

Principal Research Results

Inhalation Risk Assessment of Trace Elements Emitted from Coal-fired Power Plants

Background

Recently, the effects of chemical substances in the environment on human health and ecosystem have been a matter of concern. In order to protect living things from the effects, we have to assess the environmental risk that may cause the adverse health effects or ecological extermination. Up to now, the environmental impact of trace elements emitted from thermal power plants has been assessed on the stack gas concentrations to the background concentrations. For fulfilling the scientific knowledge of environmental impact of trace elements from power plants, health risk assessment for trace elements has been required. However there are no reports which discussed the health risk of trace elements from power plants in Japan.

Objectives

To develop an inhalation risk assessment method for trace elements emitted from coal-fired power plants and assess the inhalation risks of trace elements for domestic coal-fired power plants.

Principal Results

1. Development of inhalation risk assessment method for trace elements

An inhalation risk assessment method for 16 trace elements (Table-1) from coal-fired power plants has been developed. The inhalation exposure concentrations are calculated from the emission factor of trace elements and meteorological conditions measured at power plants, atmospheric dispersion models used for regulatory purposes by the Japan Environmental Agency and inhalation exposure model introduced to consider a reasonably exposed individual in the Japanese population. By comparing the exposure concentrations with the inhalation risk factors recommended by the U.S. Environmental Protection Agency, individual carcinogenic risk, population carcinogenic risk and hazard index for noncarcinogenic risk were calculated (Figure-1).

2. Assessment of inhalation risks of trace elements from domestic coal-fired power plants

By applying the developed method to the 39 coal-fired power plants in Japan, the inhalation risks for trace elements were assessed. The individual inhalation carcinogenic risks for 6 trace elements from domestic coal-fired power plants were estimated to be below 5×10^{-8} and 2 orders of magnitude smaller than the health risk guideline of 1×10^{-5} (Figure-2). The inhalation hazard indexes for 12 trace elements from domestic coal-fired power plants were estimated to be below 2×10^{-3} and 2 to 4 orders of magnitude smaller than the inhalation reference levels that an adverse health effect would not be anticipated. As a result of comparison between the inhalation risks of trace elements from coal-fired power plants with the accidental risk in daily life, the individual inhalation carcinogenic risks for coal-fired power plants are 2 to 7 orders of magnitude smaller than the daily risks and are well below the level that would not increase the daily risk significantly (Figure-3).

Future Developments

The results of inhalation risk assessment will be used as the fundamental materials in the risk communication for trace elements.

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Reference

Kazuo Asakura et al., 2004, "Inhalation risk assessment of trace elements emitted from coal-fired power plants", CRIEPI Report T03032 (in Japanese)

Table 1 Trace elements selected for inhalation risk assessment

No.	Substances		Carcinogenic	Non-carcinogenic
1	Arsenic	As	○	○
2	Beryllium	Be	○	○
3	Cadmium	Cd	○	○
4	Chromium	Cr	○	○
5	Nickel	Ni	○	○
6	Benzo(a)pyrene	Bap	○	NA
7	Boron	B	NA	NA
8	Cobalt	Co	NA	NA
9	Hydrogen chloride	HCl	NA	○
10	Hydrogen fluoride	HF	NA	○
11	Mercury	Hg	NA	○
12	Manganese	Mn	NA	○
13	Lead	Pb	NA	○
14	Antimony	Sb	NA	○
15	Selenium	Se	NA	○
16	Vanadium	V	NA	NA

NA : Not Available on the information of carcinogen or noncarcinogen

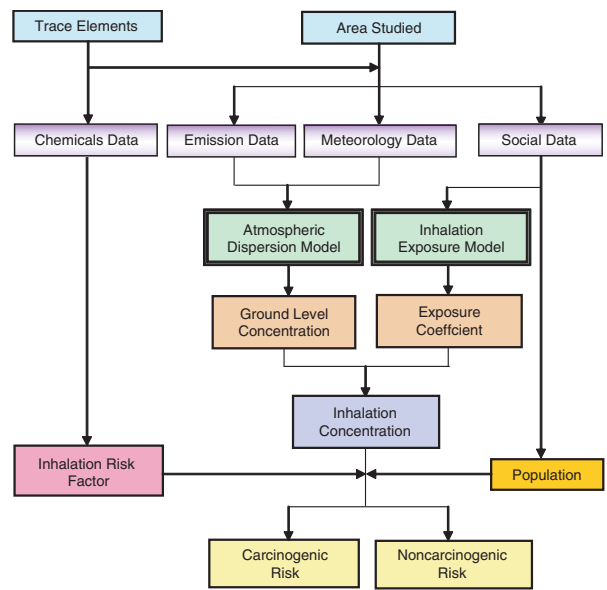


Fig. 1 Inhalation risk assessment method of trace elements from coal-fired power plants

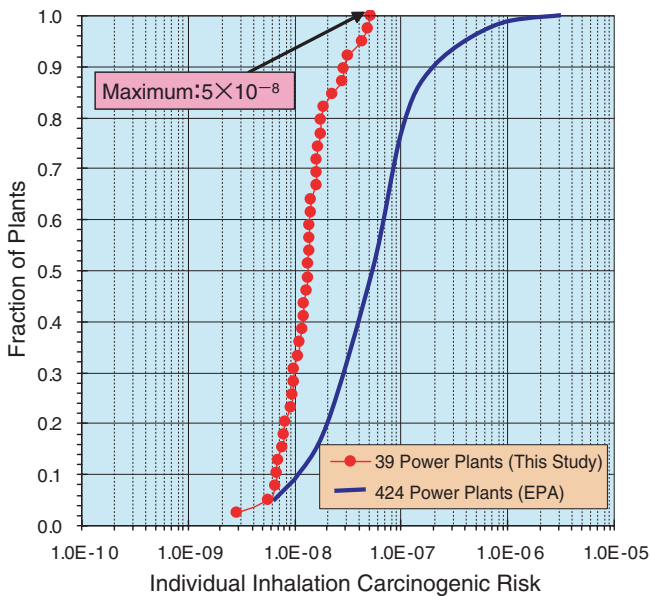


Fig. 2 Distribution of individual inhalation carcinogenic risk for coal-fired power plants

The individual inhalation carcinogenic risks of trace elements for 39 coal-fired power plants in Japan are below 5×10^{-8} and 2 to 3 orders smaller than the health risk guideline of 1×10^{-5} . The risks of 39 power plants in Japan are well below the risks of 424 power plants in the U.S..

Annual Risk	Daily Death Risk ^(*)	Inhalation Carcinogenic Risk
10^{-2}	Cancer (2.4×10^{-3})	Target Value Recommended by the Health Risk Guideline Annual Individual Risk of Coal-Fired Power Plants (This Study) Max. : 7×10^{-10} Min. : 4×10^{-11}
10^{-3}	Sudden Accident (3.1×10^{-4})	
10^{-4}	Traffic Accident (7.6×10^{-5})	
10^{-5}	Fire (8.5×10^{-6})	
10^{-6}	Natural Disaster (8.4×10^{-7})	
10^{-7}	Air Accident (1.3×10^{-7})	
10^{-8}	Thunder (2.1×10^{-8})	
10^{-9}		
10^{-10}		
10^{-11}		

(*) White paper on police (2003), Vital statistics (2003)

Fig. 3 Comparison between individual inhalation carcinogenic risk and daily death risk

The individual inhalation carcinogenic risks of trace elements for 39 coal-fired power plants are 2 to 7 orders smaller than the daily death risk. These risks are well below the level that would not increase the daily risks significantly.