基于偏微分方程的离心泵叶片反设计方法 Inverse Design Method of Centrifugal Pump Blade Based on PDE Method

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关键词： 泵叶片 优化设计 反问题 偏微分方程

摘 要： 为实现离心泵叶片的参数化优化设计，将微分方程分别应用于叶轮的轴面设计及叶片空间曲面的生成，首先用4次Bezier曲线控制叶轮轴面，用偏微分方程方法生成轴面流线及准正交线，其次用偏微分方程的方法来生成离心泵叶片空间曲面，根据叶片型线方程，利用控制叶片安放角的分布规律来控制叶片边界上点的圆周角坐标，从而控制微分方程的边界条件，最后达到控制叶片形状的目的。实现了叶片的参数化设计。采用梯度优化的方法将正问题的计算结果用于反问题中对叶片型线的更新，实现了泵叶片的优化设计。应用实例表明提出的离心泵叶片反设计方法是可行的。 In order to implement the parametric optimization design of centrifugal pump blade, the partial differential equation was used to design the impeller meridian plane and the 3-D blade surface. Firstly, quartic Bezier curve was employed to design the meridian plane, and then the partial differential equation was introduced to produce the original streamline and meridian quasi-orthogonal lines. Secondly, the partial differential equation was used to generate the centrifugal pump blade surface. According to the blade streamline equation, the angular coordinates of dispersed points on pump blade boundary was calculated from the distributions of blade angle on boundary. Consequently the boundary-value of the partial differential equation was determined. The blades geometries was controlled by adjust the distribution of the blade angle along hub and shroud. The relation between the 3-D model of pump blade and the pump design parameters was built, to achieve the parametric design of pump blade. The gradient optimizing method was introduced to realize the optimization of pump blade. The calculation result of the flow field was used to renew the shape of pump blade. The calculation case shows that the presented inverse method of centrifugal pump blade is rational.

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