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The adsorption characteristics of Pb by various particle sizes of HDPE and LDPE

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Microplastics (< 5 mm) are known to adsorb contaminants due to their small particle size and large specific surface area, which is a growing concern as they can act as carriers of heavy metals. Polyethylene (PE) is the most used plastic polymer worldwide with an increasing demand for microplastics every year. Commercial PE polymers include high-density polyethylene (HDPE) and low-density polyethylene (LDPE). This study investigated the characteristics of lead (Pb) adsorption onto HDPE and LDPE microplastics based on various particle sizes. The HDPE and LDPE were categorized into three groups with different particle size ranges (group 1: 2.5 – 1.0 mm; group 2: 1.0 – 0.3 mm; group 3: < 0.3 mm), and batch adsorption tests were conducted with five different concentrations (0, 0.5, 1, 10, and 30 mg/L) of Pb solutions. The adsorption behavior of lead in HDPE was well described by the Langmuir model ($R^2 > 0.96$), while the Freundlich model was found to be the most appropriate for LDPE ($R^2 > 0.98$). In both types of plastic, the adsorption amount of Pb increased as the particle size decreased. The adsorption amount of Pb in group 3 (HDPE q_e = 0.04 mg/g, LDPE q_e = 0.16 mg/g) was higher than that in group 1 (HDPE q_e = 0.05 mg/g, LDPE q_e = 0.21 mg/g), indicating that the high specific surface area may affect adsorption capacities. The adsorption amount of Pb was about 4.2 times higher in LDPE than in HDPE in group 3 due to structural differences between HDPE (linear structure) and LDPE (long-chain branched structure).