
Platinum group elements (PGEs) from automobile catalysts: Bioaccessibility and exposure to humans

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Abstract

Increasing number of vehicles equipped with catalyst contributes to rising concentrations of platinum group elements (PGEs: Pt, Pd, Rh) in the environment. Spreading of these metals may affect human health and one of possible pathway of PGEs into human body is via digestive system. Dust particles can settle in the airways, where they are transported by mucociliary escalator and subsequently swallowed. Moreover, children may ingest PGE-polluted soil and dust through deliberate hand-to-mouth behavior or by eating unwashed food. The main goal of our work is an assessment of PGEs leaching under simulated gastrointestinal conditions and their potential risk for human health. Four different catalysts were used for the experiment: new diesel catalyst, new gasoline catalyst and diesel and gasoline catalysts, which had traveled 100,000 km. Two different bioaccessibility tests (PBET: Physiologically-Based Extraction Test and UBM: Unified BARGE Method) simulating chemical conditions in gastrointestinal tract were carried out. The results indicated that bioaccessible fractions were up to 11.8% for Pt, 10.5% for Pd and 5.71 for Rh. Higher bioaccessibilities were obtained by the PBET compared to UBM test. The observations by high angle annular dark field scanning transmission electron microscopy (HAADF-STEM) indicated that smaller PGEs particles observed in new catalysts were probably more susceptible soluble than larger particles in old catalysts. Exposure estimations were calculated for an adult (50 kg) and daily dust exposure of 30 mg/day. The calculated daily exposures were < 13.6 µg Pt, < 32.5 µg Pd and < 1.33 µg Rh and did not exceed pharmaceutical limit for oral intake defined by European Medical Agency (100 µg/day). However, the harmful effect of PGEs cannot be fully ruled out due to their ability to accumulate in the tissues of living organisms. This study was supported by Czech Science Foundation (GAČR 13-17501S) and Grant Agency of Charles University (GAUK 253328).

Keywords: platinum group elements, bioaccessibility, gastrointestinal test, exposure to humans, automobile catalyst

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