工程热物理

燃烧器材料的热物理性质对微尺度催化燃烧的影响

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摘要：

催化燃烧可增强微型燃烧器的工作稳定性。对石英玻璃、刚玉陶瓷、紫铜3种不同材料制作的微尺度催化燃烧器，在0.12~0.36 L/min、当量比浓度下进行实验比较。利用贵金属Pt为催化剂，石棉为催化剂载体，氢气/空气预混气体为燃料。实验结果显示，催化燃烧器具有很高燃烧稳定性。使用数值模拟观察燃烧器内部燃烧过程。模拟结果显示石英玻璃和刚玉陶瓷燃烧器存在明显的热点，其在0.12 L/min时分别达到约1 475 K和1 427 K，而紫铜燃烧器内部的温度较低，一般不超过1 200 K，且分布均匀。对燃烧器散热分析发现，导热率较低的材料反而散热较高，如石英玻璃燃烧器散热在0.12 L/min时高于紫铜燃烧器2.61 W。由于不同燃烧器中的反应模式不同，石英玻璃和刚玉陶瓷中主要为气相反应，紫铜燃烧器中主要为两相反应，因此产生上述现象。

关键词： 微尺度燃烧 催化燃烧 氢气 热传导 壁面材料

Effect of Thermal Property of Materials on Micro-scale Catalytic Combustion for the Micro Combustor

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Abstract:

Catalyst is applied to enhance the stability of micro combustors effectively. In this experiment, three catalytic micro combustors made of quartz glass, alumina ceramic and copper were tested individually. The catalyst and catalyst support were Pt and asbestus respectively. The combustor was fed with H2/air mixture, and operated under stoichiometric conditions with flow rates from 0.12 to 0.36 L/min. According to the experimental results, catalytic combustors work stably. The temperature distributions on the combustor surface at different operation conditions were measured. Moreover, numeric simulation was applied to investigate the reaction process inside the micro combustor. In the quartz-glass and alumina-ceramic combustor, the temperature distribution shows obvious hot spot. At 0.12 L/min, the peak temperatures are around 1 475 K and 1 427 K, respectively. However, the temperature in the copper combustor is relative lower and distributes uniformly. Its peak temperature does not exceed 1 200 K. According to the comparison of heat loss in different combustors, the combustor with lower thermal conductivity exhibits higher heat loss, which is different from the conventional scale. For example: at the flow rate of 0.12 L/min, the quartz-glass combustor has 2.61 W higher heat loss than the copper combustor. The phenomenon is attributed to the transfer of the reaction mode. In the quartz-glass and alumina-ceramic combustor, homogeneous reaction dominates. But in the copper one, heterogeneous reaction dominates.

Keywords: micro-scale combustion catalytic combustion hydrogen thermal conductivity wall material

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