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### 模拟城市生活垃圾热处理过程中Cd与Pb挥发特性研究

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### Volatilization of Cd and Pb during thermal treatment of model solid waste in a fluidized bed incinerator

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**摘要** 以Cd与Pb为研究对象,在流化床反应器上对模拟城市生活垃圾 $Al_2O_3$ 热处理过程中重金属的动力学挥发特性进行了研究。分析了氧化还原条件、 $H_2O$ 、 $HCl$ 、 $SO_2$ 及基体 $Al_2O_3$ 对重金属的挥发特性影响。研究表明,Cd具有较强的挥发性,尤其是在通入 $HCl$ 的情况下,而Pb的挥发程度则较低,同时氧浓度的增加会降低重金属的挥发。 $Al_2O_3$ 颗粒中重金属的物理化学吸附以及重金属的扩散效应则同样在一定程度上抵制了重金属的释放,而 $SO_2$ 的通入则在一定程度上促进了Cd与Pb的释放。

**关键词:** 重金属 固体废弃物 流化床 挥发特性

**Abstract:** The Cd and Pb volatilization behavior in model solid waste in a fluidized bed incinerator with  $Al_2O_3$  bed material was investigated. The influence of redox conditions,  $H_2O$ ,  $HCl$ ,  $SO_2$  and  $Al_2O_3$  was examined. The results show that Cd has a great volatility, especially when  $HCl$  is added, while Pb volatilizes moderately. Increasing the oxygen concentration can lower the heavy metal volatilization. The sorption (either physical or chemical) of  $Al_2O_3$  particles, coupling with the internal diffusion of gaseous metal species, may control the volatilization of heavy metals. When  $SO_2$  is added, Cd and Pb show a higher volatility.

**Key words:** heavy metals solid waste fluidized bed volatilization behavior

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- [1] VINKE P, van der EIJK M, VERBREE E. Modification of the surfaces of a gas activated carbon and a chemically activated carbon with nitric acid, hypochlorite, and ammonia[J]. Carbon, 1994, 32(4): 675-686. 
- [2] HOORNWEG D, LEADER T T, LAM P, CHAUDHRY M. Waste management in China: Issues and recommendations[Z]. East Asia Infrastructure Department, World Bank, Washington DC, 2005.
- [3] 孙路石, 陆继东, 张娟, ABANADES S, FLAMANT G, GAUTHIER D. 城市垃圾焚烧过程中重金属释放行为的试验研究[J]. 燃烧科学与技术, 2003, 9(6): 516-

