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旋转封严篦齿风阻温升的试验研究与数值分析

Experimental investigation and numerical analysis of windage heating in rotating labyrinth seals

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中文摘要:

选取具有典型封严结构的真实尺寸台阶型封严篦齿,通过高速旋转条件下的风阻温升特性试验,进行了进出口压比(1.05~2.8)、封严间隙与齿尖厚度比(相对封严间隙)(2.4~4.0)、雷诺数(1900~28000)及转速(0~12000r/min)等参数对篦齿泄漏流风阻温升的影响研究.并基于试验条件,采用renormalization group(RNG)k-ε湍流模型,对同一篦齿的风阻温升特性进行了数值计算.结果表明:篦齿泄漏流温升随进出口压比、雷诺数、封严间隙与齿尖厚度比的增加而减小,但随转速的增加而增大.数值计算结果与试验数据吻合 良好,台阶型封严篦齿第1道和第2道封严齿内的风阻温升最为显著,前两道封严齿内的温升占总温升的60%. 根据试验结果,提出了计算台阶型篦齿泄漏流温升的经验公式,其计算结果与试验数据具有较好的符合性.

英文摘要:

Experiments were conducted to investigate the windage heating characteristics in real size models of stepped labyrinth seals.The change in total temperature across the labyrinth seal was measured in a high speed test facility at different pressure ratios (1.05-2.8),relative sealing clearances(2.4-4.0),Reynolds numbers(1900-28000) and rotational speeds (0-12000r/min).Based on the experiments,the renormalization group (RNG) k-ε turbulence model was used to compute the windage heating characteristics of the same stepped labyrinth seals.The results indicate that the temperature rise decreases with the increases of pressure ratio,Reynolds number and relative sealing clearance,and it increases with the increase of rotational speed.In addition,the numerical simulation satisfies the experiment.The most of the windage heating takes place in the first half of the seals,and the value of temperature rise is about 60% in the first two tooth chambers.An empirical expression for the windage heating coefficient was obtained and it fits the experimental results well.