



## Summary of the 4th IAHR Asian working group symposium on hydraulic machinery and systems

**Symposium Chair: Wang Zhengwei<sup>1</sup>**

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### 1. Background

The international Association for Hydro-Environment Engineering and Research (IAHR), founded in 1935, one of the IAHR Committee is the Hydraulic Machinery and Systems, which deals with the advancement of technology associated with the understanding of steady and unsteady flow characteristics in hydraulic machinery and conduit systems connected to, and the main emphasis is to promote interaction between the machine designers, machine users, the academic communities, and the communities at large.

To meet its objectives, the Committee focuses on the best possible exchange of technical knowledge by arranging a Committee Symposium every second year. The symposiums are designed to attract scientists and engineers from industries, universities, consultants and users of hydraulic machinery. In addition, the Committee established “Asian Working Group” specially to promote the exchange and cooperation of hydraulic machinery industry in Asian countries.

In recent years, water conservancy and hydropower in Asia have been developing dramatically. Hydraulic machinery like pump, pump turbines etc., are widely used in project construction. There are plentiful scientific and technical payoffs achieved within the related researches. The "Asian Working Group" has held three symposiums on hydraulic machinery and systems, which are: IAHR 2017 Asia Beijing, IAHR 2019 Asia Busan, IAHR 2021 Asia Nepal. And all conference proceedings have been published in IOP. After the 4th IAHR Asian Working Group Symposium on Hydraulic Machinery and Systems (hereinafter referred to as IAHR 2023 Asia Kashgar) following its convention, the conference proceedings will be published in IOP.

### 2. Scope

IAHR 2023 Asia Kashgar covered following topics: Intake system, Hydraulic turbines, Pump-turbines, Pumps, Storage pumps, Ocean energy, Small and micro hydropower, Sustainable hydropower, Energy storage and flexibility, Cavitation and multiphase flow, Multi-field coupling, Computational fluid dynamics and fluid-structure interaction, Sediment erosion, Vortex breakdown, Vibration and fatigue loading, Measurement techniques and signal processing, Model tests and laboratory tests, Smart grid and digital twin, Selected topics.

### 3. Record

From 12th to 16th August, 2023, IAHR 2023 Asia Kashgar was held in Kashgar, Xinjiang, China. More than 450 participating representatives from 12 countries including China, Japan, South Korea, Russia, Nepal, Pakistan, Switzerland, Norway, Austria, Spain, etc., gathered at the conference on-site. Further, the experts and scholars from Sweden and India, etc., a total of 14 countries' representatives,

actively participated and presented their reports online. On the first day of the conference, more than 2,000 people attended the live broadcast online and listened to the wonderful speeches of the conference.



Figure 4. Group photo of the conference.



Figure 5. Meeting site photos.

On the day of the opening ceremony on 13<sup>th</sup> August, Li Yanpo, general manager of Xinhua Hydropower Co., Ltd., Li Yuhong, chairperson of the Department of Energy and Power Engineering Council of Tsinghua University, Li Yongsheng, second-level inspector of Xinjiang Association for Science and Technology, Yuan Shouqi, professor of Jiangsu University, Chen Guangting, president of Zhejiang University of Water Resources and Electric Power, François Avellan, representative of the IAHR-Committee on Hydraulic Machinery and Systems & professor of the EPFL, and Wang Zhengwei, professor of Tsinghua University & chairman of the Symposium, delivered speeches respectively, expressing warm congratulations on the opening, sincere welcome to the guests and wishes to the success of the conference. (Bin Jian from Xinhua Hydropower Co., Ltd. and Xiaomei Guo from Zhejiang University of Water Resources and Electric Power host this opening ceremony.)



**Figure 6.** Opening Speech Guests.

Note: Top row are Li Yanpo, Li Yuhong, Li Yongsheng (from left to right). Bottom row are Yuan Shouqi, Chen Guangting, François Avellan, Wang Zhengwei (from left to right).

