Understanding the interaction between selected microplastics and the toxic dye "Congo red" in water

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HIGHLIGHTS

- The interaction between MPs and CR was initially studied to select MPs with high adsorptive performance in mg/g.
- The MPs: HDPE and PVC, yielded higher adsorptive performances and were selected for detailed experimentation.
- Pore diffusion was a key mechanism for HDPE to interact with CR, whereas electrostatic interaction was for PVC to interact with CR.
- CR desorption was also observed only for HDPE microplastics, creating the alarm to develop necessary steps to manage microplastics properly.

GRAPHICAL ABSTRACT
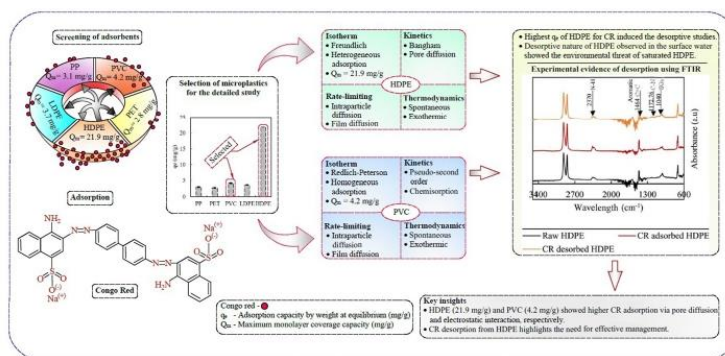
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ABSTRACT

This study thoroughly investigated the adsorption of Congo Red (CR) dye onto various microplastics (MPs), including high-density polyethylene (HDPE), polyvinyl chloride (PVC), low-density polyethylene (LDPE), polypropylene (PP) and polyethylene terephthalate (PET). Initial adsorption capacities (q_e) revealed that HDPE had the highest value (21.90 mg/g), followed by PVC (4.2 mg/g), LDPE (3.7 mg/g), PP (3.1 mg/g) and PET (2.8 mg/g). Based on these findings, HDPE and PVC were selected for detailed analysis. Adsorption experiments were conducted under controlled conditions: CR concentration of 100 mg/L, adsorbent dosage of 2 g/L, pH of 5, and temperature of 303 K. Isotherm studies indicated that HDPE followed the Freundlich model (R^2 - 0.99), while PVC was best described by the Redlich-Peterson model (R^2 - 0.97). Kinetic analysis showed that HDPE adhered to the Bangham model (reliable ((R^2 = 0.9267, 0.950, 0.988, and 0.988) R^2 values obtained for all the concentrations), highlighting pore-filling mechanisms. The conclusion, supported by FTIR analysis, indicates no significant changes in HDPE's functional groups after the adsorption. In contrast, PVC followed a pseudo-second order kinetic model (reliable R^2 values (0.999, 0.765, 0.956, 0.972) obtained for all the concentrations),

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