An overview about coal mining as an environmental source of polycyclic aromatic hydrocarbons

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Polycyclic aromatic hydrocarbons (PAHs), derived mostly from anthropogenic sources, are one of the most ubiquitous groups of organic pollutants that are harmful to the environment and to human health. The United States Environmental Protection Agency (US-EPA) has defined 16 PAHs as priority pollutants, due to their toxicity, mutagenic and carcinogenic properties. These compounds, with 2 to 6 condensed aromatic rings, are: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[123-cd] pyrene, benzo[ghi]perylene, and dibenz[ah]anthracene.

The anthropogenic sources of PAHs include incomplete combustion of fossil fuels, industries, internal combustion and diesel engine exhausts, as well as aviation exhaust, cigarette smoking, among others, while natural sources of PAHs include coal seams and carbonaceous rocks, volcanic activity and forest fires.

The environmental source of PAHs associated with coal is related with the petrogenic or native PAHs contained within the coal structure, arising from chemical conversion of organic matter during coalification, and pyrolytic PAHs resulting from coal combustion, arising from cracking of organic compounds to smaller and unstable fragments that lead to more stable PAH formation through recombination reactions. The levels and patterns of petrogenic and pyrolytic PAHs associated with coal depend on the coal rank and combustion conditions.

During coal mining, petrogenic PAHs can be released to the environment in mining operations, transport, storage of coal, disposal of coal mining rejects, among others, posing a risk to soils, sediments, groundwater, surface water, and biodiversity. The physico-chemical properties of PAHs largely determine their environmental behaviour; some of these compounds are preferentially bounded to the particulate matter but some, such as naphthalene, fluorene, phenanthrene and anthracene, can be detected in water phases. Their fate in the environment includes volatilization, photo-oxidation, chemical oxidation, adsorption in soil particles, leaching and microbial degradation.

The disposal of mining rejects in coal waste piles can therefore be a potential source of pollution given that there is potential for the release of petrogenic PAHs, thus posing a risk to surrounding environment. In addition, when considering self combustion processes in coal waste piles, there is potential for the release of pyrolyitc PAHs, which can be release in the gas phase or associated with particles given the high combustion temperatures.

Depending on the extent of the environmental impacts caused by the release of PAHs, these may have varied and deleterious effects on human health and biodiversity. The effects on human health may be directly caused by the gaseous emissions and solid particles dispersion. The soils and waters pollution may affect the local biodiversity and also human health through water consumption and land use for agriculture.

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