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# EMISSIONS OF VOLATILE AND SEMI-VOLATILE ORGANIC COMPOUNDS AND PARTICULATE MATTER FROM HOT ASPHALTS

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**ABSTRACT**

Asphalts are widely used in paving of roads, and water-proof sealing of building roofs, tanks and containers. This study evaluated the qualitative and quantitative characteristics of emissions from hot asphalts and bitumen that included reactive organic gases (ROGs) and particulate matter (PM). The ROGs consisted of several volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs) of environmental concern. The latter included several polynuclear aromatic hydrocarbons (PAHs) and alkanes. An experimental laboratory testing, sampling and analysis protocol was developed for obtaining efficient and cost-effective *a priori* estimates of asphalt emissions. The investigation identified and quantified the emissions of organics and evaluated the magnitudes as well as particle size distributions of PM emissions. The study demonstrated that the asphalt type and temperature greatly affected the emission characteristics, and that several organic compounds emitted were partitioned between gaseous and particulate phases. The factors that affected the phase distribution of organic compounds included the following: vapor pressures, ambient temperatures, collection methods, stability and reactivity, and affinity for sorption on PM.

Keywords: asphalt, volatile organic compounds, semi-volatile organic compounds, polynuclear aromatic hydrocarbons, alkanes, particulate matter

## INTRODUCTION

Asphalts are important products derived from petroleum refining, and are complex mixtures of different types of hydrocarbons including several aliphatics, naphthene aromatics, polar aromatics and asphaltenes [1, 2]. They are used in a variety of applications including paving of roads, highways, and air-fields, as well as water-proof sealing of roofs, tanks and containers. The paving of roadways and highways is the most important application on an international scale [3]. The United States maintains the largest road system in the world, and is a major consumer of paving asphalt with a production rate of about 678,000 barrels per day [4].

The preparation of hot asphalt mixes at high temperatures can potentially cause air quality problems due to emissions of particulate matter (PM) and reactive organic gases (ROGs). Most of the PM emitted from asphalt are fines in the 0.1-10 μm size range, which constitute effective nucleation sites for organic contaminants. The fine particles (or aerosols are they are sometimes called) are associated with health hazards because they are in the respirable size range, and are capable of penetrating deep into the respiratory system [5, 6]. The adverse health effects of fine particles have been reported by several researchers [7-11]. The emissions of ROGs are composed of a broad spectrum of contaminants including several volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) [12-16]. The SVOCs include several polynuclear aromatic hydrocarbons (PAHs) and alkanes. Most of these contaminants are recognized as health hazards [17] and some of them can undergo chemical transformation in the atmosphere to yield products often more hazardous than the parent compounds [18, 19]. Particulates and aerosols are also associated with other problems including degradation in visibility and deterioration in air quality [20]. The adverse health effects of asphalt fumes have been reported by several studies. A detailed review on the cancer risk of asphalt workers and roofers in various countries is provided by Partanen and Boffetta [21]. These researchers combined and analyzed the results of several epidemiological studies conducted on asphalt workers and asphalt roofers. They examined the cancer risk of the workers under three broad job categories: (i) roofers exposed to bitumen fumes, (ii) highway maintenance