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多级考虑冷气掺混流片变厚度的S_1流面研究

Research on S_1 stream surface for cooling air mixing and variable thickness flow slice in multi-stage

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中文摘要:

为减少气冷涡轮气动设计难度，提出一套基于多级气冷涡轮考虑冷气掺混及随流道翘曲、变厚度的S_1流面计算思路，编制了带冷气的翘曲S_1流面薄片计算的参数化方法程序及网格自动生成程序，改良了传统平面薄片，对比分析了改良后平面薄片、翘曲S_1流面薄片以及三维计算间差异，对某高压涡轮进行了翘曲S_1流面薄片气动优化.结果显示：与三维计算对比，改良后平面薄片最大流量差距为22.68%，翘曲S_1流面薄片为3.58%，一维数据上翘曲S_1流面薄片更逼近三维计算；型面压力分布及马赫数云图分布上翘曲面S_1流面薄片较改良后平面薄片更贴近三维计算；采用翘曲S_1流面薄片进行优化后，效率较原始方案提升0.41%，流量较原始方案仅增加0.21%.

英文摘要:

To reduce the difficulty of aerodynamic design in air-cooled turbine, a set of calculation ideas based on multi-stage air-cooled turbine were presented in consideration of the cooling air mixing, warped S_1 stream surface and variable thickness along with flow passage; the parameterization method program and automatic mesh generation program of warped S_1 stream surface slice with cooling condition were prepared, and the traditional plane slice was modified. Comparative analysis of the difference among the modified plane slice, warped S_1 stream surface slice and three-dimensional calculation was made, and aerodynamic design of a high-pressure turbine with warped S_1 stream surface slice was optimized. The results show that: in comparison with three-dimensional calculation, the maximum gap of mass flow in modified plane slice is up to 22.68%, and 3.58% in warped S_1 stream surface slice; the warped S_1 stream surface slice is closer to three-dimensional calculation on one-dimensional data; blade pressure and Mach number contour distribution of warped S_1 stream surface slice are closer to three-dimensional calculation than that of modified plane slice. After aerodynamic optimization in warped S_1 stream surface slice, compared with original model, the stage efficiency has been increased by 0.41%, while mass flow has only been increased by 0.21%.

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参考文献(共16条):

[1] Wu C H.A general theory of three-dimensional flow in subsonic and supersonic turbo machines of axial,radial and mixed-flow types[R].NACA-TN-2604,1952.

[2] Wu C H.Three-dimensional turbo machine flow equations expressed with respect to non-orthogonal curvilinear coordinates and methods of solution[R].Munich,Germany:3rd International Symposium on Air-Breathing Engines,1976.

[3] 张彦仲.21世纪航空科学技术发展展望[J].国际航空,2001(2):12-15. ZHANG Yanzhong.Outlook of aeronautical technologies in 21st century[J].International Aviation,2001(2):12-15.(in Chinese)

[4] 谭春青,王仲奇,韩万金.大转角透平叶栅叶片正弯曲的实验研究[J].航空动力学报,1994,9(4):413-415. TAN Chunqin,WANG Zhongqi,HAN Wanjin.Experimental study on blade positive curving turbine cascade with turning angle[J].Journal of Aerospace Power,1994,9(4):413-415.(in Chinese)

[5] 王雷.三维设计思想在子午流道大扩张角条件下的应用[J].航空动力学报,2012,27(12):2786-2791. WANG Lei.Application of wide angle diffused meridian passage with three-dimensional design concept[J].Journal of Aerospace Power,2012,27(12):2786-2791.(in Chinese)

[6] Denton J D.A time-marching method for two and three dimensional blade-to-blade flows[R].Aeronautical Research Council,R&M 3975,1975.

[7] Denton J D.An improved time-marching method for turbomachinery flow calculation[J].Journal for Engineering for Power,1983,105(3):514-521.

[8] Denton J D.The calculation of three dimensional viscous flow through multistage turbomachines[R].ASME Paper 90-GT-19,1990.

[9] 乔渭阳,曾军,曾文演,等.气膜孔喷气对涡轮气动性能影响的实验研究[J].推进技术,2007,28(1):14-19. QIAO Weiyang,ZENG Jun,ZENG Wenyan,et al.Experimental studies for the aerodynamic loss in gas turbine with film cooling[J].Journal of Propulaion Technology,2007,28(1):14-19.(in Chinese)

[10] 曾军,乔渭阳,孙大伟,等.带尾缘劈缝冷气喷射的涡轮叶栅性能实验及计算[J].推进技术,2008,29(6):710-715. ZENG Jun,QIAO Weiyang,SUN Dawei,et al.Numerical simulation and experiment for turbine cascade with trailing edge coolant injection[J].Journal of Propulaion Technology,2008,29(6):710-715.(in Chinese)

[11] 方祥军,刘思永,王屏,等.大扩张通道超声高载荷对转涡轮动叶三维设计方法研究[J].航空学报,2007,28(1):25-31. FANG Xiangjun,LIU Siyong,WANG Ping,et al.Research of 3D design method for rotor of supersonic high loaded contra-rotating turbine with large expansile meridional channel[J].Acta Aeronautica et Astronautica Sinica,2007,28(1):25-31.(in Chinese)

[12] 方祥军,刘思永,王屏.超跨音对转涡轮大转折角叶片的高次多项式解析造型研究[J].航空动力学报,2003,18(1):76-80. FANG Xiangjun,LIU Siyong,WANG Ping.Geometric design with polynomial method for large deflection angle blades of transonic contra-rotating turbine[J].Journal of Aerospace Power,2003,18(1):76-80.(in Chinese)

[13] 张维军,方祥军,王屏,等.三维涡轮叶片交互式造型程序设计[J].机械设计与制造,2005(10):53-55. ZHANG Weijun,FANG Xiangjun,WANG Ping,et al.The design of interactive program for three-dimensional turbine blades generation[J].Machinery Design and Manufacture,2005(10):53-55.(in Chinese)

[14] Han W J,Wang Z Q.Experimental studies on the mechanism and control of secondary flow losses in turbine cascades[J]. Journal of Thermal Science,1992,4(1):218-231.

