燃料化学学报
JOURNAL OF FUEL CHEMISTRY AND TECHNOLOGY
ISSN 0253-2409
CN 14-1140/TQ

燃料化学学报 » 2013, Vol. 41 » Issue (03): 277-284　DOI:

三维有序大孔Fe_2O_3为载氧体的生物质热解气化实验研究

赵坤[1,2], 何方[1], 黄振[1], 魏国强[1,2], 李海滨[1], 赵增立[1]

1. 中国科学院广州能源研究所, 中国科学院可再生能源与天然气水合物重点实验室, 广东 广州 510640;
2. 中国科学院大学, 北京 100049

Biomass pyrolysis/gasification using three dimensional ordered macroporous (3DOM) Fe_2O_3 as an oxygen carrier

ZHAO Kun[1,2], HE Fang[1], HUANG Zhen[1], WEI Guo-qiang[1,2], LI Hai-bin[1], ZHAO Zeng-li[1]

1. The Key Laboratory of Renewable Energy and Gas Hydrate of Chinese Academy of Sciences, Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, Guangzhou 510640, China;
2. University of Chinese Academy of Sciences, Beijing 100049, 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 (2024 KB)　HTML (1 KB)　输出: BibTeX | EndNote (RIS)　背景资料

摘要 采用无皂乳液聚合法制备单分散聚苯乙烯(PS)微球,并以硝酸盐为原料、柠檬酸为络合剂制备前驱体溶液,通过浸渍和焙烧得到三维有序大孔(3DOM) Fe_2O_3,并通过SEM、XRD、BET和压汞仪对3DOM Fe_2O_3进行表征。采用热重-质谱联用的方法,以3DOM Fe_2O_3为载氧体,对生物质在氦气气氛下的热解气化进行研究,探讨3DOM Fe_2O_3载氧体在生物质热解气化过程中代替纯氧、富氧空气或水蒸气作为生物质气化剂的可能性,并与普通分析纯Fe_2O_3与生物质热解气化的实验结果进行对比,分析3DOM Fe_2O_3在提高载氧体反应活性方面的作用。结果表明,制备的3DOM Fe_2O_3呈现排列规整的三维有序多孔形貌,层与层间通过三维孔道相连,并呈交替排列。通过与分析纯Fe_2O_3的XRD谱图对比,发现制得的3DOM Fe_2O_3为纯Fe_2O_3,无其他杂质相的存在。热重-质谱分析结果表明,Fe_2O_3作为载氧体在高温段促成了生物质气化反应的发生。与分析纯的Fe_2O_3作对比,当载氧体为三维有序大孔结构时,生物质的最大失重率提高了7.1%,气化阶段的最大失重速率提高了0.29%/min,CO、CO_2、CH_4在高温段出现两个连续的析出峰。

关键词： TG-MS　三维有序大孔　载氧体　生物质　热解气化

Abstract： Polystyrene spheres were prepared by soap free emulsion polymerization method,then three dimensional ordered macroporous (3DOM) oxides Fe_2O_3 were successfully prepared after impregnation and calcination using nitrates as raw materials and citric acid as complexing agent. The samples were characterized by the techniques of scanning electron microscopy (SEM), X-ray diffraction(XRD), BET and mercury porosimetry. Pyrolysis and gasification of biomass with Fe_2O_3 as oxygen carriers in helium atmosphere were carried out in a thermogravimetric analyzer coupled with mass spectrometry (TG-MS). The possibility of 3DOM Fe_2O_3 functioning as gasification agent in biomass gasification substituted for pure oxygen, oxygen-enriched air or steam were investigated. Furthermore, a comparison experiment was carried out by using analytically pure Fe_2O_3 to analysis the high-performance of 3DOM Fe_2O_3. The characterization results showed that 3DOM Fe_2O_3 presented a three-dimensional ordered macroporous morphology, its tiers were arranged alternatively and connected through three-dimensional pore structures. By contrast with the XRD pattern of analytically pure Fe_2O_3. TG-MS results showed that Fe_2O_3 contributed to biomass gasification in high temperature stage. When used 3DOM Fe_2O_3 as oxygen carrier, the maximum weight loss and maximum weight loss rate raised 7.1% and 0.29%/min in the gasification stage, respectively, meanwhile two generation peaks of CO, CO_2, and CH_4 appeared in the MS curves.

