Colour Kärcher-Yellow

Colour Fidelity

Contents

1 Targets

This Kärcher standard is intended to define the different "Kärcher-Colours“ as well as to regulate and standardise the evaluation in the different Kärcher plants. Furthermore, complaint criteria will be defined for suppliers.

The evaluation and complaint criteria principally applies to all colours like Kärcher-Yellow RAL 1018-HR, light grey RAL 7035-HR, slate grey RAL 7015-HR, signal grey RAL 7004-HR, basalt grey RAL 7012-HR, dust grey RAL 7037-HR, signal white RAL 9003-HR and other colours used by Kärcher.

2 Definition of the "Kärcher-Colours“

a) Kärcher-Yellow

The current Kärcher colour sample plate made of ABS material is used as a basis for the colour Kaercher-Yellow. This colour sample plate was created following the example of the colour RAL 1018-HR from the colour register 840-HR with the additional designation zinc yellow.

Department / Name: Standardization / Mrs. Glass-Etzel Phone: 07195 / 14-2446
Technical responsibility: Quality Lab & Error Analysis (CQM-L) / Mr. Benzler

b) Other Colours

For the colours basalt grey RAL 7012-HR and dust grey RAL 7037-HR there are colour charts made of material PP T20, for signal white RAL 9003-HR they are made of ABS. These serve as reference for the visual evaluation as well as for the metrological check. RAL-charts may be used only for the evaluation of colours, for which colour charts are not available.

3 Using the colour sample plates

The colour sample plate is valid for 2 years and must be stored away from sunlight, in a dry location, if possible at temperatures ≤ 23°C.

4 Evaluation of the colour fidelity

a) Visual test

An exclusively visual evaluation – a visual comparison of the test object with the colour sample plate with the naked eye – is a subjective test (subjective sensory perception, not a measuring value), which may be very dependent on the light source used (metamerism index). It does not yield any results that might be useful for the correspondence with producers. If there is no other possibility, however, the visual evaluation of the colour fidelity must be conducted in a light chamber with at least two different light types (D65 and F11).

b) Measurement engineering test

Kärcher has introduced the evaluation method by means of colour measuring instrument using the spectral procedure as per DIN 5033. Colour measurement = objective determination of three concrete colour measurement numbers to clearly identify a sample. The following colour measuring instruments are approved.

- Grid measuring instruments “Spectro-pen" and “Spectro-colour" manufactured by Dr. Lange.
- Spectral photometer “CM 2600 d“ made by Minolta.

5 Basics of colour metrics

The basis for the determination of colour coordinates in the CIE-L*a*b* system are the standard colour values. These are derived from:

- The measured reflection values (spectral curve) of the sample
- The standard spectral value functions of the normal observer
- The spectral energy distribution of the respective standard light type

6 Colour system

The CIE-L*a*b* colour room (also DIN 6174[2]) is a colour system, which has been adapted to the subjective colour perception (CIE = Commission International d´Eclairage).

- The L* axis indicates the brightness of a colour. The L* values are generally positive and are between 0 for ideal black colours and 100 for ideal white.
- The a* axis describes the red/green colour tones. Red colour tones possess positive a* values; green ones are respectively negative.
- The b* axis describes the yellow/blue colour tones. Yellow colour tones have positive and blue colour tones have negative b* values.

The colour distance ∆E* is derived from the differences between the L*, a*, b* values of two colours as per DIN 6174.
In the colour room created by ∆L*, ∆a*, ∆b* values, the ∆E* value is the diagonal line through this room. This values offers the possibility to express a colour deviation of a reference with one single numeric value (all individual values / deviations are smaller than the ∆E* value).

a) Standard light types
Kärcher has defined two standard light types.
- D65 incl. UV; 6500 K light temperature; this light is comparable to the daylight on a northern window on a cloudy day.
- F11 three-band cold white light; 4100 K light temperature; comparable to fluorescent light at an office.

b) Normal observer
Kärcher has defined the normal observer with 10°.

