EMISSIONS, CONTROLS AND ISOTOPE SIGNATURES OF HG FROM COAL-FIRED POWER PLANTS IN SOUTHERN CHINA

Zhonggen Li, X.B. Feng, L. Tang, J. Chen

State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China

lizhonggen@vip.skleg.cn

Keywords: mercury; coal-fired power plant; emission; isotope signatures; removal efficiency

Introduction

Mercury (Hg) emitted from coal-fired power plants (CFPPs) is one of the most important anthropogenic sources. China is the largest coal consumer in the world, and CFPPs burned one half the coal used in China. With more and more restrictions on SO_2 and NOx emission from CFPPs, CFPPs in China have sequentially installed the flue gas desulfurization (FGD) and DeNOx system during the 11th five year plan (2006-2010) and the 12th five year plan (2011-2015) period, respectively. Since FGD and DeNOx system have obviously synergetic effect on Hg removal, more work are needed for the updated Hg emission factors, and Hg isotope signatures from the CFPPs source. The work could provide a better understanding of the fate of Hg in the CFPPs and for the compile of an updated Hg inventory. Guizhou province in southwest China is rich in coal, and ranked No.1 in southern China. Coal in Guizhou feathered with high sulfur, and high ash content. CFPPs consumed about 58 million tons coal in 2013.

Methods

We studied 14 CFPPs in Guizhou during 2014 to 2016, including 2 CFB boilers and 12 PC boilers. Of the 14 CFPPs, 7 burned anthracite coal and the other burned bituminous coal. Air pollution control devices (APCDs) are divergent, including the combination of CFB+ESP; CFB+SNCR+ESP+WFGD; PC+SCR+ESP+WFGD; PC+SCR+ESP-FF+WFGD; PC+ SCR+ESP+WFGD+WESP. Boiler capacity for different CFPPs ranged from 150 MW, 200 MW, 300 MW to 600 MW. Hg in the flue gas were sampled with Ontario Hydro Method (OHM) and detected with CVAAS. Total Hg in solid samples such as coal, bottom ash, fly ash, flue gas filters, limestone and gypsums were determined with Lumex CVAAS. Hg isotope signatures in the flue gas and solid samples were detected with MC-ICP-MS (Nu Instruments, Nu plasma model II).

Results

Hg in feed coal of different CFPPs ranged from 70 to 320 ng/g, which is positively correlated with S content (0.4-3.8%) in feed coal (p<0.01). Hg in feed coal also controlled the total Hg concentration in flue gas out of the boiler. Ash content in coal (27% to 46%) is an important factor controlling the percentage of particulate Hg in the flue gas out of the boiler. After different APCDs, 87% to 99.9% of Hg in the flue gas was removed, either by the fly ashes or the FGD gypsums. Total Hg in the flue gas of stack ranged of 0.2-3.9 μg/m^3, with most in Hg^0 form. The emission factors of different CFPPs ranged from 0.7 to 13.6 mg Hg/t coal, much lower than the previously reported. Different combinations of coal type+boiler

type+APCDs have distinct effect on Hg speciation in the flue gas, the transformation of different Hg speciations and the removal pathways of Hg. Hg isotope signatures showed clearly mass-dependent fraction (MDF) was taken place among different coal combustion products, lighter in the fly ash and gypsum, and heavier in the flue gas. In the flue gas, Hg^{2+} form was much lighter than that in ^{202}Hg form, with MDF changed heavier 5-6‰ compared with feed coal. As much as 3-4‰ mass-independent fraction (MIF) was found in Hg^0 form of some CFPPs, while no MIF was found for that of Hg^{2+}.

Conclusion

Our study indicated the traditional APCDs used for NOx, PM and SO_2 have high synergistic effect on Hg removal, and Hg in the discharged flue gas have obviously MDF and MIF signatures.

Acknowledgments

This study is supported by the National Basic Research Program (973) of China (2013CB430001).