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飞机热气防冰系统与冰脊预测的数值模拟

Numerical simulation of aircraft hot air anti-icing system and ice ridge prediction

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中文关键词: 热气防冰系统 N-S方程 热传导 交接面插值 冰脊预测

英文关键词:hot air anti-icing system N-S equation heat transfer interface interpolation ice ridge prediction

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中文摘要:

基于流固耦合传热的思想建立了一套飞机热气防冰系统的的数值模拟方法,并将其与积冰热力学模型结合起来,实现了热气防冰系统开启时的机翼积冰预测.采用格心格式有限体积法求解N-S方程获得防冰腔与外流场;通过欧拉法在外流场的基础上获得过冷水滴撞击特性;求解三维热传导偏微分方程获得蒙皮的传热特性;采用交接面插值的方法实现防冰腔到外流场的热量传递;建立了考虑三维溢流效应的积冰热力学模型并在此基础上开展了机翼冰脊的数值预测.数值模拟结果表明:热气防冰系统开启时加热机翼表面温度最高可达308K,加热区后的上下机翼表面均有冰脊形成,通过对结果的分析表明该方法是合理可行的.

英文摘要:

A numerical simulation method was built based on the conception of fluid-solid coupled heat transfer, and ice prediction under hot air anti-icing system was carried out in associated with ice accretion thermodynamics model. Both the internal and external flow fields were got by solving N-S equation using cell-centered finite volume method. The droplet impingement result was calculated by Euler method based on the external flow field. Three-dimensional heat transfer partial differential equation was solved to get the heat transfer characteristic of the thin-gauge skin. Heat transfer from internal flow to external flow field was accomplished by using interface interpolation method. Three-dimensional ice accretion thermodynamics model was built with which ice ridge was predicted. The result shows that the heated wing surface temperature can get as high as 308 K, and ice ridge is accreted on both the upper and lower surfaces just after the heated zone when the hot air anti-icing system is on. Then, by analyzing the result, it proves that the method is rational and effective.

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