

水城褐煤热解的气体产物析出特征及甲烷的生成反应类型研究

韩峰, 张衍国, 蒙爱红, 李清海

清华大学 热科学与动力工程教育部重点实验室 二氧化碳资源化利用与减排技术北京市重点实验室, 北京 100084

Evolution of gaseous products and analysis of methane generation reaction types during pyrolysis of Shuicheng lignite

HAN Feng, ZHANG Yan-guo, MENG Ai-hong, LI Qing-hai

 Key Laboratory for Thermal Science and Power Engineering of Ministry of Education, Beijing Key Laboratory for CO₂ Utilization and Reduction Technology, Tsinghua University, Beijing 100084, China

- [摘要](#)
- [参考文献](#)
- [相关文章](#)
- [点击分布统计](#)
- [下载分布统计](#)

 全文: [PDF \(579 KB\)](#) [HTML \(1 KB\)](#) 输出: [BibTeX](#) | [EndNote \(RIS\)](#) [背景资料](#)

摘要 利用傅里叶红外光谱仪研究了煤中主要官能团的分布, 利用热重-质谱联用 (TG/MS) 在10°C/min的条件下研究了水城褐煤的热解行为, 获得了煤热解主要挥发分气体 (H₂、CH₄、H₂O、CO、CO₂) 生成的速率曲线。采用分峰拟合的方法将甲烷的生成速率曲线分解为五个峰, 通过化学动力学分析, 结合煤的结构特性、热解特性及其他挥发分气体的生成特征, 认为甲烷的生成主要由一个脱吸附过程和四个化学反应组成。

关键词: 官能团 热解 质谱 甲烷 水城褐煤

Abstract: The Fourier transform infrared (FT-IR) spectroscopy was applied to investigate the functional groups of Shuicheng lignite, and the simultaneous thermogravimetry-mass spectrometry (TG/MS) at heating rate of 10 °C/min was used to investigate the pyrolysis behavior of coal. The instantaneous evolution of the gaseous products (H₂, CH₄, H₂O, CO, CO₂) was studied by means of temperature-programmed pyrolysis experiments. The pyrolytic generation characteristics of methane was specially analyzed. Five peaks were fitted and the kinetic parameters were calculated by the fitting of curves. By the kinetic analysis combined with structure analysis, pyrolysis characteristics and the evolution features of other volatiles during pyrolysis, it is found that the lowest temperature peak represents the desorption of adsorbed methane in coal and the other four peaks are the results of methane generation during pyrolysis, which involves four types of reactions.

Key words: functional group pyrolysis mass spectrometry methane Shuicheng lignite

收稿日期: 2013-07-10;

基金资助:

国家重点基础研究发展规划 (973计划, 2011CB201502); 云南省科技创新强省计划 (2010AD010); 云南省重大科技专项—新能源 (2012ZB006)。

通讯作者: 张衍国, 研究员, Tel/Fax: 010-62783373, E-mail: zhangyg@mail.tsinghua.edu.cn. E-mail:

zhangyg@mail.tsinghua.edu.cn

引用本文:

韩峰,张衍国,蒙爱红等. 水城褐煤热解的气体产物析出特征及甲烷的生成反应类型研究[J]. 燃料化学学报, 2014, 42(01): 7-12.

HAN Feng, ZHANG Yan-guo, MENG Ai-hong et al. Evolution of gaseous products and analysis of methane generation reaction types during pyrolysis of Shuicheng lignite[J]. J Fuel Chem Technol, 2014, 42(01): 7-12.

链接本文:



















<http://rlhxxb.sxicc.ac.cn/CN/> 或 <http://rlhxxb.sxicc.ac.cn/CN/Y2014/V42/I01/7>

服务

- ▶ [把本文推荐给朋友](#)
- ▶ [加入我的书架](#)
- ▶ [加入引用管理器](#)
- ▶ [E-mail Alert](#)
- ▶ [RSS](#)

作者相关文章

- ▶ [韩峰](#)
- ▶ [张衍国](#)
- ▶ [蒙爱红](#)
- ▶ [李清海](#)

