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通 讯

液体火箭发动机液膜互击喷嘴研究动态

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在以往变推力双组元液体火箭发动机的研制中，采用了一种同轴环形缝隙式喷注器。为了研究几何参数和工作参数的改变对该喷注器液膜互击混合特性的影响，设计了一对平板直缝喷嘴来进行冷流模拟实验。

在进行实验之前用量纲分析的方法对液膜互击混合问题进行了分析。

为了避免直接描述内部机理不甚清楚的液相混合区。考虑液相混合完全由互击前两组元液膜的各自特性、相对位置关系和互击角θ确定。通过列出控制两液膜流动的守恒方程和定解条件，用方程分析法得到了控制该混合现象的二十个独立的无量纲参数〔$\Delta p_f/\rho_f V_f^2$〕，〔$\rho_f V_f \delta_f/\mu_f$〕，〔$\sigma_f/\rho_f V_f^2 \delta_f$〕，〔$\rho_g V_g \delta_f/\mu_g$〕，〔$p_g/\rho_g V_g^2$〕，〔$\theta$〕，〔$d_{1f}/\delta_f$〕，〔$d_{10}/\delta_o$〕，〔$d_{2f}/\delta_f$〕，〔$d_{20}/\delta_o$〕，〔$\delta_o/\delta_f$〕，〔$p_o/p_f$〕，〔$\mu_f/\mu_o$〕，〔$\sigma_o/\sigma_f$〕，〔$\rho_g/\rho_f$〕，〔$\mu_g/\mu_f$〕，〔$\Delta p_o/\Delta p_f$〕，〔$V_f^{(0)}/V_f$〕，〔$V_0^{(0)}/V_0$〕，〔$V_o/V_f$〕。其中，下标0，f，g分别表示氧化剂、燃烧剂和环境气体；δ表示液膜厚度；上标(0)为喷嘴入口分布值的特征值；d_1、d_2分别为通道内和自由空间液膜的长度。

在不考虑横向气流的影响，采用水/水作为模拟介质（这时不模拟任何推进剂组合，而仅分析喷注器几何参数及工作参数的改变对混合的影响），以及d_{10}/δ_o，d_{1f}/δ_f充分地大(大于50)和流动处于第二自模区（$Re>2500$）的情况下，得到了控制混合现象的七个无量纲参数：

$$\{Re_f,\ We_f,\ N_R,\ \theta,\ \delta_o/\delta_f,\ d_{2f}/\delta_f,\ d_{20}/\delta_o\}$$

其中，

$$N_R = 1/(1+\rho_f V_f \delta_f/\rho_o V_o^2 \delta_o)$$

所得到的结果已被用于指导实验以及处理实验结果。

the curvature of the surface and the presence of the ejection holes are in favour of the heat transfer augmentation. It is noted that the internal impingement heat transfer coefficient on the suction side of the cooled blade calculated by using the correlation of that on flate plate is more or less too conservative.

APPLICATION OF THE UPWIND FACTOR METHOD TO SOLUTION OF INCOMPRESSIBLE NAVIER-STOKES EQUATIONS IN NON-ORTHOGONAL CURVILINEAR COORDINATE SYSTEM

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Abstract

The upwind factor method has found successful application in the finite element scheme. The purpose of this paper is to extend its application to solution of incompressible Navier-Stokes equations in non-orthogonal curvilinear coordinate system by the finite difference method. An effective velocity is introduced to keep the control equations in the computational domain as simple as in the physical domain.

CORRESPONDENCE

DIMENSIONLESS ANALYSIS OF LIQUID IMPINGING PLANE FILM

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Abstract

Seven nondimensional parameters which describe the liquid phase mixing phenomenon of a pair of liquid plane impinging streams produced by two plane slot injectors are determined under specific conditions. The results provide an analytical means for solving liquid phase mixing problems by experiments