7 Measuring procedure and measurement execution

a) General

- The measuring device must be stored dry and at as constant a temperature (room temperature) as possible.
- After transports outside (specifically during the winter), the measurement cannot be performed until the colour measuring device has reached room temperature and the optics are free of condensation.
- There must be at least 24 hours between the production of the parts and the colour measuring procedures, as the paint will dry/harden and plastics will recrystalise which can cause changes in colour.
- The colour measuring device must be checked and maintained in regular intervals in the course of the measuring equipment monitoring (e.g. cleaning the optics). Besides that, the white standard is generally renewed every 2 years. The new calibration values of the white standard are reentered by the manufacturer (Dr. Lange or Minolta) in the course of the measuring equipment monitoring.
- The colour measuring device must be calibrated with the white standard or zero standard at least once a day (preferably after each start-up).
- The measurement must be conducted on an even surface.
- On parts that do not feature a suitable surface (large enough, even, sufficiently thick material), a colour measuring dome must be installed. This dome must meet the following requirements:
  - ❖ The material thickness in the dome area must be at least 4 mm.
  - ❖ The measured surface must have a diameter of at least 20 mm.
  - ❖ The surface (measured surface) must be brush polished (180) (not spray starting point).
  - ❖ No ejector must press on the measured surface → contamination hazard!
- On parts without defined colour measurement locations or without colour measuring dome (old parts), it makes sense to measure in several spots and to derive a median value from the individual values.
- The measuring device must be placed perpendicular onto the surface of the sample. Make sure that there is no foreign light and no light from the measuring light source.
- The surface to be measured on the component must be the same as the surface on the sample plate (reference). Thus, a mirror polished surface on the sample plate (reference) must be compared to a mirror polished surface on the sample plate (reference).

- In order to avoid influences due to differing surface structures during the colour measuring process, the measurement must always be performed on the same spot(s) on the component and this/these must be indicated in the drawing.

b) Grid measuring device

The Spectro-pen is a grid colour measuring device that measures with standard light D 65 and evaluates the visible spectral range (400 nm – 700 nm) in 10 nm intervals. The measuring geometry is 45°/0° circular, i.e. the measuring sample is lighted with polychromatic light in a circle from an angle of 45° and the receiver optics monitors the reflected light perpendicular (0°) to the sample surface.

- With translucent materials (e.g. very thin samples, i.e. wall thickness of < 3 mm), a part of the measuring light will permeate the sample and is missing during the evaluation of the reflected light. In those cases, a mirror must be held to the back of the sample during the measuring process.

c) Spectral photometer

A spectral photometer such as the CM-2600 by Minolta, measures the spectral reflection of the object to be measured from 380 – 780 nm in 5 nm increments. The measuring device uses an Ulbricht sphere to evenly light the sample from all directions. The d/8 geometry lights the sample with diffused light and receives the light at an 8° angle. By means of the gloss trap (SCI/SCE function), the light from +/- 8° can be included in the result or excluded from it. Kärcher measures with a full UV portion.

- With translucent materials, a white piece of ceramics must be held to the back of the sample during the measuring process.

8 Limit values

a) Visual test

As already mentioned in item 4 a, the visual colour evaluation does not provide any measuring values, which could be limited by limit values. The verbal explanations listed below are intended to be communication aids. Here, you must make sure that these different standard light types (D65, F11) will be included in the evaluation.

ΔL* value negative = sample is darker than the coat (too black)
ΔL* value positive = sample is lighter than the coat (too white)

Δa* value negative = sample is greener than the coat
Δa* value positive = sample is redder than the coat

Δb* value negative = sample is more blue than the coat
Δb* value positive = sample is more yellow than the coat

b) Measurement engineering test

With D65, 10° (SCI) as well as F11 10° (SCI) applies to all plastic parts as well as powder-coated and wet painted parts:

- **For Kärcher-Yellow RAL 1018-HR and other yellow colour shade such as RAL 1016 (sulfur yellow)**

∆E* < 3: is accepted (no return message to supplier).
∆E* 3-5: parts are usually returned, supplier is definitely informed by letter of complaint.
∆E* > 5: parts are always returned with a letter of complaint.

- **For all other colours such as basalt grey, dust grey, signal white … are valid:**

∆E* < 1,5 is accepted (no return message to supplier).
∆E* > 1,5 return message to supplier and if necessary return of the parts.

