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EFFECT OF DYE CONTENT ON POINT OF ZERO CHARGE OF ANIONIC LAKE DYES

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ABSTRACT

The pure dye content of FD&C yellow lake #5 and FD&C red lake #40 was found to be inversely related to the point of zero charge. The effect of the adsorbed anionic dye on the zeta potential of aqueous suspensions of FD&C yellow lake #5 at pH 5 was demonstrated.

INTRODUCTION

Lake dyes are formed by the adsorption of a soluble dye onto aluminum hydroxide (1). They are widely used as colorants and are available with various pure dye contents.

The aluminum hydroxide substrate used to prepare lake dyes exhibits a pH-dependent surface charge which is characterized by the point of zero charge (PZC),

i.e., the pH at which the net surface charge is zero. The surface potential, ψ_o, is related to the PZC by the following equation (2):

$$\psi_o = 59 \text{ mV (PZC-pH)} \qquad \text{Eq. 1}$$

The specific adsorption of anions such as carbonate (3) or phosphate (4) has been found to reduce the PZC of aluminum hydroxide and thereby alter the surface potential. Since many physical properties of suspensions are related to the surface potential, variations in the PZC of anionic lake dyes may be an important factor in the formulation and manufacture of colored suspensions. Thus, a study was undertaken to determine the effect of pure dye content on the PZC of anionic lake dyes.

MATERIALS AND METHODS

FD&C yellow lake #5 (Warner Jenkinson) with pure dye contents of 7, 14, 26 and 38% and FD&C red lake #40 (Colorcon) with pure dye contents of 14 and 40% were obtained commercially. The PZC was determined by the standard titration procedure (3) after preparation of 0.05% w/v suspensions in deionized water. The zeta potential of 0.005% w/v suspensions adjusted to pH 5 was measured using the Doppler electrophoretic light scattering analyzer (Delsa 440, Coulter).

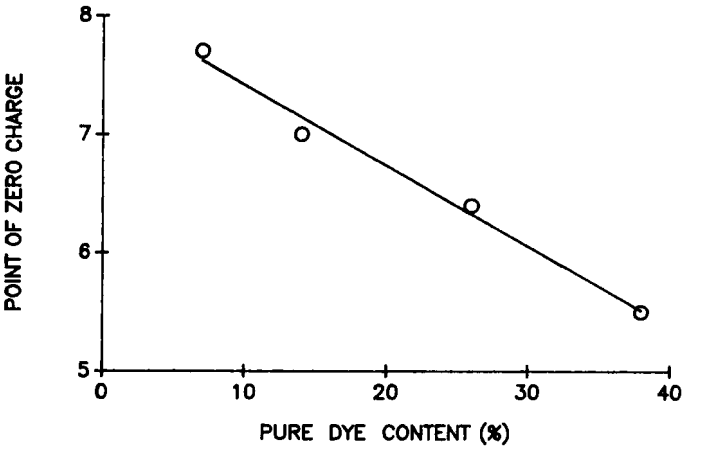

Figure 1 - Effect of pure dye content of FD&C yellow lake #5 on the point of zero charge.

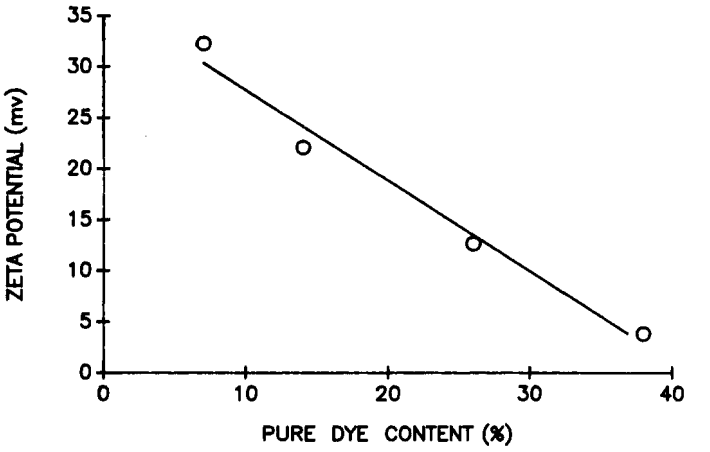

Figure 2 - Effect of pure dye content of FD&C yellow lake #5 on the zeta potential at pH 5.0.

RESULTS AND DISCUSSION

FD&C yellow #5 is a trivalent anionic dye which is adsorbed to aluminum hydroxide to produce FD&C yellow lake #5. The PZC of four commercial FD&C yellow lake #5 dyes ranging in pure dye content from 7 to 38% is inversely related to the pure dye content (Fig. 1). This behavior agrees with the inverse relationship between the PZC and the extent of carbonate (3) or phosphate (4) adsorption by aluminum hydroxide.

FD&C red #40 is a divalent anionic dye which is used to prepare FD&C red lake #40. An inverse relationship between the pure dye content and the PZC was also observed for the lake dye. The PZC decreased from 7.4 for a sample having a pure dye content of 14% to 6.1 for a batch containing 40% pure dye.

The effect of pure dye content on the surface charge of lake dyes can also be noted by measuring the zeta potential of aqueous suspensions of lake dyes. As seen in Figure 2, the zeta potential of aqueous suspensions of FD&C yellow lake #5 at pH 5 ranged from 4 to 32 mV depending on the pure dye content. Thus, the pure dye content of lake dyes should be considered in the formulation or manufacture of suspensions containing lake dyes.

REFERENCES

1. L. L.-S. Wou and B. A. Mulley, J. Pharm. Sci., 73, 1738 (1984).
2. W. M. Underwood, Rev. Sci. Instrum., 47, 1079 (1976).
3. J. R. Feldkamp, S. N. Shah, S. L. Meyer, J. L. White and S. L. Hem, J. Pharm. Sci., 70, 638 (1981).
4. J. C. Liu, J. R. Feldkamp, J. L. White and S. L. Hem, J. Pharm. Sci., 73, 1355 (1984).