[15] Sridhar M,Sunnam S,Goswami S,et al.CFD aerodynamic performance validation of a two-stage high pressure turbine[R].ASME Paper GT2011-45569,2011.

[16] 迟重然.气冷涡轮叶片的传热设计[D].哈尔滨:哈尔滨工业大学,2010. CHI Zhongran.Heat transfering design for air-cooled turbine blades[D].Harbin:Harbin Institute of Technology,2010.(in Chinese)

引证文献(本文共被引1次):

[1]王龙飞,王松涛,罗磊,温风波,崔涛.冷气对多级涡轮翘曲S1流面优化的影响[J].推进技术,2016,37(3):459-470.

相似文献(共20条):

[1] 杨弘,王仲奇,冯国泰.考虑冷气掺混的涡轮S_2流面计算方法[J].热能动力工程,1992(3).

[2] Scattering of S_0 Lamb mode in plate with multiple damage[J].Applied Mathematical Modelling

[3] 郭义,杜刚,陈江,尹红顺.多级轴流压气机S_2正问题气动性能优化[J].航空动力学报,2012,27(4):953-960.

[4] Ronglin Tang,Zhao-Liang Li,Bohui Tang.An application of the T_S-VI triangle method with enhanced edges determination for evapotranspiration estimation from MODIS data in arid and semi-arid regions: Implementation and validation[J].Remote Sensing of Environment,2010,114(3):540-3202.

[5] J. Olejní?ek,L.E. FlanneryS.A. Darveau,C.L. ExstromŠ. Kment,N.J. IannoR.J. Soukup.$CuIn_{1-x}Al_xS_2$ thin films prepared by sulfurization of metallic precursors[J].Journal of Alloys and Compounds,2011,509(41):10020-10024.

[6] J. Krustok',R. Josepson,M. Danilson,D. Meissner.Temperature dependence of $Cu_2ZnSn(Se_xS_{1-x})_4$ monograin solar cells[J].Solar Energy,2010,84(3):379-383.

[7] Antonella Leone,Giambattista Consiglio.Carbonylation studies of Pd-methyl complexes modified with 1,4-C_S-symmetrical diphosphine ligands[J].Journal of Organometallic Chemistry,2006,691(23):4816-4828.

[8] DFT calculation of core– and valence–shell electron excitation and ionization energies of 2,1,3-benzothiadiazole $C_6H_4SN_2$, 1,3,2,4-benzodithiadiazine $C_6H_4S_2N_2$, and 1,3,5,2,4-benzotrithiadiazepine $C_6H_4S_3N_2$[J].Journal of Electron Spectroscopy and Related Phenomena

[9] Isoquinolin-1(2*H*)-ones and 1,6-naphthyridin-5(6*H*)-ones by an *N*-acylation-S_NAr sequence[J].Tetrahedron

[10] Zhenbang Pi,Longyan Wang,Chao Yang.Tuning the optical properties of alloyed $CdSe_xS_{1-x}$ nanoparticles by changing the constituent stoichiometry[J].Materials Letters,2007,61(26):4857-4860.

[11] H.L. Pan,B. Yao,R. Deng,L.L. Gao.Characterization and properties of $ZnO_{1-x}S_x$ alloy films fabricated by radio-frequency magnetron sputtering[J].Applied Surface Science,2010,256(14):4621-4625.

[12] Synthesis of $(CuIn)_xCd_{2(1-x)}S_2$ photocatalysts for H_2 evolution under visible light by using a low-temperature hydrothermal method[J].International Journal of Hydrogen Energy

[13] Keiji Matsumura,R.D. Suenram,Takehiko Tanaka.Fourier transform microwave spectroscopy of isotopically substituted diacetylenes: r_S-structure, quadrupole coupling, and anisotropic nuclear spin-spin interaction[J].Journal of Molecular Spectroscopy,2006,240(1):120-126.

[14] Lisheng Chi.Synthesis, structure and magnetic properties of the S=1/2, one-dimensional antiferromagnet, $Y_5Re_2O_{12}$[J].Journal of Solid State Chemistry,2003,172(2):451-457.

[15] The interplay of T_1- and T_2-relaxation on T_1-weighted MRI of hMSCs induced by Gd-DOTA-peptides[J].Biomaterials

[16] Kh.M. Eid,H.Y. Ammar.Adsorption of SO_2 on Li atoms deposited on MgO (1 0 0) surface: DFT calculations[J].Applied Surface Science,2011,257(14):6049-6058.

[17] Alfonso Fernandez-Vazquez,Gordana Jovanovic Dolecek·An L_1 design of GCF compensation filter[J].Signal processing,2011,91(5):1143-1149.

[18] Cristian Rusu.Iterative reweighted l_1 design of sparse FIR filters[J].Signal processing,2012,92(4):905-911.

[19] Low-rank matrix decomposition in L_1-norm by dynamic systems[J].Image and vision computing

[20] Assessment of interstitial water content of articular cartilage with T_1 relaxation[J].Magnetic resonance imaging