

Colour-difference formula TUBJND 2023 (JND=just noticeable difference)

$$\Delta E_{\text{JND}}^* = \Delta E_{22}^* = A_0 [(\Delta Y_r)^2 + (A_3 \Delta a \cdot Y_{rc})^2 + (A_4 \Delta b \cdot Y_{rc})^2]^{1/2} / (A_1 + A_2 \cdot Y_r) \quad [1]$$

$$a = (x - x_c) / y, \quad a_n = (x_n - x_c) / y_n, \quad b = -0,4 B_c z / y, \quad b_n = -0,4 B_c z_n / y_n, \quad x_c = 0,11 \quad [2]$$

$$c_{ab} = [(a - a_n)^2 + (b - b_n)^2]^{1/2}, \quad Y_r = Y / Y_u, \quad Y_u = 18: \text{tristimulus value of grey} \quad [3]$$

$$Y_{rc} = Y_r - (c_{ab} / c_{ab,O})(Y_r - Y_{r,O}) \quad c_{ab,O}, Y_{r,O}: \text{Ostwald chromaticity and } Y_r \quad [4]$$

$$Y_r = (Y_{r1} + Y_{r2}) / 2 \quad \Delta Y_r = Y_{r1} - Y_{r2} \quad Y_r: \text{relative tristimulus value} \quad [5]$$

$$A_1 = 0,0170 \cdot Y_u \quad A_2 = 0,0058 \cdot Y_u \quad B_c = 0,8 \text{ (D65), } 1 \text{ (D50), } 2,5 \text{ (A)} \quad [6]$$

$$A_3 = 1,0 \cdot Y_u \quad A_4 = 1,8 \cdot Y_u \quad A_0 = 1,5 \cdot Y_u \quad \text{background D65} \quad [7]$$

$$A_3 = 1,0 \cdot Y_u \quad A_4 = 1,7 \cdot Y_u \quad A_0 = 1,0 \cdot Y_u \quad \text{background A} \quad [8]$$

Just noticeable difference (JND) in four colour directions

$$\Delta Y_r = \text{const} (A_1 + A_2 \cdot Y_r) / A_0 \quad \text{in luminance direction } WN \quad [1a]$$

$$\Delta a \cdot Y_{rc} = \text{const} (A_1 + A_2 \cdot Y_{rc}) / (A_0 \cdot A_3) \quad \text{in chromaticity direction } RG \quad [2a]$$

$$\Delta b \cdot Y_{rc} = \text{const} (A_1 + A_2 \cdot Y_{rc}) / (A_0 \cdot A_4) \quad \text{in chromaticity direction } YB \quad [3a]$$

$$\Delta c_{ab} Y_{rc} = \text{const} (A_1 + A_2 \cdot Y_{rc}) / (A_0 [A_3^2 + A_4^2]^{1/2}) \quad \text{in chromaticity direction } c_{ab} \quad [4a]$$