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热能工程

燃烧功率对旋流燃烧器热声不稳定特性的影响

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摘要： 旋流燃烧器内部流动复杂，涡系丰富，为研究燃烧功率对其热声不稳定特性的影响，搭建了旋流燃烧器热声不稳定试验台架。旋流燃烧器工作在常压下，其燃料风喷口直径为2 mm，通过切向进气方式引入旋转二次风，燃烧室直径为48 mm，高度为600 mm。试验测量了燃烧功率为2.8～7.1 kW的CH4/Air火焰的脉动压力和温度分布，旋流强度约为0.58。试验结果表明：旋流燃烧器热声不稳定的共振频率介于251～273 Hz之间，声压级SPL与燃烧功率Pc有线性关系：SPL=112.099+3.537×Pc。采用联合时频分析方法研究了压力脉动波形，发现旋流燃烧器内的压力脉动介于时不变性质与时变性质之间，其短时频谱的主峰频率和振幅均为时间的函数，但主峰频率的变化范围较小；当燃烧功率为6.2 kW时，最大的短时声压级可达153 dB。

关键词： 旋流燃烧器 热声不稳定 燃烧功率 频谱分析

Influence of Combustion Power on Characteristics of Thermoacoustic Instability in a Swirl Combustor

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Abstract: The fluid flow inside swirl combustors is very complicated, which drives a rich variety of vortex systems. In order to study the impact of combustion power on the characteristics of thermoacoustic instability inside swirl combustors, an experimental setup has been built. The swirl combustor works under the standard atmosphere, the inner diameter of the fuel jet is 2 mm, while the swirling secondary air was introduced tangentially into the combustion chamber, which has a diameter of 48 mm and a height of 600 mm. The oscillating pressure as well as the temperature of the CH4/Air flames was measured under different combustion power Pc (2.8～7.1 kW), the corresponding swirl intensity is about 0.58. Experimental results showed that the thermoacoustic resonant frequency lies between 251 Hz and 273 Hz, and that the sound pressure level (SPL) increases linearly with the combustion power (SPL=112.099+3.537×Pc). Joint time frequency analysis method was employed to investigate the fluctuating pressure waveforms, and results found that the oscillating pressure signals inside the swirl combustor show a property between time-constant and time-variant, and that both the main resonant frequency and amplitude are time functions, but the range of resonant frequency is relatively small. Under the experimental case with combustion power of 6.2 kW, the short-time SPL reaches 153 dB.

Keywords: swirl combustor thermoacoustic instability combustion power spectrum analysis

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