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Effects of Temperature and Mechanical Abrasion on Microplastics

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Abstract : Since the last decade, a wave of research has begun to study the prevalence and impact of ever-increasing plastic pollution in the environment. The wide application and ubiquitous distribution of plastic have become a global concern due to its persistent nature. The disposal of plastics has emerged as one of the major challenges for waste management landfills. Microplastics (MPs) have found its existence in almost every environment, from the high altitude mountain lake to the deep sea sediments, polar icebergs, coral reefs, estuaries, beaches, and river, etc. Microplastics are fragments of plastics with size less than 5 mm. Microplastics can be classified as primary microplastics and secondary microplastics. Primary microplastics includes purposefully introduced microplastics into the end products for consumers (microbeads used in facial cleansers, personal care product, etc.), pellets (used in manufacturing industries) or fibres (from textile industries) which finally enters into the environment. Secondary microplastics are formed by disintegration of larger fragments under the exposure of sunlight, mechanical abrasive forces by rain, waves, wind and/or water. A number of factors affect the quantity of microplastic present in freshwater environments. In addition to physical forces, human population density proximal to the water body, proximity to urban centres, water residence time, and size of the water body also affects plastic properties. With time, other complex processes in nature such as physical, chemical and biological break down plastics by interfering with its structural integrity. Several studies demonstrate that microplastics found in wastewater sludge being used as manure for agricultural fields, thus having the tendency to alter the soil environment condition influencing the microbial population as well. Inadequate data are available on the fate and transport of microplastics under varying environmental conditions that are required to supplement important information for further research. In addition, microplastics have the tendency to absorb heavy metals and hydrophobic organic contaminants such as PAHs and PCBs from its surroundings and thus acting as carriers for these contaminants in the environment system. In this study, three kinds of microplastics (polyethylene, polypropylene and expanded polystyrene) of different densities were chosen. Plastic samples were placed in sand with different aqueous media (distilled water, surface water, groundwater and marine water). It was incubated at varying temperatures (25, 35 and 40 °C) and agitation levels (rpm). The results show that the number of plastic fragments enhanced with increase in temperature and agitation speed. Moreover, the rate of disintegration of expanded polystyrene is high compared to other plastics. These results demonstrate that temperature, salinity, and mechanical abrasion plays a major role in degradation of plastics. Since weathered microplastics are more harmful as compared to the virgin microplastics, long-term studies involving other environmental factors are needed to have a better understanding of degradation of plastics.

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