H25: Colorants for Four Colour-Printing

By far the largest volumes of ink are used in three and four colour sets. Because large amounts are used annually, the cost of the inks and economy of use is a major consideration. A standard colour, high tinctorial strength and economy in use are vital characteristics for colorants that are suitable for process inks.

Inks for four-colour printing

Colour

There are various standards, such as the Kodak scale and the European norm, which aim to standardise the colours that can be obtained with four-colour sets.

Transparency

The order in which the colours are printed determines the transparency requirement of the inks. The transparency of the first colour down is less important, whereas subsequent colours have to possess high transparency. For offset inks in Europe, yellow is often printed last and therefore needs to be transparent.

Dispersibility

Transparency may be optimised through effective dispersion.

The pigments need to have ***good dispersibility***, and to remain stable during the dispersion process.

Solvent fastness

Modern mills, for example the bead mill, generate heat energy and this can cause pigments with poor solvent fastness to dissolve. On cooling, these types of pigment will recrystallise, resulting in the loss of colour strength and transparency. Therefore pigments used in process colours may be required to have at least moderately good solvent fastness in the mineral oils or the solvents used in the formulation of heat set varnishes.

Light fastness

Light fastness is not considered to be vital for most publications, but if it is required pigments such as CI Pigment Yellow 74 can be use for the yellow and CI Pigment Red 184 for the magenta may be used.

Heat stability

Heat fastness is not very important since even heat set inks rarely reach temperatures that affect the pigments used.

Process cyan

The cyan standard is always based on CI Pigment Blue 15:3, whose molecular structure is shown in Figure 1.

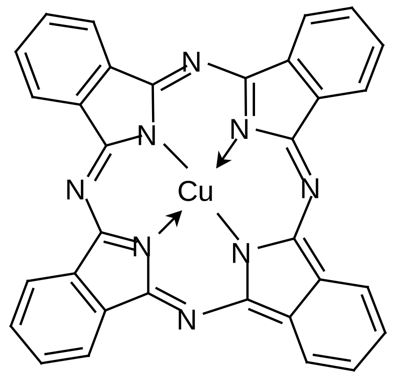

Figure 1: C.I. Pigment Blue 15

Phthalocyanine pigment was discovered in 1928 by Scottish Dyes (later to become ICI and now Avecia). Chemists noticed a blue impurity when heating phthalimide in a ceramic lined vessel that was damaged, exposing some iron. The impurity proved almost impossible to destroy. Commercial grades were introduced about ten years later, complexed around copper rather than iron. Figure 2 shows the size of particles of the pigment.

There have been some concerns about the copper in CI Pigment Blue 15:3, but this is so strongly bound within the molecule that it is not bio-available and therefore is not considered to be an environmental hazard.

The pigment exists in at least five crystal forms (α β γ δ ε), i.e. the pigment is polymorphic, but only three forms are commercially produced (α β ε). Pigment 15:3 is the β-phthalocyanine form and a greenish blue shade.