Key words： TG-MS　3DOM　oxygen carrier　biomass　pyrolysis gasification

收稿日期: 2012-09-11;

基金资助:

国家自然科学基金(51076154);"十二五"国家科技支撑计划(2011BAD15B05)。

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
- 赵坤
- 何方
- 黄振
- 魏国强
- 李海滨
- 赵增立

通讯作者: 何方,Tel:020-87057721,E-mail:hefang@ms.giec.ac.cn。 E-mail: hefang@ms.giec.ac.cn

引用本文:

赵坤,何方,黄振等. 三维有序大孔Fe_2O_3为载氧体的生物质热解气化实验研究[J]. 燃料化学学报, 2013, 41(03): 277-284.

ZHAO Kun,HE Fang,HUANG Zhen et al. Biomass pyrolysis/gasification using three dimensional ordered macroporous (3DOM) Fe_2O_3 as an oxygen carrier[J]. J Fuel Chem Technol, 2013, 41(03): 277-284.

链接本文:

http://rlhxxb.sxicc.ac.cn/CN/ 或 http://rlhxxb.sxicc.ac.cn/CN/Y2013/V41/I03/277

[1] De DIEGO L F, ORTIZ M, GARCIA-LABIANO F, ADÁNEZ J, ABAD A, GAYÁN P. Hydrogen production by chemical-looping reforming in a circulating fluidized bed reactor using Ni-based oxygen carriers[J]. J Power Sources, 2009, 192(1): 27-34.

[2] 赵海波, 刘黎明, 徐迪, 郑楚光, 刘国军, 蒋林林. 气体燃料化学链燃烧技术中的溶胶凝胶Ni基载氧体研究[J]. 燃料化学学报, 2008, 36(3): 261-266. (ZHAO Hai-bo, LIU Li-ming, XU Di, ZHENG Chu-guang, LIU Guo-jun, JIANG Lin-lin. NiO/$NiAl_2O_4$ oxygen carriers prepared by sol-gel for chemical-looping combustion fueled by gas[J]. Journal of Fuel Chemistry and Technology, 2008, 36(3): 261-266.)

[3] 张璐. 化学链燃烧技术中载氧体$CaSO_4$的性能研究. 武汉:华中科技大学, 2009. (ZHANG Lu. Experimental Investigation of CaSO4 for Chemical-Looping Combustion. Wuhan: Huazhong University of Science and Technology, 2009.

[4] De DIEGO L F, ORTIZ M, ADANEZ J, GARCÍA-LABIANO F, ABAD A, GAY N P. Synthesis gas generation by chemical-looping reforming in a batch fluidized bed reactor using Ni-basedoxygen carriers[J]. Chem Eng J, 2008, 144(2): 289-298.

[5] JOHANSSON M, MATTISSON T, LYNGFELT A, ABAD A. Using continuous and pulse experiments to compare two promising Nickel-based oxygen carriers for use in chemical-looping technologies[J]. Fuel, 2008, 87(6): 988-1001.

[6] BOLHAR-NORDENKAMP F J, PROLL T, KOLBITSCH P, HOFBAUER H. Performance of a NiO-based oxygen carrier for chemical looping combustion and reforming in a 120 kW unit[J]. Energy Procedia, 2009, (1): 19-25.

[7] 黄振，何方，李海滨，赵增立. 天然铁矿石为载氧体的生物质化学链气化制合成气实验研究[J]. 燃料化学学报, 2012, 40(3): 300-308. (HUANG Zhen, HE Fang, LI Hai-bing, ZHAO Zeng-li. Synthesis gas generation by chemical-looping gasification of biomass using natural hematite as oxygen carrier[J]. Journal of Fuel Chemistry and Technology, 2012, 40(3): 300-308.)

[8] SADAKANE M, ASANUMA T, KUBO J, UEDA W. Facile procedure to prepare three-dimensionally ordered macroporous (3DOM) perovskite-type mixed metal oxides by colloidal crystal templating method[J]. Chem Mater, 2005, 17(13): 3546-3551.

[9] BLANCO A, CHOMSKI E, GRABTCHAK S, IBISATE M, JOHN S, LEONARD S W, LOPEZ C, MESEGUER F, MIGUEZ H, MONDIA J P, OZIN G A, TOADER O, van DRIEL H M. Large-scale synthesis of a silicon photonic crystal with a complete three dimensional bandgap near 1.5 micrometres[J]. Nature, 2000, 405(6785): 437-440.

