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简报

障碍物对脉冲爆震发动机性能影响的数值模拟

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Numerical Simulation of Effect of Obstacles on Pulse Detonation Engine Performances

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摘要 运用计算流体力学方法计算了理想脉冲爆震发动机（PDE）单次爆震的性能参数，并和Wintenberger半分析模型进行了对比，研究了圆环形障碍物阻塞比和节距内径比对空气流动损失和脉冲爆震发动机单次爆震性能的影响，并与连续的多脉冲爆震实验的相关结果做了比较。研究结果表明，数值模拟计算得到的冲量和Wintenberger半分析模型得到的冲量非常接近，佐证了数值模拟方法和结果的正确性；障碍物阻塞比增大、节距内径比减小或进口速度增大，空气流过障碍物时的总压恢复系数减小，流动损失增大；障碍物阻塞比增大，单次爆震的体积比冲减小，单位燃油消耗率增大，性能降低；当阻塞比为41%时，体积比冲为理想爆震管体积比冲的92%，损失了8%；障碍物节距内径比增大，单次爆震的体积比冲先减小后增大，而单位燃油消耗率先增大后减小，不同节距内径比的体积比冲为理想爆震管体积比冲的94%左右，不同节距内径比对性能影响规律与多次脉冲爆震实验结果趋势符合。

关键词： 脉冲爆震发动机 障碍物 单次爆震 数值模拟 模型

Abstract： The performance parameters of the single cycle detonation wave of an ideal pulse detonation engine (PDE) are calculated by solving unsteady two dimensional (2D) reacting N S equations, and these parameters are compared with the results obtained from the Wintenberger semi analytic model. The effects of ring obstacles on the loss of air flowing through the PDE and the performances of single cycle detonation wave of the PDE are studied. The data of numerical simulation are compared with those of multi pulse detonation experiments conducted on a 60 mm inner diameter detonation tube. The results show that the calculated impulse is almost the same as the impulse used by the Wintenberger semi analytic model, which means the numerical simulation method is valid. The blockage ratio increases, or the obstacle pitch and inner diameter ratio decreases, while the total pressure recovery coefficient decreases. The blockage ratio increases, the impulse per unit volume of single cycle detonation wave decreases and the specific fuel consumption increases. When the blockage ratio is about 41%, the impulse per unit volume is 92% of that of the ideal PDE. The obstacle pitch and inner diameter ratio increases, the impulse per unit volume of single cycle detonation wave first decreases and then increases, while the specific fuel consumption first increases and then decreases. This effect of different obstacle pitch and inner diameter ratios on PDE performance agrees with that of the multi pulse detonation experiments.

Keywords： pulse detonation engine obstacle single-cycle detonation wave numerical simulation models

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