- [1] Ouml: ZTASN A, YÜRÜM Y. Pyrolysis of Turkish Zonguldak bituminous coal. Part 1. Effect of mineral matter[J]. Fuel, 2000, 79(10): 1221-1227. 
- [2] PORADA S. The reactions of formation of selected gas products during coal pyrolysis[J]. Fuel, 2004, 83(9): 1191-1196. 
- [3] CRAMER B. Methane generation from coal during open system pyrolysis investigated by isotope specific, Gaussian distributed reaction kinetics[J]. Org Geochem, 2004, 35(4): 379-392. 
- [4] 朱学栋, 朱子彬. 煤热失重动力学研究[J]. 高校化学工程学报, 1999, 13(3): 223-228. (ZHU Xue-dong, ZHU Zi-bin. Study of the coal pyrolytic kinetics by thermogravimetry[J]. Journal of Chemical Engineering of Chinese Universities, 1999, 13(3): 223-228.)
- [5] 吕太, 张翠珍, 吴超. 粒径和升温速率对煤热分解影响的研究[J]. 煤炭转化, 2005, 28(1): 17-20. (LV Tai, ZHANG Cui-zhen, WU Chao. Study on the effect of coal diameter and heating rate on the coal pyrolysis[J]. Coal Conversion, 2005, 28(1): 17-20.) 
- [6] ARENILLAS A, RUBIERA F, PIS J J. Simultaneous thermogravimetric-mass spectrometric study on the pyrolysis behaviour of different rank coals[J]. Anal Appl Pyrolysis, 1999, 50(1): 31-46. 
- [7] GEORGAKOPOULOS A. Study of low rank Greek coals using FTIR spectroscopy[J]. Energy Sources, 2003, 25(10): 995-1005. 
- [8] BARUAH M K, GOGOI P C. A new form of sulphur in coal: The discovery of an iron-sulphur coordination compound[J]. Fuel, 1998, 77(9): 979-985. 
- [9] 庞博, 戴和武. 兴隆庄煤显微组份热解失重及热解反应动力学研究[J]. 燃料化学学报, 1989, 17(1): 1-7. (PANG Bo, DAI He-wu. Weight loss determination and pyrolytic kinetics study on Xing-long-zhuang Coal macerals[J]. Journal of Fuel Chemistry and Technology, 1989, 17(1): 1-7.) 
- [10] 朱学栋, 朱子彬. 煤化程度和升温速率对热分解影响的研究[J]. 煤炭转化, 1999, 22(2): 43-47. (ZHU Xue-dong, ZHU Zi-bin. Study on the effect of coal rank and heating rate on the pyrolysis[J]. Coal Conversion, 1999, 22(2): 43-47.)
- [11] 沈兴. 差热, 热重分析与非等温固相反应动力学[M]. 北京: 冶金工业出版社, 1995: 75-76. (SHEN Xing. DTA, TGA and non-isothermal kinetics of solid-reactions[M]. Beijing: Metallurgical Industry Press, 1995: 75-76.)
- [12] JÜNTGEN H. Review of the kinetics of pyrolysis and hydrolysis in relation to the chemical constitution of coal[J]. Fuel, 1984, 63(6): 731-737. 
- [13] 李美芬, 曾凡桂, 贾建波, 谢克昌. 三种高变质程度煤热解过程中H₂的逸出特征研究[J]. 燃料化学学报, 2007, 35(2): 237-240. (LI Mei-fen, ZENG Fan-gui, JIA Jian-bo, XIE Ke-chang. TG/MS study on evolution characteristics of hydrogen from pyrolysis of three high rank coals[J]. Journal of Fuel Chemistry and Technology, 2007, 35(2): 237-240.) 
- [14] ARENILLAS A, RUBIERA F, PIS J J. Simultaneous thermogravimetric-mass spectrometric study on the pyrolysis behaviour of different rank coals[J]. J Anal Appl Pyrolysis, 1999, 50(1): 31-46. 
- [15] 刘生玉, 王宝俊, 谢克昌. 镜煤抽提物热解特性的实验研究[J]. 燃料化学学报, 2003, 31(5): 420-425. (LIU Sheng-yu, WANG Bao-jun, XIE Ke-chang. Experimental study on pyrolysis of extract from vitrain[J]. Journal of Fuel Chemistry and Technology, 2003, 31(5): 420-425.) 
- [16] 闫金定, 崔洪, 杨建丽, 刘振宇. 热重质谱联用研究兖州煤的热解行为[J]. 中国矿业大学学报, 2003, 32(3): 311-315. (YAN Jin-ding, CUI Hong, YANG Jian-li, LIU Zhen-yu. Research on pyrolysis behavior of Yanzhou coal using TG/MS[J]. Journal of China University of Mining & Technology, 2003, 32(3): 311-315.) 
- [17] VAN HECK K H, HODEK W. Structure and pyrolysis behaviour of different coals and relevant model substances[J]. Fuel, 1994, 73(6): 886-896. 
- [18] 傅献彩, 沈文霞, 姚天扬. 物理化学(下册)[M]. 4版. 北京: 高等教育出版社, 1993: 751-752. (FU Xian-cai, SHEN Wen-xia, YAO Tian-yang. Physical chemistry, volume 2[M]. 4th ed. Beijing: High Education Press, 1993: 751-752.)
- [19] WEISHAPTOVA Z, MEDEK J, KOVÁ? L. Bond forms of methane in porous system of coal II [J]. Fuel, 2004, 83(13): 1759-1764. 
- [20] ALEXEEV A D, ULYANOVA E V, STARIKOV G P, KOVRIGA N N. Latent methane in fossil coals[J]. Fuel, 2004, 83(10): 1407-1411. 
- [21] SAVAGE P E. Mechanisms and kinetics models for hydrocarbon pyrolysis[J]. J Anal Appl Pyrolysis, 2000, 54(1): 109-126. 
- [22] 曾凡桂, 贾建波. 霍林河褐煤热解甲烷生成反应类型及动力学的热重-质谱实验与量子化学计算[J]. 物理化学学报, 2009, 25(6): 1117-1124. (ZENG Fan-gui, JIA Jian-bo. Reaction types and kinetics of methane generation from Huolinhe lignite pyrolysis by TG/MS experiment and quantum chemical calculations[J]. Acta Physico-Chimica Sinica, 2009, 25(6): 1117-1124.)
- [23] PORADA S. The reactions of formation of selected gas products during coal pyrolysis[J]. Fuel, 2004, 83(9): 1191-1196. 

