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Comparison of Polycyclic Aromatic Hydrocarbons Levels in Sludges from Municipal and Industrial Wastewater Treatment Plants

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Abstract This study was carried out to investigate the concentrations and potential sources of the polycyclic aromatic hydrocarbons (PAHs) in sludge of 14 wastewater treatment plants (WWTPs). Sludge samples were collected from 2 municipal WWTPs, 11 industrial WWTPs, and 1 sanitary landfill leachate treatment plant within the city of Bursa, Turkey during the summer of 2008. Ultrasonication was applied for extraction and gas chromatography–mass spectrometry was used to analyze the PAH contents of the samples. Twelve of the 16 EPA-listed PAH compounds were determined. Total PAH concentrations ($\sum_{12}$ PAHs) determined in all of the sludge samples ranged from 1,781 to 19,866 μg/kg dry matter (dm). The sum of 8 of the 11 EU PAHs varied between 1,481 and 17,314 μg/kg dm, and 3 of the samples exceeded the proposed EU limit for land application. One of the automotive industry sludges contained the highest level of PAHs, followed by one of the municipal sludges. The average sum of 5- and 6-ring PAH compounds in all of the sludge samples amounted to almost 65% of the total PAHs. The diagnostic ratios of specific PAHs were calculated to determine the dominant sources for the PAHs in the sludge samples.

Sludge is an unavoidable byproduct of the wastewater treatment process. Municipal and industrial sludge outputs are increasing day by day with rapid urbanization and the reinforcement of the regulations on wastewater treatment. Sludge management has become one of the most critical issues in wastewater treatment due to its huge amount. It is reported that 6.2 million tons dry matter (dm) is produced annually in the United States (Harrison et al. 2006). The annual sludge production of the European Union (EU) was 5.5 million tons dm in 1992 and is assumed to have increased up to more than 9 million tons by 2006 (Laturnus et al. 2007). The production of municipal sludge from Turkish wastewater treatment plants (WWTPs) is also expected to reach more than 1 million tons dm per year by 2020 (Salihoglu et al. 2007).

Land application has been used as a sustainable and economical sludge disposal option, especially in European countries (Laturnus et al. 2007). Large amounts of organic matter and nutrients that the sludge contains can make it suitable as fertilizer for agricultural purposes (Stamatiadis et al. 1999). On the other hand, the sludge can also contain organic, inorganic, and microbial pollutants and pathogens that would present ecological and health risks if used as fertilizer (Eriksson et al. 2008; Klöpffer 1996). It is essential to know and control the levels of these contaminants before considering the sludge management options.

Polycyclic aromatic hydrocarbons (PAHs) are a large group of organic contaminants present in sewage sludge (Eriksson et al. 2008). Because of their hydrophobic and lipophilic nature, PAHs tend to be sorbed on the solids in wastewater and accumulate in the sludge. PAH sources are diverse, ranging from intense use of petroleum products (automobile fuels, lubricating oils, etc.) to combustion processes (fuel, wood, and coal burning, automobile exhaust, heat and power generation, etc.) (Latimer and Zheng 2003).

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