

Article

# Laboratory Modeling of an Axial Flow Micro Hydraulic Turbine

Daniil Suslov <sup>1,2,\*</sup> , Ivan Litvinov <sup>1,2</sup> , Evgeny Gorelikov <sup>1,2</sup>, Sergey Shtork <sup>1,2</sup>  and David Wood <sup>2,3</sup> 

<sup>1</sup> Kutateladze Institute of Thermophysics, 630090 Novosibirsk, Russia; litvinov@itp.nsc.ru (I.L.);

gorelikov@yandex.ru (E.G.); shtork@itp.nsc.ru (S.S.)

<sup>2</sup> Physics Department, Novosibirsk State University, 630090 Novosibirsk, Russia; dwood@ucalgary.ca

<sup>3</sup> Department of Mechanical and Manufacturing Engineering, University of Calgary, Calgary, AB T2N 1N4, Canada

\* Correspondence: d.suslov@ngs.ru

**Featured Application:** The identified features of the flow for different cases are necessary for predicting the parameters of micro hydraulic turbines and developing recommendations for expanding the range of regulation of turbine operating cases while maintaining high operating efficiency.

**Abstract:** This article is devoted to detailed experimental studies of the flow behind the impeller of an air model of a propeller-type microhydropower turbine in a wide range of operating parameters. The measurements of two-component distributions of averaged velocities and pulsations for conditions from part load to strong overload are conducted. It is shown that the flow at the impeller outlet becomes swirled when the hydraulic turbine operating mode shifts from the optimum one. The character of the behavior of the integral swirl number, which determines the state of the swirled flow, is revealed. Information about the flow peculiarities can be used when adjusting the hydraulic unit mode to optimal conditions and developing recommendations to expand the hydraulic turbine operation control range with preservation of high efficiency. This stage will significantly save time at the stage of equipment design for specific field conditions of water resource.

**Keywords:** axial micro hydraulic turbine; swirl number; hydraulic turbine efficiency; laser-Doppler anemometer (LDA)



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## 1. Introduction

Hydropower, being the oldest area of renewable energy, currently provides a significant contribution to world electric energy generation [1]. The basis of this production is large-scale hydropower plants (HPP), which are built on large rivers and require heavy capital expenditures on the creation of dams. Further broadening of hydropower is limited on the one hand because suitable water resources for the creation of large-scale hydropower systems are already fully exploited in many countries [2]. On the other hand, the construction of new big HPP in places where such resources exist is hampered by economic reasons or safety concerns [3]. At that time, it is recommended the attention to utilization of the hydropower potential of natural water sources in the form of small rivers and streams [4], as well as technical systems of irrigation and water supply [5]. According to the classification of hydro turbines used in the literature, the class of microhydropower turbines (MHT) include devices less than 100 kW, which are considered often as an off-grid technology for the electricity generation [6,7]. Development of MHT systems addresses the current global concerns on climate change demanding decarbonization of the energy generation sector and increasing use of renewable energy sources [8–12]. Microhydropower has been considered as a reliable electricity generation technology for remote communities [11,13], living where extension of centralized power distribution networks is very expensive.

Different hydro turbine types are employed nowadays depending on parameter range of available water resources in terms of head and flowrate [1,11]. As moving towards

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mass transfer surface and groundwater flow among others

