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LPP低污染燃烧室两相喷雾燃烧性能数值研究

Numerical investigation of two-phase spray combustion performance for LPP low-emission combustor

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中文关键词： 贫油预混预蒸发 低污染燃烧室 两相喷雾燃烧 燃烧性能 热力型NOx

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中文摘要:

采用Fluent软件对贫油预混预蒸发（LPP）低污染燃烧室两相喷雾燃烧流场、温度场和污染排放性能进行数值计算.在副模结构保持不变时，LPP低污染燃烧室头部在相同工况下，数值研究不同的主模旋流角度对燃烧流场、温度场以及污染排放的影响.采用标准的k-ε模型对湍流黏性进行模拟，采用离散相模型对油珠颗粒的运动轨迹进行追踪，采用非预混平衡化学反应模型来模拟化学反应速率.数值计算结果表明：①在LPP低污染燃烧室头部存在明显的中心回流区、角回流区和唇口回流区；②中心回流区外形呈橄榄形状，并且回流区长度都较长，随着主模旋流角度的增大，中心回流区逐渐变胖且变短，角回流区则逐渐变小；③随着主模旋流角度增大，压力损失也随之增大；④热力型NOx生成的速率与燃烧温度超过1950K区域的面积大小和最高的燃气温度有直接的关系，在副模和主模火焰锋面附近，由于燃烧温度高，是热力型NOx的集中分布区域；⑤出口温度分布系数随着主模旋流角度的增加呈现出先减少后增加的趋势，且主模旋流角度为45° （C方案）时出口温度分布系数最小，即C方案的出口温度分布最均匀；⑥在相同的工况下，C方案燃烧性能相对最优.

英文摘要:

Two-phase spray combustion flow field, temperature field and pollution emission performance of lean premixed prevaporized (LPP) low-emission combustor were calculated by software of Fluent. When the structure of pilot swirler and the inlet condition of LPP low-emission combustor were kept unchanged, influences of different primary swirler angles on combustion flow field, temperature field and pollution emission were investigated. Standard k-ε model was applied to simulate turbulent viscosity; fuel droplet trajectories were modeled by discrete phase model; non-premixed chemical equilibrium model was used to simulate the chemical reaction rates. Numerical results are as follow: (1) There are obvious primary recirculation zone, corner recirculation zone and lip recirculation zone in LPP low-emission combustor head. (2) The shape of primary recirculation zone is olive, and the length of primary recirculation zone is very long. With the increase of primary swirler angle, the primary recirculation zone becomes fatter and shorter, and the area of corner recirculation zone becomes smaller. (3) With the increase of primary swirler angle, the pressure loss will increase. (4) The production rate of thermal NOx is directly related with the area of temperature over 1950K and the highest temperature of gas. Near the flame front of pilot swirler and primary swirler, because of the high temperature, it is the main production area of thermal NOx. (5) With the increase of primary swirler angle, outlet temperature distribution factor increases firstly and then decreases. When the primary swirler angle is 45 degrees (just C project), outlet temperature distribution factor is the least, which means that the outlet temperature