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Spatial Trends of Mercury in the Surface Soils around the Shi li-quan Power Plant of Zaozhuang City, China

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***Abstract*—Mercury (Hg) deposition in soils derived from coal combustion in coal-fired power plants can be large and quickly. In this study, Shi li-quan power plant, a large ultra-high voltage thermal power plant which is located in Zaozhuang City was selected to study the effect of the coal-fired power plant on the Hg deposition in surrounding soils. Results showed that the average soil Hg contents near the power plant is ~0.1 mg/kg which is about 5-fold than the background level of Shandong province (0.019 mg/kg). Soil Hg contents decreased with increasing distance from power plant and the decreasing speed being relatively slow in the northeast of the power plant due to convenient transportation and dense population.**

Keywords—mercury; soil; shi li-quan power plant; spatial distribution

I. INTRODUCTION

Mercury (Hg) is a heavy metal which has toxic effect on human health and other organisms [1]. Human activities such as mining and smelting, coal combustion in coal fired power plants, industrial processes and residential coal burning are important anthropogenic sources of Hg in the environment [2]. Among all these anthropogenic sources, coal fired power plants are the main emissions [3]. Incomplete combustion of coal in power plants generates fly ash and associated Hg deposits quickly in surrounding soils [4]. Studies have indicated that Hg emission from coal fired power plants account for ~70% of the deposition of Hg in soils close to these plants [5].

China's reform, opening up promotes economic and social development while increases the demand for energy and leads to the accumulation of Hg in environment. Environment effects of Hg have raise high interest since 1980s [6]. According to reports, the Hg contents in sediment of the Nansi Lake catchment has increased extremely rapid since 1981 due to economic resurgence. [7]. Shi li-quan power plant developed with the pace of the policy is a large ultra-high voltage thermal power plant. It is located in Zaozhuang city with abundant coal resources. As a deposition record, soils reflect the accumulation history of soil Hg contents close to coal-fired power plants and factors such as physical and chemical properties of soil, topography and human activities may change the distribution of Hg in surrounding soils [8].

This study intended to: 1. Describe the distribution characteristics of Hg contents in surface soil near the Shi li-quan power plant. 2. Try to understand the influence of the power plant on the surrounding soils Hg contents.

II. MATERIALS AND METHODS

A. Study Area and Sampling

Shi li-quan power plant was located in the southern suburb of Zaozhuang city (34° 27′–35° 19′ N, 116° 48′–117° 49′ E)Shandong province, which is the first large-scale ultra-high-pressure thermal power plant, designed and built by Shandong Electric Power. The site where Shi li-quan power plant located are shown in Fig.1. In May 2012, approximately 1160 samples were collected at 0-20 cm of the soil surface in the catchment basin of Zaozhuang City. All samples were transported to the laboratory with a polythene bag after collected by Luoyang spade. These soil samples were air-dried at normal temperature, and then reserved the samples after removed the large particles by 10 mesh sieve.

FIGURE I. STUDY AREA IN SHIZHONG DISTRICT, ZAOZHUANG CITY

B. Analysis of mercury in soil

Total Hg was measured in the laboratory of the Wuhan Institute of Geology and Mineral Resources Monitoring. Samples weighing about 0.25g were digested in Teflon container by the microwave heating in a mixture of HNO_3-$HClO_4$ solution. The digestion solution samples were diluted to 25 ml with deionized water, then be used for the

determination of total mercury content by atomic fluorescence spectrometer(AFS-230E, Beijing, China).

III. Results and Discussion

The average contents of soil Hg in the central core is ~0.1 mg/kg which is about 5-fold than the background level in Shandong province(about 0.019 mg/kg) [9], even in the outermost zone, the contents is also as high as 0.052 mg/kg, which is 2.7-fold than background level.

Distribution characteristics of Hg contents in surface soil near the Shi li-quan power plant are shown in Fig. 2. Which is consistent with the research results of Shan Ping et al, showing that surface soils around the coal-fired power plants has extremely high Hg contents, and the overall distribution of soil Hg contents showed stepped distribution characteristics [10]. In this study, the power plant is located in the center of the content gradient. Soil Hg contents presents a gradient variation from the center to the periphery and decreased with increasing distance from the power plant. The contents around the power plant (0.1 mg/kg) is 2-fold higher than the outermost zone (0.52 mg/kg).