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520. (SUN Lu-shi, LU Ji-dong; ZHANG Juan, ABANADES S, GAUTHIER D. Experimental investigation on heavy metal emission performance from incineration of municipal solid waste[J]. Journal of Combustion Science and Technology, 2003, 9(6): 516-520.)
- [4] MUNIZ J, HERRERO J E, FUERTES A B. Treatments to enhance the SO<sub>2</sub> capture by activated carbon fibers[J]. Appl Catal B, 1998, 18(1/2): 171-179. 
- [5] WILLIAM P L, WENDT J O L. Toxic metal emissions from incineration: Mechanisms and control[J]. Prog Energy Combust Sci, 1993, 19(2): 145-185. 
- [6] BRAZHNYK D V, ZAITSEV Y P, BACHERIKOVA I V, ZAZHIGALOV V A. Oxidation of H<sub>2</sub>S on activated carbon KAU and influence of the surface state[J]. Appl Catal B, 2007, 70(1/4): 557-566. 
- [7] 上官炬, 杨直, 苗茂谦. 硝酸改性褐煤半焦制备烟气脱硫剂[J]. 太原理工大学学报, 2007, 38(3): 229-232. (SHANG-GUAN Ju, YANG Zhi, MIAO Mao-qian. The SO<sub>2</sub> adsorbent prepared by the oxidation with HNO<sub>3</sub> from lignite Semi-Coke[J]. Journal of Taiyuan University of Technology, 2007, 38(3): 229-232.)
- [8] 黄伟, 孙盛凯, 李玉杰, 杨爱军, 贾艳秋. 硝酸改性处理对活性炭性能的影响[J]. 生物质化学工程, 2006, 40(6): 17-21. (HUANG Wei, SUN Sheng-kai, LI Yu-jie, YANG Ai-jun, JIA Yan-qiu. Influence of nitric acid modification on the properties of activated carbon[J]. Biomass Chemical Engineering, 2006, 40(6): 17-21.)
- [9] 吴开金, 官新宇, 官九红, 陈涵, 林冠烽. 硝酸改性对活性炭吸附性能的影响[J]. 福建林业科技, 2009, 36(5): 35-37. (WU Kai-jin, GUAN Xin-yu, GUAN Jiu-hong, CHEN Han, LIN Guan-feng. Influence of nitric acid modification on the adsorption properties of activated carbon[J]. Journal of Fujian Forestry Science and Technology, 2009, 36(5): 35-37.)
- [10] 张永奇, 房倚天, 黄戒介, 王洋. 活性焦孔结构及表面性质对脱除烟气中SO<sub>2</sub>的影响[J]. 燃烧科学与技术, 2004, 10(2): 160-164. (ZHANG Yong-qi, FANG Yi-tian, HUANG Jie-jie, WANG Yang. Effects of micropore structure and surface properties on the SO<sub>2</sub> removal in flue gas by active coke [J]. Journal of Combustion Science and Technology, 2004, 10(2): 160-164.)
- [11] DURLAK S K, BISWAS P, SHI J. Equilibrium analysis of the affect of temperature, moisture and sodium content on heavy metal emissions from municipal solid waste incinerators[J]. J Hazard Mater, 1997, 56(1/2): 1-20. 
- [12] ZHANG Y G, CHEN Y, MENG A, LI Q, CHENG H. Experimental and thermodynamic investigation on transfer of cadmium influenced by sulfur and chlorine during municipal solid waste (MSW) incineration[J]. J Hazard Mater, 2008, 153(1/2): 309-319. 
- [13] ZHANG H, HE P J, SHAO L M. Fate of heavy metals during municipal solid waste incineration in Shanghai[J]. J Hazard Mater, 2008, 156(1/3): 365-373. 
- [14] CRUJEIRA T, LOPES H, ABELHA P, SARGACO C, GONCALVES R, FREIRE M, CABRITA I, GULYURTLU I. Study of toxic metals during combustion of RDF in a fluidized bed pilot[J]. Environ Eng Sci, 2005, 22(2): 241-250. 
- [15] ABANADES S, FLAMANT G, GAUTHIER D. Kinetics of heavy metal vaporization from model wastes in a fluidized bed[J]. Environ Sci Technol, 2002, 36(17): 3879-3884. 
- [16] BELEVI H, LANGMEIER M. Factors determining the element behavior in municipal solid waste incinerator: 2 laboratory experiments[J]. Environ Sci Technol, 2000, 34(12): 2507-2512. 
- [17] ABANADES S, FLAMANT G, GAUTHIER D. Modelling of heavy metal vaporisation from a mineral matrix[J]. J Hazard Mater, 2001, 88(1): 75-94. 
- [18] JAKOB A, STUCKI S, KUHN P. Evaporation of heavy metals during the heat treatment of municipal solid waste incinerator fly ash[J]. Environ Sci Technol, 1995, 29(9): 2429-2436. 
- [19] ABANADES S, FLAMANT G, GAGNEPAIN B, GAUTHIER D. Fate of heavy metals during municipal solid waste incineration[J]. Waste Manage Res, 2002, 29(7): 55-68.
- [20] JAKOB A, STUCKI S, STRUIS R P W J. Complete heavy metal removal from fly ash by heat treatment: Influence of chlorides on evaporation rates[J]. Environ Sci Technol, 1996, 30(11): 3275-3283. 
- [21] MILLER B B, KANDIYOTI R, DUGWELL D R. Trace element behavior during co-combustion of sewage sludge with polish coal[J]. Energy Fuels, 2004, 18(4): 1093-1103. 
- [22] LIU J, FALCOZB Q, GAUTHIERB D, FLAMANTB G, ZHENG C Z. Volatilization behavior of Cd and Zn based on continuous emission measurement of flue gas from laboratory-scale coal combustion[J]. Chemosphere, 2010, 80(3): 241-247. 
- [23] CHIANG K, JIH J, LIN K. The effects of calcium hydroxide on hydrogen chloride emission characteristics during a simulated densified refuse-derived fuel combustion process[J]. J Hazard Mater, 2008, 157(1): 170-178. 
- [24] MATSUDAA H, OZAWAA S, NARUSEA K, ITOA K, KOJIMAB Y, YANASEC T. Kinetics of HCl emission from inorganic chlorides in simulated municipal wastes incineration conditions[J]. Environ Sci Technol, 2005, 60(2): 545-552.
- [25] VERHULST D, BUEKENS A. Thermodynamic behavior of metal chlorides and sulfates under the conditions of incineration furnaces[J]. Environ Sci Technol, 1995, 1(30): 50-56.
- [1] 张力, 张俊广, 杨仲卿, 唐强. 超低浓度甲烷在Cu/γ-Al<sub>2</sub>O<sub>3</sub>催化颗粒流化床中的燃烧特性[J]. 燃料化学学报, 2012, 40(07): 886-891.
- [2] 苏德仁, 刘华财, 周肇秋, 阴秀丽, 吴创之. 生物质流化床氧气-水蒸气气化实验研究[J]. 燃料化学学报, 2012, 40(03): 309-314.
- [3] 王昶, 李丹, 郝庆兰, 王刚, 宋扬, 李桂菊. 粉粒流化床中松木生物质热解特性的研究[J]. 燃料化学学报, 2012, 40(02): 156-163.

