航空学报
ACTA AERONAUTICA ET ASTRONAUTICA SINICA
ISSN 1000-6893
CN 11-1929/V

航空学报 » 2012, Vol. 33 » Issue (8) :1384-1393   DOI:

电脉冲除冰系统除冰激励的简化与影响因素

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Simplification of De-icing Excitation and Influential Factors of the Electro-impulse De-icing System

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摘要 首先建立了电脉冲除冰系统的电路模型,求解了有无二极管条件下的理论脉冲电流曲线,通过分析计算电流与实验电流,提出了将正弦半波电流函数用于电磁场分析以简化研究除冰激励的观点,同时求解了不同电流方式下的电磁压力分布,再用结构动力学分析了不同压力载荷下实验铝板的响应位移。其次通过比较铝板中心位移实验值与动力学求解的响应位移值,其有效的吻合程度验证了用正弦半波函数电流简化电脉冲除冰激励分析的可行性。最后,在利用正弦半波电流函数简化分析脉冲激励的基础上,研究了电流大小、电频率、铝板厚度、铝板弹性模量、铝板密度以及铝板长宽比对最大响应位移的影响。研究结果表明,最大响应位移随电流增大而增大,随铝板厚度、弹性模量与密度的增大而减小,且随电频率的改变而改变,但几乎不受铝板长宽比的影响;在研究电频率时得出,可将电频率与系统结构固有频率以1:1的比例设计,此关系式是电脉冲除冰系统电路设计的基础。

关键词： 电脉冲除冰系统 脉冲电路 脉冲电流 压力分布 最大响应位移 影响因素

Abstract： A circuit model of the electro-impulse de-icing system is developed to obtain the theoretical impulse current with/without diodes. By analyzing the calculated and experimental current, a half sine current function is proposed to simplify the de-icing excitation in the electromagnetic field analysis. The magnetic pressure distribution is simulated in different current methods. The response displacement is solved by structural dynamic analysis under different pressure conditions. Comparison of the experimental and simulated displacement of the the center of the aluminum plate shows good agreement of the response displacement, which indicates that it is feasible to use the half sine current function to simplify the de-icing excitation. Furthermore, influential factors of the impulse response are studied based on the half sine current, such as the current, electrical frequency, the thickness, elastic modulus, density, and ratio of length and width of the aluminum plate. The study concludes that the maximum response displacement increases with the current. However, it decreases with the thickness, elastic modulus and density of the aluminum plate. It changes with the electrical frequency but hardly with the ratio of length and width of the aluminum plate. Moreover, the relationship of the electrical frequency and the natural frequency of the structure is defined as 1:1 as the foundation to design the impulse circuit of the electro-impulse de-icing system.

Keywords： electro-impulse de-icing system impulse circuit impulse current pressure distribution maximum response displacement influential factor

Received 2011-10-11;

Fund:国家自然科学基金(10972106)

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引用本文:

李清英, 朱春玲, 白天. 电脉冲除冰系统除冰激励的简化与影响因素[J]. 航空学报, 2012, 33(8): 1384-1393.

LI Qingying, ZHU Chunling, BAI Tian. Simplification of De-icing Excitation and Influential Factors of the Electro-impulse De-icing System[J]. Acta Aeronautica et Astronautica Sinica, 2012, 33(8): 1384-1393.