The pigment has excellent light fastness, as shown in Figure 3

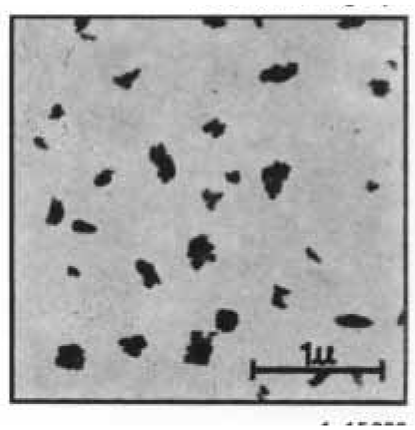

Figure 2: Blue 15: 3 particles

Figure 3: Blue 15:3 light fastness panels

The reflectance spectra of offset prints are shown in Figure 4

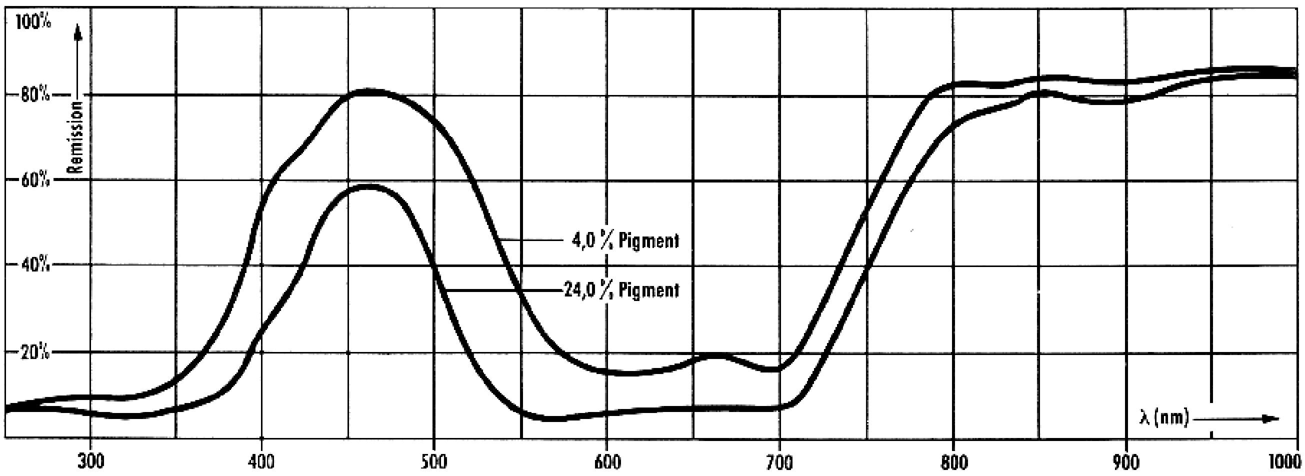

Figure 4: Reflectance spectra of offset prints of inks containing Pigment Blue 15:3

Process yellow

The yellow standard is usually obtained with CI Pigment Yellow 13 (in Europe), whose molecular structure is shown in Figure 5.

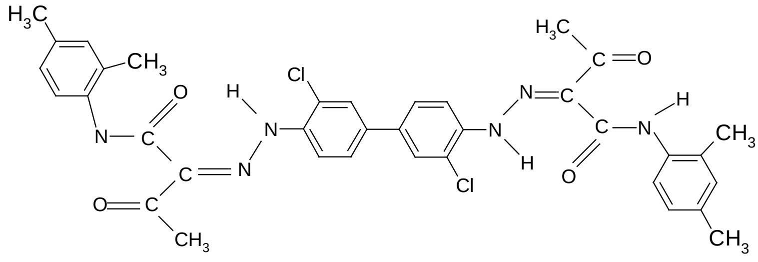

Figure 5: CI Pigment Yellow 13

This pigment is a type of diarylide yellow. They were formerly known as "benzidine yellows" as they are manufactured from 3, 3' dichlorobenzidine (DCB). However, this name should be avoided as it confuses them with benzidine dyes, over which there are legitimate safety concerns.

In Europe, CI Pigment Yellow 13 is used in most printing inks, in the United States, CI Pigment Yellow 12 and Yellow 14 predominate. Yellow 13 has a slightly redder shade, is somewhat stronger and has better fastness properties than the other two types of pigment.

A conventional grade of CI Pigment Yellow 13 is not noted for transparency, special grades are required, based on mixed couplings and the pigments are often surface treated to ensure the particle size in the dispersion is minimised. Figure 6 shows the size of particles of the pigment. The pigment has a high tinctorial strength, good heat stability and good solvent fastness. However, the light fastness is poor to moderate as shown in Figure 7.

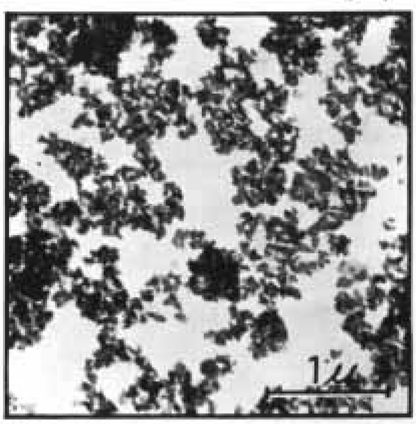

Figure 6: Yellow 13 particles

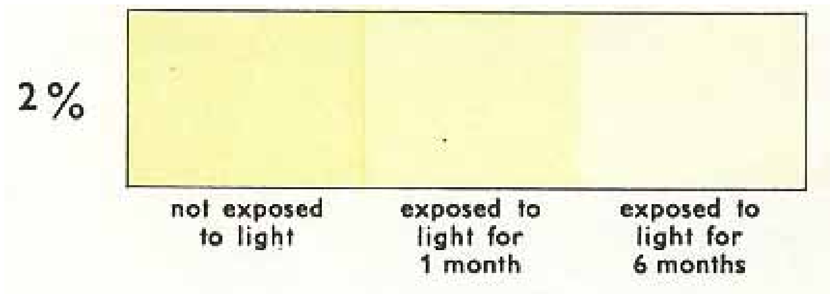

Figure 7: Yellow 13 light fastness panels

The reflectance spectra of offset prints are shown in Figure 8.

