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发动机进气道短舱前缘结冰三维模拟研究

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Three-dimensional Simulation Research on Ice Shape at Engine Inlet Nacelle Front

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摘要

为计算发动机进气道短舱前缘的结冰冰形,在Messinger结冰热力学模型的基础上发展了一套纯三维的表面溢流水流动结冰模型。考虑空气摩擦力为表面溢流水流动的主要驱动力,用空气对进气道表面的剪切力来确定溢流水的流动方向及流量分配。为求解溢流水结冰模型,发展了一套重复查找表面控制体状态的方法,能够快速完成整个三维表面的计算。用该方法对某三维发动机进气道进行计算,得到了三维结冰冰形,并将计算结果与FENSAP-ICE计算结果进行了对比,结果显示两者的冰形轮廓基本一致,仅在冰角处存在差异,表明本文三维发动机结冰计算模型与计算方法是有效的,其计算精度与FENSAP-ICE结果相当。

关键词： 发动机 三维模拟 冰形 溢流水 热力学模型

Abstract:

To simulate the ice shape at an engine inlet nacelle front, a pure three-dimensional ice accretion model based on Messinger's thermodynamic model is established, which took the surface runback water stream into consideration. Regarding the air friction as the main factor to drive the surface runback water stream, the shear force of the inlet surface is used to determine the direction and flow distribution of the runback water. To solve the ice accretion model of the water film, an approach of repeatedly searching the surface control volume condition is developed, which could achieve the calculation of the whole three-dimensional surface. Ice accretion calculation of a certain three-dimensional engine inlet is carried out, and the three-dimensional ice shapes are obtained. Comparison between the computational results and FESAP-ICE results indicates that the ice profiles of both methods are coincident approximately except for the difference at the ice horn location. The comparison results confirm the validity of the three-dimensional engine ice accretion model and the computational method, and the precision of the results is almost the same as that of the FENSAP-ICE software.

Keywords: engine three-dimensional simulation ice shape runback water thermodynamic model

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