- [1] 董勇, 喻敏, 王鹏, 张梦泽, 睢辉, 崔琳, 张立强, 徐夕仁, 马春元. CaCl₂添加对热解煤中汞析出规律影响的实验研究[J]. 燃料化学学报, 2014, 42(01): 31-36.
- [2] 柏静儒, 李晓航, 张亮, 贾春霞, 王擎. 柳树河页岩微波干燥及其对热解特性的影响[J]. 燃料化学学报, 2014, 42(01): 37-42.
- [3] 武景丽, 陈天举, 罗希韬, 杨静, 王志奇, 吴晋沪, 孙立. 典型城市固体废物热解动力学机理研究[J]. 燃料化学学报, 2014, 42(01): 43-47.
- [4] 梁皓, 宋喜军, 尹泽群, 张喜文, 方向晨. 化学链制氢中Fe₂O₃/LaFeO₃载氧体的性能研究[J]. 燃料化学学报, 2013, 41(12): 1512-1519.
- [5] 黄鑫, 张书, 林雄超, 王永刚, 徐敏. 低温加压热解脱氧对胜利褐煤亲水性的影响[J]. 燃料化学学报, 2013, 41(12): 1409-1414.
- [6] 钟梅, 马风云. 不同气氛下煤连续热解产物的分配规律及产品品质分析[J]. 燃料化学学报, 2013, 41(12): 1427-1436.

- [7] 王永刚, 周剑林, 陈艳巨, 胡秀秀, 张书, 林雄超. ^{13}C 固体核磁共振分析煤中含氧官能团的研究[J]. 燃料化学学报, 2013, 41(12): 1422-1426.
- [8] 张俊姣, 廖航涛, 陆强, 张阳, 董长青. 果糖低温快速热解制备糠醛的机理研究[J]. 燃料化学学报, 2013, 41(11): 1303-1309.
- [9] 孔娇, 程柱, 董洁, 焦海丽, 李凡. 平朔煤热解过程中PAHs的释放特性[J]. 燃料化学学报, 2013, 41(11): 1281-1286.
- [10] 李梅, 杨俊和, 张启锋, 常海洲, 孙慧. 用XPS研究新西兰高硫煤热解过程中氮、硫官能团的转变规律[J]. 燃料化学学报, 2013, 41(11): 1287-1293.
- [11] 刘自松, 魏永刚, 李孔斋, 王华, 祝星, 杜云鹏. $\text{Fe}_2\text{O}_3/\text{Al}_2\text{O}_3$ 氧载体用于甲烷化学链燃烧: 负载量与制备方法的影响[J]. 燃料化学学报, 2013, 41(11): 1384-1392.
- [12] 苏亚欣, 任立铭, 苏阿龙, 邓文义. 甲烷在金属铁及氧化铁表面还原NO的研究[J]. 燃料化学学报, 2013, 41(11): 1393-1400.
- [13] 张书, 白艳萍, 米亮, 郑盼盼, 陈绪军, 许德平, 王永刚. 升温速率对胜利褐煤热解过程中N迁移转化的影响[J]. 燃料化学学报, 2013, 41(10): 1153-1159.
- [14] 张晋玲, 王美君, 陈望舒, 付春慧, 任秀荣, 常丽萍. 逐级酸处理对锡盟褐煤的结构及热解特性的影响: 气相产物的生成[J]. 燃料化学学报, 2013, 41(10): 1160-1165.
- [15] 王长真, 司兰杰, 李海, 闻霞, 孙楠楠, 赵宁, 魏伟, 孙予罕. 无模板剂一锅法合成介孔Ni-CaO-ZrO₂催化剂及其在CH₄-CO₂重整反应中的应用研究[J]. 燃料化学学报, 2013, 41(10): 1204-1209.

版权所有 © 《燃料化学学报》编辑部

本系统由北京玛格泰克科技发展有限公司设计开发 技术支持: support@magtech.com.cn