indicated in this work with as the symbol of the formula L, the equivalent melanopic lux is calculated as

$$EML = R \cdot L$$

The conversion factors $a_{mel,v}$, $\gamma_{mel,v,D65}$ und R differ by only a constant factor for a given spectrum. They are defined on the basis of the mela-nopic action spectrum s_{mel}, which describes the sensitivity of the intrinsically photosensitive retinal ganglion cells (ipRGCs) and is tabulated in the above-specified CIE and DIN standards.

$$a_{mel,v} \cdot \frac{\int X_\lambda(\lambda) \cdot S_{mel}(\lambda)\, d\lambda}{\int X_\lambda(\lambda) \cdot V(\lambda)\, d\lambda}$$

$$\gamma_{mel,v,D65} = a_{mel,v} \cdot \frac{\int S_{D65}(\lambda) \cdot V(\lambda)\, d\lambda}{\int S_{D65}(\lambda) \cdot S_{mel}(\lambda)\, d\lambda} = a_{mel,v} \cdot 1{,}104$$

$$R = a_{mel,v} \cdot \frac{\int V(\lambda)\, d\lambda}{\int S_{mel}(\lambda)\, d\lambda} = a_{mel,v} \cdot 1{,}219$$

Here, X_λ is the spectrum of the light source to be evaluated, S_{D65} is the spectrum of the CIE standard illuminant D65 (daylight), V(λ) refers to the luminous sensitivity function, and the integration progresses from 380 to 780 nm and is performed in practice as a summation with steps of 1nm.

* The use of this quantity and the units "melanopic lux" and "equivalent melanopic lux" are not compatible with the SI system.