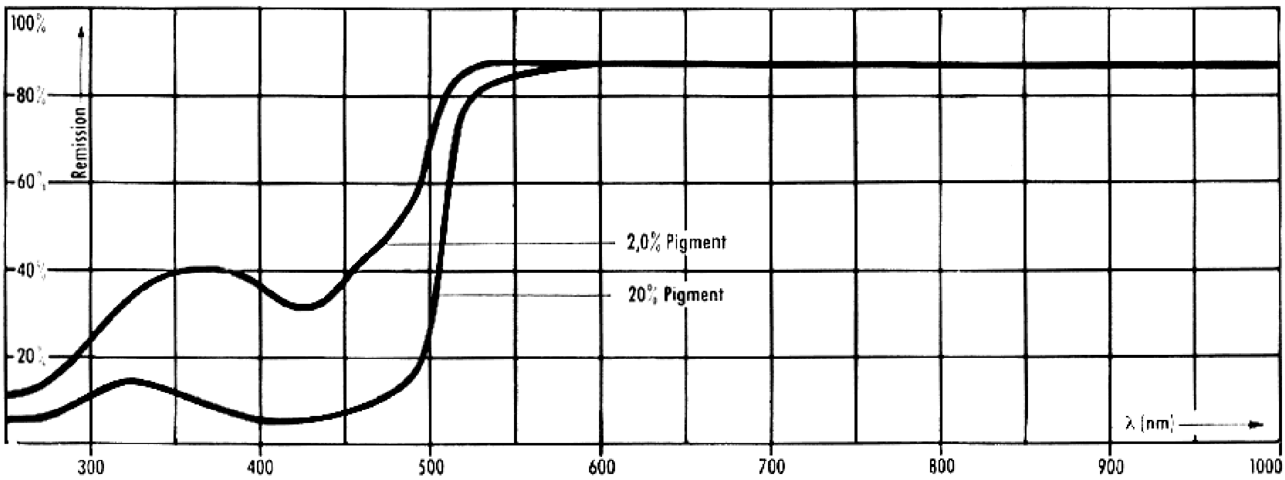

Figure 8: Reflectance spectra of offset prints of inks containing Pigment Yellow 13

Process magenta

The magenta standard is usually obtained with CI Pigment Red 57:1, whose molecular structure is shown in Figure 9.

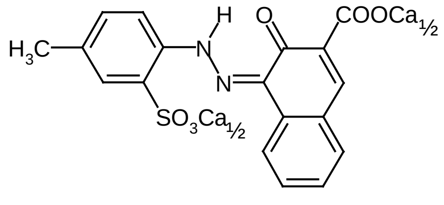

Figure 9: CI Pigment Red 57:1

CI Pigment Red 57:1 (also known as Lithol® Rubine, Rubine Toner or Calcium 4B toner) is a toner type of pigment and this type is one of the easiest to manufacture and one of the most economic. Consequently, they are particularly useful for printing inks and Red 57:1 is the natural choice for the magenta standard.

Figure 10 shows the size of particles of the pigment.

The light fastness of toner type pigments and the shade of toners are influenced by the metal cation. Calcium (Ca) is the metal cation present in Red 57:1. The light fastness of Red 57:1 is moderate, as illustrated in Figure 11. The pigment has good heat stability and moderate solvent fastness.

A problem with most types of toner pigments is that they are not fast to alkali. This is also true for Red 57:1, which has relatively poor fastness to soap and detergents for example.

