Health Issues Concerning Inhalation of Petroleum Diesel and Biodiesel Exhaust

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Abstract

The public and regulatory agencies will question the comparative health risks from inhaling Biodiesel (BDE) and petroleum diesel (PDE) exhaust. The principal health concern for inhaled PDE is lung cancer from the respirable soot, which contains known mutagens and carcinogens. Epidemiology suggests that heavy occupational exposures to PDE may slightly increase lung cancer risk; however, the magnitude of the risk is uncertain and controversial. Inhalation of high concentrations of PDE is also irritating to the lung. Lifetime inhalation exposures of rats to high concentrations of PDE causes chronic lung disease and an increase in lung tumors associated with the soot. Identical exposures are not carcinogenic in Syrian hamsters, and produce equivocal results in mice. Similar tumor responses of rats to PDE soot and mutagen-poor carbon black suggest that the organic mutagens are not important in the rat response. The responses of rat and monkey lungs to inhaled PDE soot differ, and it is now considered unlikely that the rat lung tumor results are applicable to humans. There are no epidemiological studies of inhaled BDE, and no published inhalation carcinogenicity studies. At this time, the relative health effects of Biodiesel and petroleum diesel exhaust can best be estimated by comparing the soot mass produced, the mutagenicity of organic emissions, and the irritant potentials of the two materials when inhaled. BDE contains less soot mass than PDE, and a greater portion of BDE soot is soluble. The soluble organic fraction of BDE soot is less mutagenic than that of PDE soot. These differences suggest that the carcinogenic potential of inhaled Biodiesel exhaust is probably less than that of petroleum diesel exhaust. Little is known about the relative irritant potentials of inhaled Biodiesel and petroleum diesel exhaust. Depending on the fuel, engine, and operating conditions, irritating gases and vapors can be greater or lesser for BDE than for PDE. The persistence and irritancy of BDE soot in the lung should be tested in animals. Overall, our present information suggests that the health risks of Biodiesel might be less than for petroleum diesel, and that the future of Biodiesel fuels will be limited more by economic factors than by health concerns.
Introduction

Engines burning petroleum diesel fuels have been in general use for many decades, and questions continue to be raised by the public and regulatory authorities concerning the potential adverse health effects of occupational and environmental exposures to inhaled petroleum diesel exhaust. If Biodiesel fuels, diesel fuels derived from plant and animal oils, are to be successfully introduced into more general use, questions concerning the potential health impacts of inhaling Biodiesel exhaust and the comparative toxicity of Biodiesel and petroleum diesel exhausts must be addressed. The purpose of this paper is to present a summary review of the potential health effects of Biodiesel exhaust. There have been few studies of the toxicity of Biodiesel exhaust, but several studies of the composition of Biodiesel emissions. Therefore, this review presents a preliminary assessment of Biodiesel health issues based primarily on the comparative compositions of Biodiesel and petroleum diesel emissions.

Health effects of inhaling petroleum diesel exhaust

Our current understanding of the nature and potential health risks of inhaled petroleum diesel exhaust (PDE) was recently summarized well by the Health Effects Institute [1]. Concerns for the health effects of PDE have largely been focused on the risk for lung cancer from inhaled soot. Petroleum diesel soot consists of a carbon core to which a complex mixture of organic compounds, sulfates, nitrates, and metals is adsorbed. Soot particles in diluted exhaust are almost all less than one μm in diameter and are thus readily inhaled [2]. Approximately 20 to 30% of the particles in the size range of PDE soot would be expected to deposit in the lung and airways when inhaled by humans [3]. The soluble (solvent-extractable) organic fraction (SOF) consists of aliphatic, heterocyclic, and polycyclic aromatic hydrocarbons (PAHs), and their derivatives, among which are several known mutagens and carcinogens. Concern for potential chemical-induced cancer risk from inhaled diesel soot arose in the mid 1950s when Kotin et al. [4] found that the SOF caused cancer when applied to mouse skin. This concern was elevated in the late 1970s when U.S. Environmental Protection Agency (USEPA) researchers reported that the SOF was a direct-acting mutagen in the Ames Salmonella assay [5]. These findings, and a predicted increase in diesel engine use in light-duty vehicles, stimulated a world-wide research effort to define lung cancer risk which continues today.

Epidemiology

Between 1957 and 1993, 34 epidemiological studies either focused on lung cancer risk from inhaled PDE or contained information from which some measure of risk from PDE could be inferred [1]. This body of information includes 18 cohort studies and 16 case-control studies. To a degree which varied from study to