With complaints, the information of the ∆E value is not expressive enough to perform colour corrections. Therefore, with complaints, in addition to the ∆E* value, the ∆L*, ∆a*, ∆b* values must also be indicated. The ∆E* value is always ≥ the largest individual value, i.e. ∆L*, ∆a*, ∆b* must also be > = 3 resp. < = 1,5.

Example of a complaint test:
Deviation of the colour fidelity from the reference (e.g. Kärcher colour sample plate).
With the Spectro-pen by Dr. Lange, the following values were measured:
∆E*= 5.4 (D65) nominal: < 3
The ∆E value is comprised of: ∆L*=1.4; ∆a*=4.8; ∆b*=2.0.
The large, positive ∆a* value (4.8) means that the part is too red.
The delivery is rejected.

Note: We recommend helping yourself to the pool of materials released by Kärcher; this will guarantee that the above mentioned criteria for the "Kärcher Colours" are met (Kärcher-Inside\Knowledge\Engineering).

9 Prevailing Norms

DIN 6174
DIN 5033-1 to DIN 5033-9
KäN 037.008 surface suffusions

Encl. A: CIE – L*a*b* - system in accordance with DIN 6174

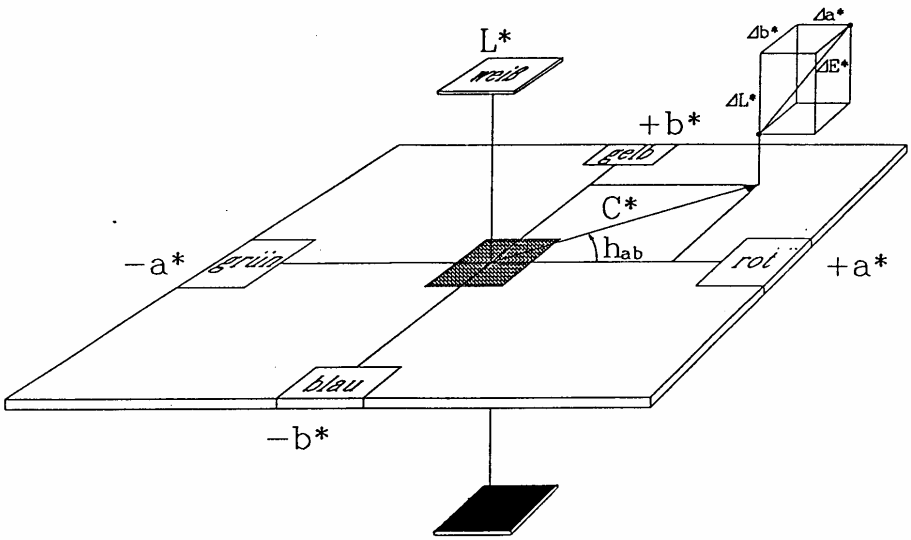

Abbildung CIE -L*a*b* - System nach DIN 6174

Die L*, a*, b* - Werte werden aus den Normfarbwerten nach Gleichung (10) bis (14) errechnet und sind somit auch von der verwendeten Normlichtart (A, C oder D65) und von dem Normalbeobachter (2° oder 10°) abhängig.

$$L^* = 116 \bullet \sqrt[3]{\frac{Y}{Y_n}} - 16 \qquad (10)$$

$$a^* = 500 \bullet \left\{ \sqrt[3]{\frac{X}{X_n}} - \sqrt[3]{\frac{Y}{Y_n}} \right\} \qquad (11)$$

$$b^* = 200 \bullet \left\{ \sqrt[3]{\frac{Y}{Y_n}} - \sqrt[3]{\frac{Z}{Z_n}} \right\} \qquad (12)$$

$$C^* = \sqrt{a^{*2} + b^{*2}} \qquad (13)$$

$$h_{ab}{}^* = \arctan \frac{b^*}{a^*} \qquad (14)$$

	2° - Normalbeobachter			10° - Normalbeobachter		
	Lichtart					
	D65	C	A	D65	C	A
X_n	95,05	98,07	109,85	94,81	97,28	111,14
Y_n	100,00	100,00	100,00	100,00	100,00	100,00
Z_n	108,90	118,22	35,58	107,34	116,14	35,20