[10] TESSIER P M, VELEV O D, KALAMBUR A T, RABOLT J F, LENHOFF A M, KALER E W. Assembly of gold nanostructured films templated by colloidal crystals and use in surface-enhanced Raman spectroscopy [J]. J Am Chem Soc, 2000, 122(39): 9554-9555.

[11] SORENSEN E M, BARRY S J, JUNG H-K, RONDINELLI J M, VAUGHEY J T, POEPPELMEIER K R. Three-dimensionally ordered macroporous $Li_4Ti_5O_{12}$: Effect of wall structure on electrochemical properties[J]. Chem Mater, 2006, 18(2): 482-489.

[12] 徐俊峰, 刘坚, 赵震, 张桂臻, 段爱军, 姜桂元, 徐春明. 三维有序大孔钙钛矿$LaFeO_3$催化剂的制备及其催化炭黑颗粒燃烧性能[J]. 催化学报, 2010, 31(2): 236-341. (XU Jun-feng, LIU Jian, ZHAO Zhen, ZHANG Gui-zhen, DUAN Ai-jun, JIANG Gui-yuan, XU Chun-ming. Preparation and catalytic performance of three-dimensionally orderedmacroporous perovskite-type $LaFeO_3$ catalyst for soot combustion[J]. Chinese Journal of Catalysis, 2010, 31(2): 236-341.)

[13] 赵铁鹏, 高德淑, 雷钢铁, 李朝晖. 三维有序大孔α-Fe_2O_3的制备及电化学性能研究[J]. 化学学报, 2009, 67(17): 1957-1961. (ZHAO Tie-peng, GAO De-shu, LEI Gang-tie, LI Zhao-hui. Fabrication and electrochemical properties of three-dimensionally ordered macroporous α-Fe_2O_3[J]. Acta Chimica Sinica, 2009, 67(17): 1957-1961.)

[1] 王健，张守玉，郭熙，董爱霞，陈川，熊绍武，房倚天. 平朔煤和生物质共热解实验研究[J]. 燃料化学学报, 2013, 41(01): 67-73.

[2] 王学斌，许伟刚，靳维新，张利孟，王新民，谭厚章. 热解温度对生物质焦理化特性的影响[J]. 燃料化学学报, 2013, 41(01): 74-78.

[3] 杨天华，丁佳佳，李润东，开兴平，孙洋，刘炜. 燕麦秸秆燃烧灰中矿物质分布及沉积行为[J]. 燃料化学学报, 2012, 40(11): 1310-1316.

[4] 张怡，陈登宇，张栋，朱锡锋. 生物油TG-FTIR分析与热解气化特性研究[J]. 燃料化学学报, 2012, 40(10): 1194-1199.

[5] 邓剑，罗永浩，张云亮，王芸. 生物质半焦与煤混合气化协同作用的动力学研究[J]. 燃料化学学报, 2012, (08): 943-951.

[6] 马俊国，葛庆杰，马现刚，徐恒泳. 浆态床反应器中生物质合成气合成二甲醚的研究[J]. 燃料化学学报, 2012, 40(07): 843-847.

[7] 李凯，定明月，李宇萍，王铁军，吴创之，马隆龙. 镍基整体式催化剂上生物质粗燃气重整调变的特性研究[J]. 燃料化学学报, 2012, 40(06): 692-697.

[8] 魏立纲，张丽，徐绍平. 自由落下床中生物质与煤共热解的协同效应对焦油组成的影响[J]. 燃料化学学报, 2012, 40(05): 519-525.

[9] 尹建军，段钰锋，王运军，王卉，冒咏秋，韦红旗. 生物质焦的表征及其吸附烟气中汞的研究[J]. 燃料化学学报, 2012, (04): 390-396.

[10] 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.

[11] 陈定千，沈来宏，肖军，宋涛，顾海明，张思文. 基于镍基修饰的铁矿石载氧体煤化学链燃烧实验[J]. 燃料化学学报, 2012, 40(03): 267-272.

[12] 黄振，何方，李海滨，赵增立. 天然铁矿石为氧载体的生物质化学链气化制合成气实验研究[J]. 燃料化学学报, 2012, 40(03): 300-308.

[13] 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.

[14] 任海君，张永奇，房倚天，王洋. 煤焦与生物质焦共气化反应特性研究[J]. 燃料化学学报，2012, 40(02): 143-148.

[15] 高　英，陈汉平，汪　君，石　韬，杨海平，王贤华. 生物质水热液化和炭化产物特性研究[J]. 燃料化学学报，2011, 39(12): 893-900.