- [4] 许桂英, 孙国刚. 生物质与石油焦共气化特性的研究[J]. 燃料化学学报, 2011, 39(06): 438-442.
- [5] 柏静儒, 王 擎, 秦 宏, 郑国宽, 杨迎军, 关晓辉. 油页岩飞灰对重金属离子的吸附动力学及热力学[J]. 燃料化学学报, 2011, 39(05): 378-384.
- [6] 林郁郁, 张 楚, 章明川, 张 健, 徐旭常. CaO伴随生物质热裂解制油同时脱氧的小型流化床实验研究[J]. 燃料化学学报, 2011, 39(03): 182-188.
- [7] 李国建, 胡艳军, 陈冠益, 钟英杰, 张雪梅. 城市污水污泥与固体垃圾混烧过程中重金属迁移特性的研究[J]. 燃料化学学报, 2011, 39(02): 155-160.
- [8] 余 剑, 朱剑虹, 郭 凤, 段正康, 刘云义, 许光文. 生物质在微型流化床中热解动力学与机理[J]. 燃料化学学报, 2010, 38(06): 666-672.
- [9] 李克忠, 张 荣, 毕继诚. 煤和生物质共气化制备富氢气体的实验研究[J]. 燃料化学学报, 2010, 38(06): 660-665.
- [10] 王学涛, 金保升, 徐斌, 吴健. 利用旋风炉玻璃化处理垃圾焚烧飞灰实验研究[J]. 燃料化学学报, 2010, 38(05): 621-625.
- [11] 王其成, 张锴, 任金天, 孙国刚, 蒋剑春. Geldart B 类颗粒气固流化床内的压力波动特性(英文)[J]. 燃料化学学报, 2009, 37(06): 763-768.
- [12] 王小波, 阎常峰, 赵增立, 潘守聚, 李海滨, 陈勇. 垃圾焚烧飞灰熔融污染物排放研究[J]. 燃料化学学报, 2008, 36(06): 748-752.
- [13] 高鹏, 吴晋沪, 王洋. 射流流化床煤气化炉中气固流动和传热、传质的CFD模拟研究[J]. 燃料化学学报, 2008, 36(03): 360-364.
- [14] 陈勇, 张衍国, 李清海, 陈昌和. 垃圾焚烧中氯化物对重金属Pb迁移转化特性的影响[J]. 燃料化学学报, 2008, 36(03): 354-359.
- [15] 曹建涛, 程中虎, 房倚天, 景慧敏, 王 洋. 加压流化床流化性质的实验与模拟研究[J]. 燃料化学学报, 2007, 35(06): 743-747.

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