Dyes for the mass coloration of plastics

Lynn A. Bente

INTRODUCTION

In the few short years since 1856 when mauve was discovered by Perkin there has been a furious effort to develop commercially viable dyes for coloration of all media. Plastic resins ever since the invention of phenolics have been colored with both dyes and pigments. Dyes, as opposed to pigments, are soluble in or have an affinity for the media being colored. As dyes are solubilized in the polymer this molecular dispersion has the ability to develop much brighter and cleaner colors than pigments that derive their color from a crystal matrix. The trade-off for this brightness is reduced light and heat stability from pigments.

In recent years heavy metal pigments have been legislated out of use due to their supposed toxicity. Whether we agree or not with this concept, we no longer have them available for our use. This has necessitated an increase in the total number of colorants that can replace the high chroma colorants of lead and cadmium in specialty resins.

Dyes are classified and discussed by structure. To aid in this identification the AATCC and The Society of Dyers and Colorists have published the Color Index. This publication details dye classifications by structure, generic name and an identifying Constitution Number. Other information listed is solubility parameters, heat and light stability and chemical resistance. Recently, the larger dye manufacturers have chosen not to disclose a great deal of information concerning new dyes.
AZOS

The general structure of a typical azo dye is shown in Figure 1. All azo dyes contain the bond \(-N=N-\). One of the largest families of dyes, the azo dyes have found their way into many polymer applications. This is mainly due to their extreme brightness and low cost. Many of these dyes are staples of the color palette, especially for styrene, acrylcs, some polyesters and minor ABS applications. Heat stability needs to be monitored but the light stability is acceptable for many low end applications.

The range of color of the azo family is normally yellow, orange and red with variations of each. Many of the violets and blue dyes have come out of production due to the greater heat and light stability of the violet and blue anthraquinone dyes.

In recent years, legislation in some countries has restricted the manufacture and use of azo dyes because of the possible toxicity of the intermediates and the potentially hazardous degradation products.

The most typically used azo dyes (Color Index Construction Number) are:

- Solvent Yellow 14 (12055)
- Solvent Red 1 (12150)
- Solvent Black 3 (26150)
- Solvent Yellow 16 (12700)
- Solvent Red 23 (26100)
- Solvent Yellow 18 (12740)
- Solvent Red 24 (26105)
- Solvent Yellow 72 (N.L.)
- Solvent Red 26 (26120)
- Solvent Orange 7 (12140)
- Disperse Red 1 (11110)

As the melting points of these dyes are low (<180–200°C), processing temperatures need to be kept to a minimum and sublimation can occur in a number of them. Solubility of these dyes is very high and this allows them to disperse easily. Migration can occur at elevated loading, and use in plasticized resins is not suggested. Also they are not suggested for olefinic resins but azo and disazo dyes (i.e. Solvent Red 210) have been used in polypropylene holiday ribbon for many years.

Recently azo dyes have been attached to polymer backbones to make oligomeric type dyes. Problems with this type of colorant arise as you are adding as much of the polymer as you are of the dye.

More and more azo dyes are now produced in China and India. The purity of the dye needs to be monitored as to remaining insolubles such as intermediates or iron which can dull the color.