

THE HEAVY METALS IN THE PROCESSING SCREEN PRINTING INKS

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Abstract

The contents of heavy metals were analyzed in the two types (solvent-based and water-based) of processing screen printing inks. Mass concentrations of heavy metals (copper, iron, zinc, manganese, chromium, nickel, cadmium, and lead) were determined in the tested screen inks by combining the gravimetric method and atomic absorption spectroscopy. The results indicated that the measured mass concentration of copper (2049.9 mg kg⁻¹) in solvent-based cyan ink is 2.4 times higher than in water-based cyan. Other detected metals show higher concentration values with water-based processing inks.

Introduction

The printing industry uses different types of ink, which may be more or less harmful to the environment. It is impossible to determine the ecologically optimal composition of inks because each printing technique dictates the content of specific components due to the quality and speed of printing [1]. The composition of printing inks includes natural and synthetic organic or inorganic pigments whose main disadvantage is their environmental unacceptability [2].

Experimental

The processing screen printing inks (cyan - C, magenta - M, yellow - Y, and black - K) based on solvent (S) and water (W) were digested by using the dryash method (500°C, 6 h). After digestion, 5 g of each sample was weighed (with an accuracy of ±0.01 g) in a ceramic crucible and diluted with 50 mL of 0.5 mol L⁻¹ nitric acids (p.a., Merck, Germany). The sample blanks have also been performed with an empty ceramic crucible. After samples were cooled to room temperature in a desiccator, the solutions were filtered through a quantitative cellulose filter paper (Macherey-Nagel, Germany). Heavy metals analyses were carried out by atomic absorption spectroscopy (PerkinElmer Aanalyst 700) according to the standard EPA 7000B method. Heavy metal contents were assessed on a triplicate sample (n = 3), and mean values were used [3].

Results and discussion

The mass concentration (γ , mg kg⁻¹) levels of copper, iron, zinc, manganese, chromium, nickel, cadmium, and lead in the CMYK processing solvent and water-based screen printing inks are presented in Figure 1. Based on the obtained results of the analysis of the content of heavy metals in the screen printing inks, it is observed that the highest concentration of copper is in solvent-based cyan (2049.9 mg kg⁻¹), iron in water-based yellow (30.9 mg kg⁻¹), zinc in water-based magenta (160.1 mg kg⁻¹), manganese in water-based cyan (5.4 mg kg⁻¹), chromium in water-based cyan (0.6 mg kg⁻¹), cadmium in water-based black (0.4 mg kg⁻¹), and lead in water-based magenta (2.7 mg/kg). Only in the case of copper, the measured concentration value is 57.7% higher in solvent-based than water-based cyan ink. But, iron, zinc, manganese, chromium, cadmium, and lead concentrations are higher by 82, 96, 95, 98, 79, and 78%, respectively, in water-based CMYK inks.

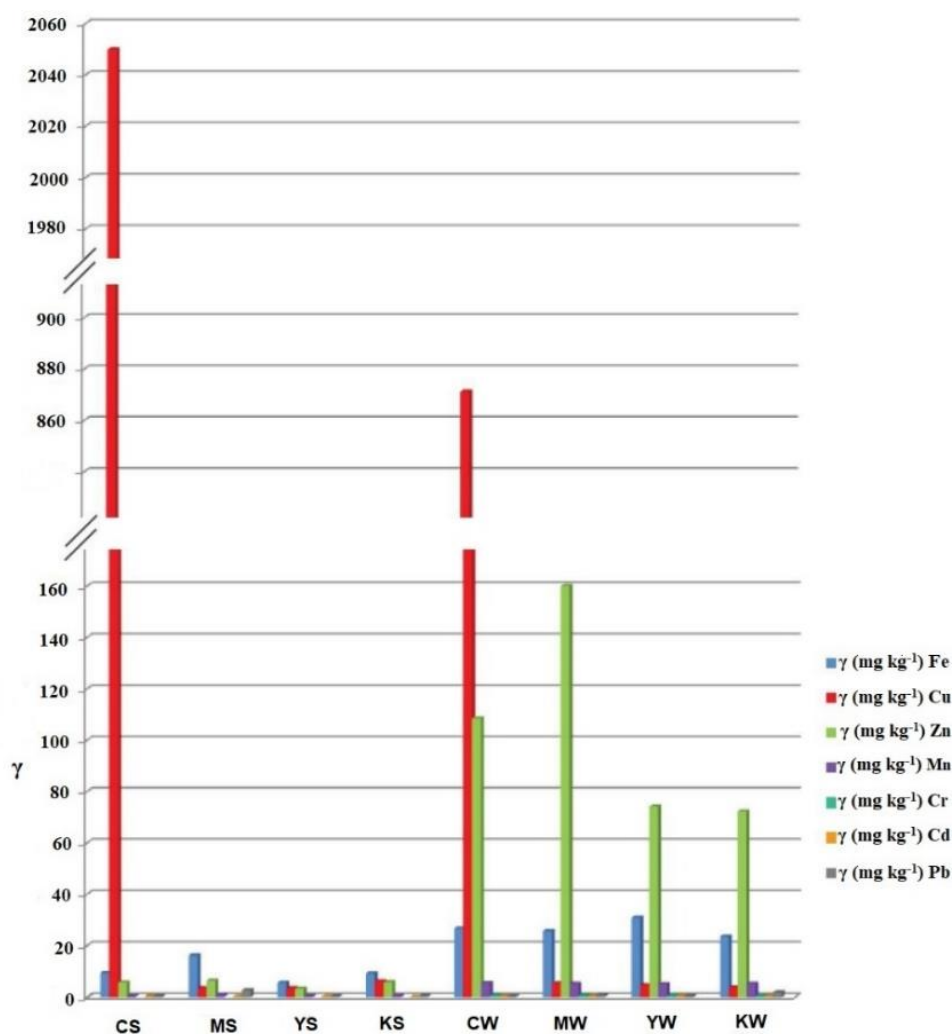


Figure 1. Mass concentration levels of detected heavy metals in the CMYK solvent and water-based screen printing inks

Conclusion

Screen printing inks contain heavy metal compounds (in pigments) and intensive drying agents - siccatives (organic salts of manganese, cobalt, or lead). The proportion of heavy metals in processing screen printing inks must be reduced, neutralized, or replaced with environmentally acceptable substances.

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