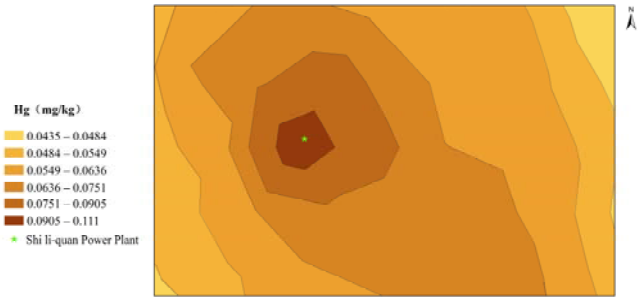

FIGURE II. SPATIAL DISTRIBUTION OF SOIL HG CONTENTS NEAR THE SHI LI-QUAN POWER PLANT

The decreasing trend curve of Hg contents with gradient center distance is shown in Fig.3. The decreasing trend showed a slightly difference in two opposite directions. Soil Hg contents decreased from 0.111 to 0.0596 mg/kg within the 4 km distance along northeast while decreased from 0.111 to 0.043 mg/kg within the 4 km distance along southwest. Along northeast and southwest, soil Hg contents both decreased quickly within 1 km around the gradient center and then decreased slowly within 1 to 2.5 km from the gradient center and finally attach a constant value. However, the decreasing speed along northeast (0.022 mg/kg per km) was lower than that along southwest (0.4 mg/kg per km).

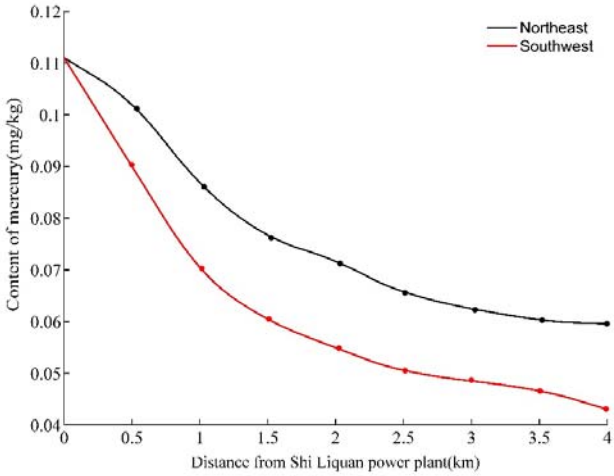

FIGURE III. DECREASING TREND CURVE OF HG CONTENTS WITH GRADIENT CENTER DISTANCE

It should be noted that, convenient transportation and dense population in the northeast of the power plants are favorable for the accumulation of Hg in soils. Other factors, such as physical and chemical properties of soil may also influence the distribution pattern of Hg deposition around the power plants. It has been indicated that Hg and organic matter have strong complexation which could influence the accumulation of Hg in soils [11]. In addition, strong correlation between soil Hg contents and TOC has been reported in other studies [12]. In this study, brown soil in the northeast of the power plant has relatively high organic content compared with the cinnamon soil in the southwest of the power plant. Which may be benefit for the complexing with Hg.

IV. Conclusion

Distribution of soil Hg contents is closely related to the distance to the power plant. Soil Hg contents decreased with increasing distance from the Shi li-quan power plant. Within the 4km distance along northeast and southwest soil Hg contents decrease to 0.0596 and 0.043 mg/kg. Average soil Hg content in the central zone is 0.1 mg/kg which is about 5-fold than the background level, the contents is about 0.052 mg/kg in the outermost zone which is 2.7-fold than background level. Due to the convenient transportation and dense population, contents decreased slowly in the northeast of the power plant. In addition, brown soil with relatively high organic content in the northeast of the power plant has a much stronger complexation effect with Hg which may be the reason for larger accumulation of Hg.

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