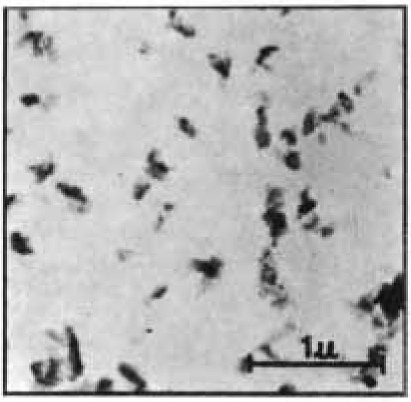

Figure 10: Red 57:1 particles

Figure 11: Red 57:1 light fastness panels

The reflectance spectra of offset prints of inks containing Red 57:1 are shown in Figure 12.

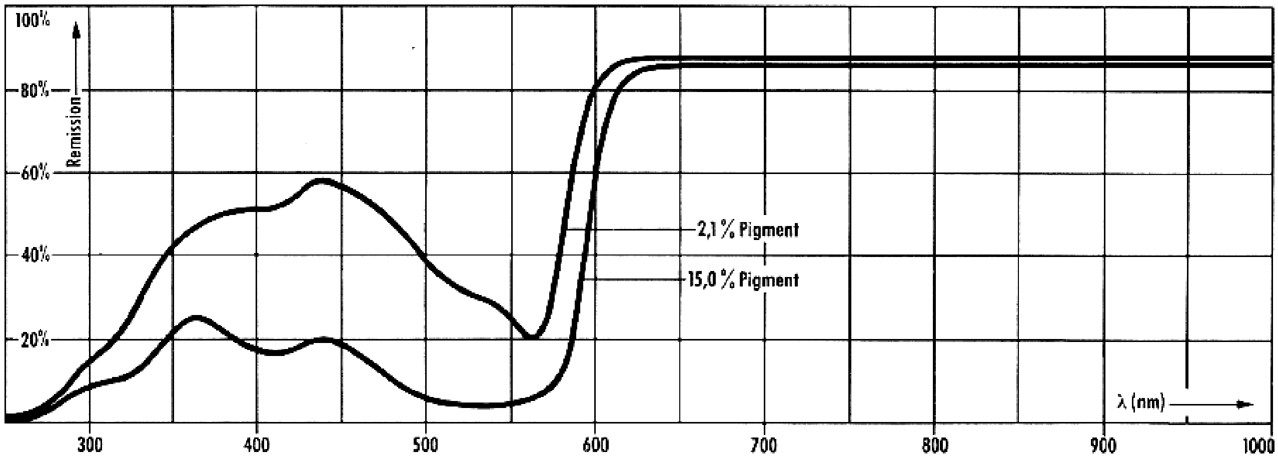

Figure 12: Reflectance spectra of offset prints of inks containing Pigment Red 57:1

Process black

The black standard is based on carbon black. Adding a strong blue, such as Alkali Blue or Iron Blue to the carbon black can improve the jetness of carbon black.

Carbon black pigments are obtained by burning a suitable carbon rich liquid or gas with a limited but controlled supply of air. The products of the incomplete combustions are cooled and collected.

Typical sizes of carbon black pigments range from 0.03 µm to 0.10 µm depending on the conditions of production. Figure 13 shows the characteristic spherical shape of carbon black pigments.

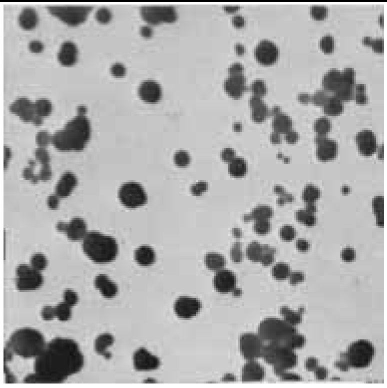

Figure 13: Particles of a Furnace black. Mag. 16,000

Health and safety

In the UK there is no legislation dealing with the physiological properties of pigments used for food packaging, except a duty of care demanding no harm to the consumer, nor affect in any way the quality of the food being packaged. However, it is generally understood that coloured inks should not come into direct contact with food.

CI pigment Red 53:1 (often used in a secondary colour between magenta and orange) is usually avoided for children's publications as it is a type of toner pigment using barium to produce the salt from the acid dye.

The insolubility and excellent migration fastness of most organic pigments largely eliminates human health hazards. However, care may need to be taken when handling pigments due to the potential presence of impurities (possibly heavy metals or residual amines). Good manufacturing procedures and appropriate sample clean up methods help to ensure that the levels of impurities are minimised. When pigments are incorporated into formulations it is invariably components other than pigments that are likely to pose the greatest ecological and toxicological risks.