

## Formation of particulate-phase and gas-phase polycyclic aromatic hydrocarbons in cigarette smoke

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**Abstract.** This study examines the concentrations of particulate-phase polycyclic aromatic hydrocarbons (PAHs) and gas-phase PAHs in sidestream cigarette smoke. Sixteen PAHs were determined for four brands of cigarettes. The volume of the experimental room is approximately 66 m<sup>3</sup>. The air samples in the room were collected before and after smoking. The median total of particulate-phase and gas-phase PAH concentrations before smoking 3.13 ng/m<sup>3</sup> and 48.0 ng/m<sup>3</sup>, respectively. The median concentrations of them after smoking were 10.0 ng/m<sup>3</sup> and 79.6 ng/m<sup>3</sup>. The median increases in the total of 16 PAH concentrations per cigarette during smoking were 271 ng for the particulate-phase PAHs and 1960 ng for the gas-phase PAHs. According to the relationship between particulate-phase and gas-phase PAHs after smoking, the two- to four-ring gas-phase PAHs and the higher molecular weight particulate-phase PAHs were probably formed from similar precursors. The relationship between the total suspended particulate (TSP) concentration and the increase in the total particulate-phase concentration of the 16 PAHs per cigarette during smoking were significantly positive. The increase in the total gas-phase concentration of the 16 PAHs tended to increase as the TSP concentration increased. This may indicate that decreasing the amount of TSP produced inhibits the production of PAHs during smoking.

**Keywords:** sidestream cigarette smoke; particulate-phase polycyclic aromatic hydrocarbons; gas-phase polycyclic aromatic hydrocarbons; total suspended particulate

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### 1. Introduction

Cigarette smoke is an important source of toxic chemicals to active smokers and those exposed to second-hand smoke. Exposure to cigarette smoke poses risks of developing cancers and various respiratory and cardiovascular diseases (IARC 2004, OEHHA 2005). Evidence that smoking is a major cause of heart disease has been found in many studies (Villablanca *et al.* 2000, Messner and Bernhard 2014). More than 7000 chemicals, including many carcinogens and hazardous chemicals, have been found in cigarette smoke. These constituents of cigarette smoke include polycyclic aromatic hydrocarbons (PAHs) (IARC 2010), which are primarily produced as a result of incomplete combustion of organic material in car engines, incinerators, and factories (Nam *et al.* 2008, Obrist *et al.* 2015, Subramanian *et al.* 2015). Each PAH molecule has two or more fused

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