Technogenic aerosol of Kuzbass coal cleaning plants and its potential hazard to human health

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Chromatomass spectrometry is used to study the composition of organic compounds adsorbed on aerosol particles emitted by coal cleaning plants. An analysis has shown that technogenic aerosols emitted by coal cleaning plants comprise dangerous toxicants which are a potential ecological hazard to human health.

Coal cleaning plants are important technological units in territories with mining industry. Distinguishing features of the production process of coal cleaning plants (technological processes of flotation and drying of a concentrate) make them intense sources of technogenic aerosols. The flotation process is accompanied by emission of the background aerosol immediately in air of working rooms of coal cleaning shops, and drying a concentrate brings the thread of aerosol pollution of territories adjacent to these plants.

Aerosol particles themselves as mechanical admixtures comprised in the air basin are a hazard to human health, if their number density is high. But still more hazardous are many chemical compounds adsorbed on aerosol particles. Therefore, a comprehensive study of the chemical composition of admixtures adsorbed on aerosol particles is an important problem of estimating a potential ecological hazard of working coal cleaning plants. This is especially actual, because there are data of medical organizations on more frequent cancer diseases among women working at coal cleaning plants.

Our investigations were carried out at the Central Coal Cleaning Plant located in Belovo, Kemerovo region. As main reagents, "thermogasoilB and foaming agent, by-products of petrochemical production process, were used for coal cleaning in a technological flotation cycle.

Aerosols were sampled in the air of industrial rooms and outdoors with the help of devices of aspiration type having an air circulation rate of 50 liter/min. The initial composition of thermogasoil and floating agent were qualitatively analyzed using an MM 70-70 chromatomass spectrophotometer comprising a capillary quartz column 60 mm in length and 0.25 mm in diameter with methylsiloxane phase DB-1. An analysis of initial reagents and air samples has shown their practically identical composition. In Fig. 1 a fragment of the recorded mass spectrogram is shown, and in Table 1 the most typical chemical compounds, comprised in the initial reagent and aerosol fraction, are given. More than 100 different chemical compounds belonging to groups of saturated hydrocarbons, phenols, aromatic hydrocarbons, and polyaromatic hydrocarbons were identified.

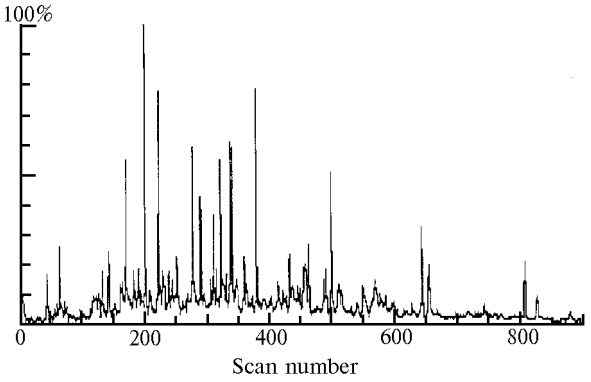

Fig. 1. Fragment of mass chromatogram of thermogasoil. The scan number is plotted on the abscissa. The total ionic current, in relative units, is plotted on the ordinate.

Our analysis was carried out according to Ref. 1. Medical and biological data were borrowed from the database of the National Institute of Professional Safety and Health of the USA. As can be seen, the majority of compounds indicated in Table 1 can be referred to the second class of hazard. In addition, many indicated compounds are mutagenic and carcinogenic. Hence, the conclusion about relative safety of reagents used at coal cleaning plants, drawn on the basis of sanitary-hygienic experiments in chambers filled with vapor of thermogasoil or foaming agent, cannot be considered correct.

Indeed, at room temperature only the group of saturated hydrocarbons has noticeable vapor density. Just saturated hydrocarbons are responsible for the irritating effect, which is considered in sanitary-hygienic experiments. At the same time, the lack of aerosol experiments leaves aside a potential hazard of the above-mentioned organic compounds for human health.

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Table 1. Some organic compounds found in thermogasoil.

Compound	Irritating effect	Pathology of reproductive function	Mutagenic and teratogenic effects
Aromatic hydrocarbons			
1,4 -dimethylbenzene	+	+	–
3-methyl-1-ethylbenzene	+	–	–
1,3-dimethylbenzene	+	+	–
1-ethyl-4-methylbenzene	+	–	–
1,3,5-trimethylbenzene	+	–	–
1,2,3,4-tetramethylbenzene	+	–	–
Polyaromatic compounds			
Naphthalene	+	–	–
1-methylnaphthalene	–	–	+
1,4,6-trimethylnaphthalene	–	–	–
Fluorene	–	–	+ , +
9-methylene-9H-fluorene	–	–	+
Phenanthrene	–	–	+ , +
Diphenyl	–	–	+
3,4-dimethyl-1,1-diphenyl	–	–	+
Phenols			
2,3-dimethylphenol	+	–	+
3,5-dimethylphenol	+	–	+
2,3,6-dimethylphenol	–	–	
2-ethyl-5-mehtylphenol	–	–	
2,4-dimethylphenol	+	–	+
Aliphatic hydrocarbons			
Nonane	–	–	+
4,5-dimethylnonane	–	–	
Decane	–	–	+
1-methyl-2-propylcyclohexane	+	–	
Tetradecane	–	–	+
Pentadecane	+	–	+
2,7,10-trimethyldodecane	–	–	+

Note. Here "+" denotes the presence of the indicated effect, and "–" denotes its absence.

Thus, owing to generation of aerosols comprising dangerous chemical compounds, the flotation and drying processes at coal cleaning plants bring a significant ecological hazard to human health and call for special engineering and organizational protective measures.

References

1. R. A. Khmel'nitskii and E. S. "rodskii, *Mass Spectrometry of Environmental Pollution* (Khimiya, Moscow, 1990), 100 pp.