Metamerism and colour constancy

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Abstract
Metamerism and inadequate colour constancy can cause serious problems within the entire textile production chain. In the first part of this paper the two phenomena – and in particular the difference between them - are explained, and the factors that can cause Metamerism and poor colour constancy are demonstrated.

Introduction
If a pair of samples looks identical under a particular illuminant, e.g. under shop light, but different under another light source, the samples are described as metameric. They have different reflectance curves and produce different sets of colour co-ordinates under different light sources. In colorimetry, Metamerism is defined using a Metamerism index.

The reason lies in the different reflectance curves of jeans and T-shirt

(Fig. 2).
Colour constancy

If one sample changes colour appearance when it is illuminated using a different light source, we talk about inadequate colour constancy of the sample. The different spectral energy distribution of the light source in combination with the reflectance curve of the sample results in a change in colour appearance. In colorimetry, colour constancy is defined by a colour inconstancy index. The second situation is an example of inadequate colour constancy. The dress changes its colour according to the illumination, from the elegant reseda green in daylight to a dull sandy beige under restaurant lighting (Fig. 3).

The cause of this colour change is the combination of the garment’s reflectance curve with the relative energy distribution of the different types of illumination. The reflectance curve, although that of a green shade, reflects a high proportion of light in the red area of the light spectrum (Fig. 4).

Inadequate colour constancy of a standard often comes about because dyeing recipes with optimum colour constancy are difficult to formulate. Colour constancy cannot be visually tested until the desired shade has been achieved. A great many recipes would therefore have to be test dyed before the one with the best colour constancy could be selected. A correct visual assessment, however, is almost impossible. For that purpose the eye has first to be adapted to the reference illumination, e.g. daylight, and this takes some 2 to 5 minutes. Then, on switching to the illumination to be tested, the eye has again to be adapted to the new light environment. But after about 5 minutes we have forgotten what the dyeing looked like under the reference illumination because we have a very poor memory for colours. For that reason we often switch quickly back and forth between the two types of illumination so we can evaluate the colour impression, not simultaneously but in rapid succession. But rapid switching does not allow our eye to adapt either to the reference illumination or to the test illumination. Moreover the colour of the light source is often projected onto the colour of the test sample, thereby distorting the test result. A better approach is to determine the colour constancy calorimetrically. A number of formulas are available which simulate the necessary adaptation of the eye to a new light source (Fig. 10). As mentioned earlier, Metamerism arises because the colour standard in the laboratory has been dyed with other dyes than those used.
Later for the production batch. For the dyer of colour standards it is important for the desired shade to be dyed exactly right and for the dyeing supplied to be level. At this stage the fastness properties of the dyeing are unimportant or the requirements are often completely unknown. In the production batch, however, the requirements have to be met, and this frequently necessitates a different dye selection. Again, for technical reasons different dyes have often to be used or, for cost reasons, the dyeing recipe has to be altered, for example for dark navy, grey or brown shades. The best scenario would be if the colour standards were dyed with the same dyes as are applied later in production. Or again if a different substrate is to be dyed a technically optimized dye selection is used which also satisfies the fastness requirements. If, for argument’s sake, the colour standard was specified on cotton, and afterwards the same shade has to be dyed on polyamide, polyester or wool. Yet the designer who selects the colours for the fashion collections, or the sample dyer who prepares the requisite colour standards generally lacks this dyeing know-how. It would therefore be important to coordinate the requirements of the fashion branch on the one hand and the technical competence of the dyers or dye suppliers on the other.

References