### **Monthly Catalog of United States Government**

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**Small Hydropower** Sunil Kumar Singal, Varun Goel, Himanshu Nautiyal, Dimitris Papantonis, 2023-02-19 Small Hydropower Design and Analysis presents a comprehensive guide to the design operation and maintenance of small hydropower plants Using detailed diagrams and illustrations the book examines the classifications components equipment feasibility and analysis of each aspect of SHPs Following a broad introduction the book discusses classification approaches based on head discharge capacity etc analyzes site selection and gives an overview of key development stages SHP components for civil engineering works and electro mechanical equipment have dedicated chapters that are followed by a chapter on how to design new components for the civil mechanical and electrical aspects of a plant Subsequent chapters provide guidance on economic and financial analysis environmental impact troubleshooting and diagnosis in operating plants and refurbishment and upgradation of SHPs when and why this is needed and how to approach it Finally several case studies provide real world examples of SHPs in operation giving readers insight into the practical needs of operating SHPs Addresses all aspects of small hydropower including civil works hydro mechanical power generation and distribution costing and financial analysis environmental impact and plant refurbishment and upgrading Provides dedicated chapters on the environmental and ecological impacts of small hydropower plants Assesses common problems in SHPs and provides tools for troubleshooting diagnosis and solutions including for site specific issues Presents detailed real world case studies showing the application of key aspects of SHP design operation maintenance environmental and ecological assessment and refurbishment

*The proceedings of the 10th Frontier Academic Forum of Electrical Engineering (FAFEE2022)* Xuzhu Dong, Qingxin Yang, Weiming Ma, 2023-08-23 This book includes the original peer reviewed research papers from the 10th Frontier Academic Forum of Electrical Engineering FAFEE 2022 held in Xi an China in August 2022 It gathers the latest research innovations and applications in the fields of Electrical Engineering The topics it covers include electrical materials and equipment electrical energy storage and device power electronics and drives new energy electric power system equipment IntelliSense and intelligent equipment biological electromagnetism and its applications and insulation and discharge computation for power equipment Given its scope the book benefits all researchers engineers and graduate students who want to learn about cutting edge advances in Electrical Engineering

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*Hydrologic Modelling* Manish Pandey, N.V. Umamahesh, Jew Das, Jaan H. Pu, 2024-12-01 This book comprises proceedings of the 28th International Conference on Hydraulics Water Resources River and Coastal Engineering HYDRO 2023 It focuses on emerging opportunities and challenges in the field of hydrology and hydrological modelling The book covers a range of topics

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Exhibition on Sustainable Energy and Advanced Materials ICE SEAM 2019 held on 16 17 October 2019 in Surakarta Indonesia It focuses on two relatively broad areas advanced materials and sustainable energy and a diverse range of subtopics Advanced Materials and Related Technologies Liquid Crystals Semiconductors Superconductors Optics Lasers Sensors Mesoporous Materials Nanomaterials Smart Ferrous Materials Amorphous Materials Crystalline Materials Biomaterials Metamaterials Composites Polymers Design Analysis Development Manufacturing Processing and Testing for Advanced Materials Sustainable Energy and Related Technologies Energy Management Storage Conservation Industrial Energy Efficiency Energy Efficient Buildings Energy Efficient Traffic Systems Energy Distribution Energy Modeling Hybrid and Integrated Energy Systems Fossil Energy Nuclear Energy Bioenergy Biogas Biomass Geothermal Power Non Fossil Energies Wind Energy Hydropower Solar Photovoltaic Fuel Cells Electrification and Electrical Power Systems and Controls

*Feasibility Studies for Small Scale Hydropower Additions* Hydrologic Engineering Center (U.S.),1979      **Scientific and Technical Aerospace Reports** ,1989      *Selected Water Resources Abstracts* ,1990      **Digital and Information Technologies in Economics and Management** Arthur Gibadullin,2024-03-13 This book covers the III International Scientific and Practical Conference Digital and Information Technologies in Economics and Management DITEM2023 which was held on November 21 23 2023 The conference addressed issues of networks and systems related to the use of information technologies in economics and management of various sectors A distinctive feature of the conference is that it featured presentations by authors from China Bulgaria Uzbekistan Oman Kazakhstan and Russia Researchers from different countries presented the process of transition to new information technologies of various network and system structures and sectors The conference made it possible to develop new scientific recommendations on the use of information computer digital and intellectual technologies and networks in industry and fields of activity that can be useful to state and regional authorities international and supranational organizations the scientific and professional community

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