燃料化学学报
JOURNAL OF FUEL CHEMISTRY AND TECHNOLOGY

燃料化学学报 » 2013, Vol. 41 » Issue (02): 228-234 DOI:

O_2/CO_2气氛下木醋调质石灰石再燃/先进再燃脱硝性能研究

刘洪涛, 韩奎华, 路春美, 李辉

山东大学 能源与动力工程学院, 山东 济南 250061

Experimental study on reburning/advanced reburning performance of limestone for NO reduction under O_2/CO_2 atmosphere

LIU Hong-tao, HAN Kui-hua, LU Chun-mei, LI Hui

School of Energy and Power Engineering, Shandong University, Jinan 250061, 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 (860 KB) HTML (1 KB) 输出: BibTeX | EndNote (RIS) 背景资料

摘要 在O_2/CO_2气氛下利用沉降炉脱硝实验台,对木醋调质石灰石和醋酸钙的再燃/先进再燃脱硝特性以及氨气的选择性非催原脱硝特性进行了研究。结果表明,木醋调质石灰石和醋酸钙的再燃脱硝效率随温度的升高先提高后降低,1 323 K时获得最硝效率分别为82.70%和78.52%;再燃脱硝氧浓度不宜过高,合适的再燃比为14%~17%,停留时间为0.8 s。氨气选择性非还原脱硝在1 173 K时获得最高脱硝效率为95.41%,温度窗口为1 142~1 335 K;随着氧浓度的增大,脱硝效率不断降低,反宜的氨氮比为1.5,停留时间为1.2 s。按氨氮比0.75向再燃区喷入氨气可显著提高木醋调质石灰石和醋酸钙的再燃脱硝效率脱硝反应适宜的温度区间也得到显著拓宽,1 323 K时两者获得的先进再燃脱硝效率分别为93.49%和92.79%。

关键词: O_2/CO_2 木醋液 醋酸钙 先进再燃 NO 选择性非催化还原

Abstract: NO reduction characteristics of reburning/advanced reburning using limestone modified by wo vinegar and calcium acetate, as well as selective non-catalytic reduction using ammonia, are investigate a drop-tube system under O_2/CO_2 atmosphere. Results show that NO reduction efficiency of limestone modified by wood vinegar and calcium acetate through basic reburning increases first and then decrease with increasing temperature. The maximum NO reduction efficiency of 82.70% and 78.52% can be obtain 1 323 K, respectively. High oxygen concentration is not conducive to NO reduction. The optimum reburni fuel fraction and residence time for basic reburning is 14%~17% and 0.8 s, respectively. The maximum N reduction efficiency of selective non-catalytic reduction is 95.41% at 1 173 K in temperature window of 142~1 335 K. With increasing oxygen concentration, NO reduction efficiency declines continuously. The optimum $[NH_3]/[NO]$ molar ratio and residence time for selective non-catalytic reduction is 1.5 and 1.2 s respectively NO reduction efficiency of reburning is significantly increased, while the reaction temperatur window is obviously broaden when ammonia is injected into reburning zone at $[NH_3]/[NO]$ mol ratio of 0.7 The maximum NO reduction efficiency of limestone modified by wood vinegar and calcium acetate advanc reburning is 93.49% and 92.79% at 1 323 K, respectively.

Key words: O_2/CO_2 wood vinegar calcium acetate advanced reburning NO selective non-catalytic reduction

收稿日期: 2012-10-16;

基金资助:

山东大学自主创新基金(2010TS020); 山东大学研究生自主创新基金(yzc11058)。

通讯作者: 路春美,韩奎华;E-mail:cml@sdu.edu.cn,hankh@163.com;Tel:0531-88392264。 E-mail: cml@sdu.edu.cn;hankh@163.com

引用本文:

刘洪涛,韩奎华,路春美等. O_2/CO_2气氛下木醋调质石灰石再燃/先进再燃脱硝性能研究[J]. 燃料化学学报, 2013, 41(02): 228-234

LIU Hong-tao,HAN Kui-hua,LU Chun-mei et al. Experimental study on reburning/advanced reburning performan
vinegar for NO reduction under O_2/CO_2 atmosphere[J]. J Fuel Chem Technol, 2013, 41(02): 228-234.

