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整体叶轮自由曲面叶片精密电解加工工艺研究

赵建社^{1,2}, 徐家文^{1,3}, 徐家文^{1,2}, 刘玉杰^{1,2}

1. 南京航空航天大学 机电学院, 江苏 南京 210016;
2. 江苏省精密与微细制造技术重点实验室, 江苏 南京 210016;
3. 盐城工学院 机械工程学院, 江苏 盐城 224051

Research on Electrochemical Machining Process for Fine Finishing of Integral Impeller with Free-form Surface Blade

ZHAO Jianshe^{1,2}, WANG Fuyuan^{1,3}, XU Jiawen^{1,2}, LIU Yujie^{1,2}

1. College of Mechanical & Electrical Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China;
2. Jiangsu Province Key Laboratory of Precision and Micro-Manufacturing Technology, Nanjing 210016, China;
3. College of Mechanical Engineering, Yancheng Institute of Technology, Yancheng 224051, China

摘要

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摘要

针对自由曲面整体叶轮提出了一种适用于自由曲面叶片型面精加工的电解工艺 (ECM) 方法, 采用分步法对整体叶轮的叶间通道进行加工, 再采用成形阴极对叶片进行精加工, 使其满足叶片加工要求。为了实现叶片的精加工, 设计了叶片电解精加工实验装置, 设计中利用运动仿真软件对成形阴极结构进行了改进, 并运用流场模拟软件对阴极流道进行模拟分析, 使阴极形状和极间的电解液流速满足加工要求。在加工实验过程中, 对阴极的运动路径进行了分析与优化, 通过优化减少了进给方向对叶片加工间隙分布不均的影响, 并采用高频脉冲电源加工减小加工间隙, 提高叶片加工精度。实验结果表明, 该工艺方案可行, 加工的整体叶轮自由曲面叶片精度得到了显著提高。

关键词: 整体叶轮 电解加工 叶片 路径优化 精加工

Abstract:

An electrochemical machining (ECM) method suitable for free-form surface blades is proposed in this paper for the fine finishing operation of an integral impeller. A fractional-step method is first adopted to form a passage between adjacent blades. Then a shaping cathode is utilized to finish the blade to its requirements on the above basis. An experimental device for the electrochemical machining of blades is developed. The cathode shape is improved by the motion simulation software and the flow channel of the cathode is analyzed by a numerical simulation software during the design, so that the shape of the cathode and the electrolyte flow rate in the interelectrode meet the machining requirements. During the machining experiment, the motion path of the cathode is optimized to reduce its influence on the distribution of interelectrode gaps. A high frequency pulse power is used to reduce the interelectrode gap and improve blade machining accuracy in the experiments. The experimental results show that, the ECM process for the free-form surface blade is feasible and the precision of the machined blade in the integral impeller is significantly improved.

Keywords: integral impeller electrochemical cutting blades path optimization fine machining

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Corresponding Authors: 赵建社, Tel.: 025-84891686E-mail: zhaojs@nuaa.edu.cn Email: zhaojs@nuaa.edu.cn

About author: 赵建社男, 博士, 副教授。主要研究方向: 特种加工新技术、整体构件组合电加工技术。Tel: 025-84891686E-mail: zhaojs@nuaa.edu.cn; 王福元男, 博士, 教授。主要研究方向: CAD/CAM、特种加工技术。Tel: 0515-88298571E-mail: wfyycit@163.com; 徐家文男, 硕士, 教授, 博士生导师。主要研究方向: 特种加工技术、机械制造及其自动化、计算机应用。Tel: 025-84893859E-mail: Xjw052@nuaa.edu.cn

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