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Editorial

Special Issue on Optimization and Flow Characteristics in Advanced Fluid Machinery

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Abstract: This editorial discusses the importance of Advanced Fluid Machinery in the sustainable development of energy. Fluid machinery is crucial in many engineering applications, including aerospace, civil, mechanical, and chemical engineering. This Special Issue, entitled "Optimization and Flow Characteristics in Advanced Fluid Machinery", features several research articles exploring flow characteristics and optimization in fluid mechanics. The authors present innovative ideas, methodologies, and techniques to advance the field of fluid mechanics. The papers cover a wide range of topics, including computational fluid dynamics (CFD), turbulence modeling, heat transfer, multiphase flow, and fluid–structure interactions. The articles featured in this Special Issue also investigate the relevant hydrodynamic attributes of turbomachinery, high-pressure jets, marine propulsion systems, and internal combustion engines to a considerable extent, significantly expanding the scope of research within the Special Issue.

Keywords: fluid machinery; optimization; flow characteristics; CFD

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Advanced Fluid Machinery is the key component for the sustainable development of energy and water resources, including various transport processes for liquids. Where fluid flows, fluid machinery works. Therefore, fluid machinery occupies an important position in the social economy. This Special Issue, entitled "Optimization and Flow Characteristics in Advanced Fluid Machinery", will promote a platform for the sharing of knowledge among researchers in the field of fluid machinery, including theoretical analysis, numerical simulation, and experimental study.

Fluid mechanics is a field that is fundamental to numerous engineering applications such as aerospace, civil, mechanical, and chemical engineering. Understanding the behavior of fluids and their flow characteristics is crucial in designing effective and efficient systems. Optimization of these systems is equally important to enhance their performance and reduce energy consumption. Therefore, the Special Issue focuses on the optimization of fluid mechanics systems to improve their efficiency and performance.

The Special Issue comprises several research articles that explore various aspects of flow characteristics and optimization in fluid mechanics. The papers in this Special Issue cover a wide range of topics, including computational fluid dynamics, turbulence modeling, heat transfer, multiphase flow, and fluid–structure interactions. The authors have presented innovative ideas, methodologies, and techniques that have the potential to advance the field of fluid mechanics.

The ability to move fluids is essential for many industrial processes, and pumps are often the most efficient and effective way to achieve this. By providing a steady flow of fluid, pumps help to maintain consistent pressure, temperature, and other important parameters, which is critical for ensuring that processes operate correctly and safely. In [1], a volute reference scheme with passive rotation speed is proposed, which provides new ideas about rotor–rotor interference in dishwasher innovation. Another study [2] proposes impellers with different hub radii for self-priming pumps and analyzes the internal flow characteristics, blade surface load, pressure pulsation characteristics, and radial force distribution of each scheme. The optimization of diffuser blades in multistage submersible pumps is discussed in [3]. The study used numerical simulation to optimize the lean and sweep of the diffuser blades to improve efficiency and pressure recovery coefficient while reducing non-uniformity. Similarly, the influence of blade structure on the performance of a vortex pump is investigated in [4]. In [5], an automated optimization platform is presented for improving the operating efficiency of mixed flow pumps driven by hydraulic motors. The platform optimizes both the meridional shape and blade profiles of the impeller and diffuser simultaneously using CFD and genetic algorithms. In [6], the internal flow characteristics of a slurry pump are investigated, and the effects of different particle volume concentrations, particle sizes, and pump speeds on the impeller's wear characteristics and hydraulic performance are studied. In [7], the cavitation performance of a liquefied natural gas (LNG) submerged pump and pressure pulsation characteristics are analyzed. In [8], the correlation between internal flow patterns and blade load distributions in centrifugal impellers is investigated using particle image velocimetry (PIV). Another study [9] investigates the formation mechanism of the secondary tip leakage vortex (S-TLV) in cavitating flows using numerical simulations. Tip clearance is another important parameter affecting pump performance, as investigated in [10]. The article studies the influence of tip clearance on the performance and energy dissipation of an axial flow pump, as well as an axial flow pump operating as a turbine. The hydrodynamic characteristics of bidirectional axial flow pumps are investigated in [11], including pressure pulsations, under positive and negative operation. Article [12] uses CFD, one-dimensional theory, and response surface methodology to enhance the performance of a diving tubular pump, an important part of underground water conveyance equipment. In [13], a numerical simulation study of a vertical axial flow pump is presented. Article [14] investigates the impact of non-uniform suction flow on the transient characteristics of a vertical axial flow pump through unsteady calculations and external characteristic tests. The effects of different coolants and working temperatures on the hydraulic and cavitation performances of two impellers with different types of blades in a centrifugal pump for aircraft cooling systems are investigated in [15]. Article [16] presents an optimization system based on CFD, optimized Latin hypercube sampling (OLHS), machine learning (ML), and multi-island genetic algorithm (MIGA) to improve the efficiency of high-specific-speed axial flow pumps under non-design conditions. The Gaussian process regression (GPR) model was found to have the highest prediction accuracy for impeller head and weighted efficiency. The authors of [17] investigated the effect of blade number on the internal flow condition of a high-specific-speed centrifugal pump. The start-up characteristics of large axial flow pump systems and the challenges they face during the start-up process are investigated in [18].

The articles featured in this Special Issue also investigate the relevant hydrodynamic attributes of turbomachinery, high-pressure jets, marine propulsion systems, and internal combustion engines to a considerable extent, thereby significantly expanding the scope of research within the Special Issue. A new method for precise position control of hydraulic cylinders in hydraulic support used in fully mechanized mining faces is proposed in [19]. Article [20] investigates the cavitation behavior of submerged high-pressure jets with organ pipe nozzles of different outlet shapes. Article [21] optimizes the structural parameters of a coal-breaking and punching nozzle for high-pressure water jet technology in low-permeability coal seams to improve jet performance and increase coal seam permeability. Article [22] focuses on the static characteristics of aerostatic journal bearings with porous bushing, and a flow model is established based on the Reynolds lubrication equation, Darcy equation for porous material, and continuity equation. A new framework for the application of the Harmonic Balance Method (HBM) in the open-source software OpenFOAM is introduced in [23], which is commonly used for turbomachinery calculations. Article [24] evaluates the impact of the Miller cycle on the internal aerodynamics of a spark ignition engine and recommends the need to intensify the internal aerodynamics to prevent significant turbulence degradation while still gaining efficiency in the Miller cycle. In addition, the cavitation resistance of small ship propellers in the coastal waters of South Korea is investigated through a demonstration test in [25]. Finally, Article [26] examines the flow characteristics within the pre-swirl system of a marine gas turbine at low rotational speed and shows the effects of nozzle pressure on radial velocity, core swirl ratio, and pressure.

Overall, this Special Issue presents an excellent opportunity for researchers to explore new ideas and approaches to optimize fluid mechanics systems. The papers in this issue highlight the importance of optimization in enhancing the performance and efficiency of fluid mechanics applications. It is hoped that this Special Issue will inspire further research in this area, leading to new breakthroughs and innovations in the field of fluid mechanics.

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