[1] 段伦博, 赵长遂, 李庆钊, 李英杰, 陈晓平. O_2/CO_2气氛下煤焦燃烧实验研究[J]. 燃料化学学报, 2009, 37(6): 65
sui, LI Qing-zhao, LI Ying-jie, CHEN Xiao-ping. Experimental investigation on coal and char combust
Fuel Chemistry and Technology, 2009, 37(6): 654-658.)

[2] 韩奎华, 路春美, 侯庆伟, 刘志超, 马传利, 高山. 煤在不同O_2/CO_2气氛下燃烧硫析出特性研究[J]. 燃料化学学报, :
LU Chun-mei, HOU Qing-wei, LIU Zhi-chao, MA Chuan-li, GAO Shan. The characteristics of sulfur re
mixed-CO_2 gas with different oxygen concentrations[J]. Journal of Fuel Chemistry and Technology,

[3] XIONG J, ZHAO H, ZHENG C, LIU Z, ZENG L, LIU H, QIU J. An economic feasibility study of O_2/CO_2
on existing coal-fired power plants in China[J]. Fuel, 2009, 88(6): 1135-1142.

[4] PAK P S, LEE Y D, AHN K Y. Characteristics and economic evaluation of a power plant applying oxy
output and decrease CO_2 emission[J]. Energy, 2010, 35(8): 3230-3238.

[5] CROISET E, THAMBIMUTHU K V. NO_x and SO_2 emissions from O_2/CO_2 recycle coal combustion[J]. F

[6] 谢芳, 张军, 盛昌栋, 张永春, 陈洁. O_2/CO_2气氛下CH_4再燃还原NO的实验研究[J]. 工程热物理学报, 2010, 31(9
SHENG Chang-dong, ZHANG Yong-chun, CHEN Jie. Experimental study on reduction of NO by CH_4 r
Engineering Thermophysics, 2010, 31(9): 1599-1602.)

[7] 牛胜利, 路春美, 高攀, 韩奎华, 耿萍, 程中杰. 生物质再燃降低NO_x排放的实验研究[J]. 燃料化学学报, 2008,36(5
mei, GAO Pan, HAN Kui-hua, GENG Ping, CHENG Zhong-jie. NO_x reduction using biomass as reburnin
and Technology, 2008, 36(5): 583-587.)

[8] 牛胜利, 韩奎华, 路春美. 生物质先进再燃脱硝特性研究[J]. 燃料化学学报, 2010, 38(6): 745-751. (NIU Sheng
on nitrogen oxides reduction by advanced biomass reburing process[J]. Journal of Fuel Chemistry a
751.)

[9] 韩奎华, 路春美, 牛胜利, 高攀. 气体先进再燃脱硝试验研究[J]. 中国电机工程学报, 2009, 29(20): 47-51. (HAN
GAO Pan. Experimental study on advanced gas reburning for NO_x reduction[J]. Proceedings of the C

[10] NIMMO W, PATSIAS A A, HAMPARTSOUMIAN E, GIBBS B M, WILLIAMS P T. Simultaneous reduction
combustion by calcium magnesium acetate[J]. Fuel, 2004, 83(2): 149-155.

[11] NIMMO W, PATSIAS A A, HALL W J, WILLIAMS P T. Characterization of a process for the in-furnace
salts of calcium[J]. Ind Eng Chem Res, 2005, 44(12): 4484-4494.

[12] NIMMO W, PATSIAS A A, HAMPARTSOUMIAN E, GIBBS B M, FAIRWEATHER M, WILLIAMS P T. Calciu
advanced reburning for NO control with simultaneous SO_2 reduction[J]. Fuel, 2004, 83(9): 1143-11

[13] PATSIAS A A, NIMMO W, GIBBS B M, WILLIAMS P T. Calcium-based sorbents for simultaneous NO_x/
furnace[J]. Fuel, 2005, 84(14/15): 1864-1873.

