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水合肼中混入尿素后的非催化还原脱硝研究

Investigation of urea spiked hydrazine solution as a reductant for selective non-catalytic reduction of NO_x

关键词：选择性非催化还原(SNCR) 水合肼 尿素 脱硝 温度窗口

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摘要：在对比了尿素和水合肼($N_2H_4 \cdot H_2O$)选择性非催化还原(SNCR)脱除烟气中NO_x温度特性的基础上,尝试将两者混合以降低SNCR脱硝反应的温度窗口.实验结果显示,水合肼有一中温区温度窗口(550～650 ℃),最佳温度在600 ℃左右,远低于尿素SNCR脱硝的温度窗口和最佳温度.对比尿素和水合肼在不同条件下混合后的脱硝规律发现,将部分水合肼用尿素替代后虽然脱硝效率有所下降,但维持了水合肼的中温脱硝特征,某些条件下甚至出现脱硝效率上升的现象;并且反应过程中无氨分解产生和逸出;而尿素单独使用时在此温区内则有氨逸出.研究还表明,将水合肼加入到尿素中并无有益效果.而当还原剂/NO的化学计量比(Normalized stoichiometric ratio,NSR)为2.0时,在水合肼中加入尿素,以16.7%的尿素N替代水合肼N,混合还原剂的峰值脱硝效率出现在530 ℃左右,并维持在单独使用水合肼时峰值的93.3%的水平;温度在503～567 ℃范围变化时,混合还原剂维持了可观的中温脱硝效率.研究表明,有望通过在水合肼中添加适量尿素以降低水合肼SNCR中温脱硝的成本.

Abstract: Based on investigation of the reaction behaviors of urea-based and hydrazine-based selective non-catalytic reduction (SNCR) of NO_x, the two reductants, urea and hydrazine, were blended to lower the temperature window of SNCR removal of NO_x. The experimental results showed that there existed a special moderate temperature window ranging from 550 ℃ to 650 ℃ for hydrazine-based SNCR de-NO_x process and the optimum temperature was around 600 ℃, which was far below that of urea. It was also showed that by spiking hydrazine hydrate into urea solution no improvement was observed for urea-based SNCR de-NO_x process, while by adding urea into hydrazine hydrate solution at a certain level the special moderate temperature window for SNCR de-NO_x maintained, with the maximum efficiencies marginally decreased or even increased. No NH_3 slip was detected during this SNCR process, which was quite different from urea-based process. When spiking urea into hydrazine hydrate solution to a level that 16.7% of nitrogen element (N) in the solution was provided by urea and at a normalized stoichiometric reductant/NO ratio (NSR) of 2.0, a peak de-NO_x efficiency was obtained around 530 ℃ which was 93.3% of the original peak efficiency of hydrazine hydrate without urea spike. When temperature changed from 503 ℃ to 567 ℃, acceptable SNCR de-NO_x efficiencies were retained for this blended reductant. The cost of SNCR de-NO_x process based on hydrazine hydrate in industry can be therefore reduced by a similar urea spike.

Key words: selective non-catalytic reduction (SNCR) hydrazine urea de-NO_x temperature window

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