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Editorial: Optimal design and efficiency improvement of fluid machinery and systems: volume II

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Editorial on the Research Topic
Optimal design and efficiency improvement of fluid machinery and systems: volume II

Introduction

Fluid machinery is integral to a wide range of industries, from energy generation to transportation, and from industrial processing to environmental protection. The challenge of improving the performance, reliability, and efficiency of these systems has led to significant advancements in their design and operation. *Optimal Design and Efficiency Improvement of Fluid Machinery and Systems: Volume II* compiles 13 insightful research papers that tackle a variety of issues in fluid machinery, including optimization techniques, performance enhancement, and energy efficiency. These contributions offer both theoretical insights and practical applications, helping to address complex challenges in modern fluid systems.

This volume covers a wide spectrum of fluid machinery, including pumps, turbines, compressors, and hydrodynamic couplings, and uses cutting-edge methodologies such as numerical simulations, experimental validation, and optimization algorithms. The papers have been categorized into three major themes: Optimization and Performance Enhancement, Cavitation and Flow Instabilities, and Fluid-Structure Interaction and Hydraulic Losses. Each category reflects the critical areas of research in the field of fluid machinery.

Optimization and performance enhancement

This category addresses the ongoing efforts to optimize the design and improve the performance of various fluid machinery systems. Zhai et al. present a study on hydrogen circulation pumps (HCPs) that introduces a multifactor and multi-objective optimization method for improving hydrogen utilization efficiency. The optimization of key parameters, such as the rotor blade number and the helix angle, has led to significant performance improvements, as demonstrated by experimental validation. Similarly, Yang et al. explore the design of electric coolant pumps (ECPs) for electric vehicles, with a focus on how suction pipe structures affect hydraulic performance and efficiency. Their findings highlight the importance of optimizing the flow patterns within the pump to improve energy efficiency.

The research conducted by Wang et al. on marine gas turbines explores how inlet distortion impacts the turbine's aerodynamic stability, providing a novel simulation device to predict and analyze pressure distortion. Their work offers a critical tool for ensuring stable turbine performance under varying conditions. Additionally, Ma et al. investigate the performance of self-priming jet pumps in irrigation systems, emphasizing the challenges of achieving optimal performance while maintaining compact designs. This research has important implications for developing more efficient and stable irrigation systems.

Cavitation and flow instabilities

Cavitation and flow instability are two of the most critical challenges in fluid machinery design and operation, affecting performance and reliability. The study by Xiao et al. provides a deep analysis of pressure pulsation in pump turbines, a major contributor to operational instability. Using the Hilbert Huang transform, they uncover complex frequency characteristics that inform the design of more stable turbines. Similarly, Lang et al. explore cavitation monitoring in non-clogging pumps, utilizing an optimized neural network for cavitation detection. Their findings provide a robust methodology for real-time diagnosis, which could significantly improve the operational reliability of pumps.

Cui et al. focus on the cavitation behavior in hydrodynamic couplings, a common component in heavy-duty mining equipment. Their work emphasizes the instability caused by cavitation in low-speed ratios, providing a model that predicts cavitation development and its detrimental effects on performance. In the same vein, Zhang et al., Zhang et al. delve into cavitating and non-cavitating wake flows around circular cylinders. By employing large eddy simulation (LES) and the Schnerr-Sauer cavitation model, they provide valuable insights into how cavitation alters energy dissipation and vortex dynamics in fluid systems.

Fluid-structure interaction and hydraulic losses

Understanding the complex interactions between fluid flows and structural components is essential for improving the efficiency of fluid machinery. Zhu et al. study the impact of the number of blades on energy dissipation and flow patterns in mixed-flow pumps, highlighting the role of fluid-structure interaction in optimizing pump performance. The increase in blade number improves flow characteristics but can also induce rotating stall under certain conditions. Huo and Zha investigate how blade inlet geometry impacts the efficiency and hydraulic losses in mixed-flow pumps. Their findings underscore the importance of blade design in minimizing flow losses and enhancing overall pump performance.

Chang et al. take a different approach by studying the wear characteristics of U-shaped elbows using a CFD-DEM coupling model. Their research investigates how particle flow dynamics, including collision frequency and wear rate, are influenced by factors such as bend spacing and particle concentration. The insights gained here are crucial for optimizing the design and operation of piping systems in industrial applications.

Lastly, Yan et al. introduce a novel fluidic oscillator design, employing movable feedback channels and resonators to regulate jet frequency. This design offers a more stable and efficient solution for flow control applications, particularly in compressor systems, where frequency adaptation is critical under varying operational conditions.

Summary

In conclusion, the studies presented in Volume II of Optimal Design and Efficiency Improvement of Fluid Machinery and Systems provide valuable advancements in the field of fluid machinery optimization. The research addresses critical challenges such as cavitation, flow instability, energy dissipation, and fluid-structure interaction, offering innovative solutions to improve the design and performance of fluid systems across a variety of industrial applications.

Gratitude is extended to all the authors for their dedicated contributions and to the reviewers whose insightful feedback has significantly enhanced the quality of this Research Topic. Appreciation is also due to the editorial board and publication team for their continuous support and effort in ensuring the successful compilation and publication of this volume.

Finally, thanks are given to the readers for their engagement with this Research Topic. It is hoped that the findings and insights shared in this volume will inspire further research and innovation in the optimization of fluid machinery, leading to the development of more efficient and sustainable systems in the future.

Author contributions

YY: Writing – original draft. LJ: Writing – review and editing. RA: Writing – review and editing, Supervision. KK: Writing – review and editing. RT: Writing – review and editing, Supervision. AP: Supervision, Writing – review and editing.

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