[14] NIU S L, HAN K H, ZHAO J L, LU C M. Experimental study on nitric oxide reduction through calcium
2011, 36(2): 1003-1009.

[15] 王海英, 杨国亭, 周丹. 木醋液研究现状及其综合利用[J]. 东北林业大学学报, 2004, 32(5): 55-57. (WANG Hai-
Research situation and comprehensive utilization of wood vinegar[J]. Journal of Northeast Forestry

[16] YATAGAI M, NISHIMOTO M, HORI K, OHIRA T, SHIBATA A. Termiticidal activity of wood vinegar, its
[J]. J Wood Sci, 2002, 48(4): 338-342.

[17] 刘洪涛, 韩奎华, 路春美. 基于无模式法推断木醋调质石灰石热解动力学参数[J]. 中国电机工程学报, 2012, 32(26
hua, LU Chun-mei. Inference of the thermal decomposition parameters of limestone modified by wo
method[J]. Proceedings of the CSEE, 2012, 32(26): 31-36.)

[18] PICHON S, BLACK G, CHAUMEIX N, YAHYAOUI M, SIMMIE J M, CURRAN H J, DONOHUE R. The comb
Measured flame speeds and ignition delays and a detailed chemical kinetic model for the oxidation
156(2): 494-504.

[19] 王志强, 孙绍增, 钱琳, 曹华丽, 秦裕琨. 煤气再燃还原氮氧化物的特性研究[J]. 中国电机工程学报, 2007, 27(20)
Shao-zeng, QIAN Lin, CAO Hua-li, Qin Yu-kun. Characteristic study on NO_x reduction with coal-gas
CSEE, 2007, 27(20): 42-45.)

[20] 高攀, 路春美, 韩奎华, 甄天雷, 丁立新. 天然气/液化气先进再燃脱硝特性研究[J]. 煤炭学报, 2007, 32(11):1191
Kui-hua, ZHEN Tian-lei, DING Li-xin. NO reduction performance of natural gas and petroleum gas ac
Coal Society, 2007, 32(11): 1191-1195.)

[21] 韩奎华, 路春美, 王永征, 牛胜利, 刘志超, 郝卫东. 选择性非催化还原脱硝特性试验研究[J]. 中国电机工程学报, 2(
Chun-mei, WANG Yong-zheng, NIU Sheng-li, LIU Zhi-chao, HAO Wei-dong. Experimental study on D
non-catalytic reduction[J]. Proceedings of the CSEE, 2008, 28(14): 80-85.)

[22] 刘洪涛, 牛胜利, 韩奎华, 路春美. 非催化烟气还原脱硝法脱硝特性的试验研究[J]. 动力工程, 2009, 29(9): 850-8
HAN Kui-hua, LU Chun-mei. Experimental study on flue gas denitrification by selective non-catalytic
Power Engineering, 2009, 29(9): 850-853.)

[1] 张晓鹏, 沈伯雄. Mn/Ce-ZrO_2催化剂低温NH_3-SCR脱硝性能研究[J]. 燃料化学学报, 2013, 41(01): 123-

[2] Mohammad Karimi, Forouzan Aboufazeli, Hamid Reza Lotfi Zadeh Zhad, Omid Sadeghi, Ezzatollah N
of Pt/Ru/Sn/W fullerene electrode for methanol oxidation in direct methanol fuel cell[J]. 燃

[3] 刘洪涛, 韩奎华, 路春美. O_2/CO_2气氛下木醋调质石灰石直接硫化反应动力学研究[J]. 燃料化学学报, 2012,

[4] 王力, 陈继涛, 张华伟, 李敏, 张林林, 刘珊珊. $KMnO_4$溶液改性半焦对烟气中气态Hg^0的吸附性能研究[J]. 燃
1504.