During the conference, 31 specially invited speakers made wonderful keynote reports for the plenary and parallel sessions, shared their recent research achievements and engineering application cases to the conference. (Daqing Qin from Harbin Electric Machinery Co., Ltd., Quanwei Liang and Qinghua Shi from Dongfang Electric Machinery Co., Ltd., Young-ho Lee from Korea Maritime & Ocean University, Desheng Zhang from Jiangsu University and Jinyang Xue from Andritz (China) Co., Ltd., host the plenary session.)

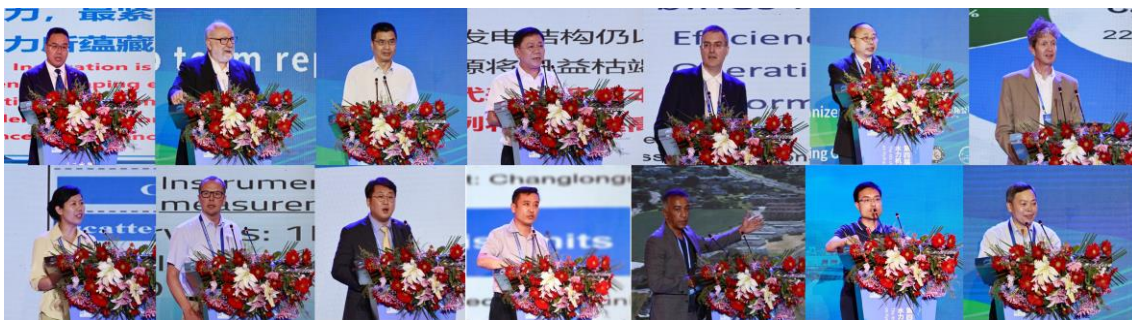
**Table 1.** Invited lecture information.

Speaker	Title	Affiliation/Country
Yanpo Li	Research on Key Technologies of Hydraulic Turbines and Optimization of Basin Dispatching	Xinhua Hydropower Co., Ltd., China
François Avellan	Demonstrating Hydropower plants support to the power system flexibility	EPFL, Switzerland
Qiang Yao	Challenges and opportunities for low-carbon energy transformation in Xinjiang	Xinjiang University, China
Xueshan Liu	Development achievements and Prospects of Pumped Storage Power Station in China	China Southern Power Grid Energy Storage Co., Ltd., China
Xavier Escaler	Development of a Structural Health Monitoring system for hydraulic turbines in the frame of the AFC4 Hydro project	Universitat Politècnica de Catalunya, Spain
Daqing Qin	The Role & Development Direction of Pumped Storage & Conventional Hydro in New Power System	Harbin Electric Machinery Co., Ltd., China
Christof Gentner	Variable speed pumped storage plants: discussion of design-influencing factors	GE Renewable Energy, Switzerland
Xiaomei Guo	Key Technologies and Applications of Centrifugal pumps with High Anti-Cavitation Performance	Zhejiang University of Water Resources and Electric Power, China
Morten Kjeldsen	Digitalization in Hydropower- Challenges and Opportunities	Flow Design Bureau AS., Norway
Jin-Hyuk	Development of a Positive Displacement Hydraulic	Korea Institute of



KIM	Turbine for Replacing the PDCV in Water Supply Pipeline System	Industrial Technology, Korea
Quanwei Liang	Recent developments and applications of some hydro-techniques in DEC	Dongfang Electric Machinery Co., Ltd., China
Mohamed Farhat	What do we know on cavitation and its effects on hydraulic machines?	EPFL, Switzerland
Chaoshun Li	Intelligent operation and maintenance technology, equipment, and system for hydropower units	Huazhong University of Science and Technology, China
Zhengwei Wang	Multiphysics coupling dynamic analysis of hydraulic machinery	Tsinghua University, China
Maria Collins	Recent progress in pump turbine RD & Mega Kaplan	Andritz Hydro GmbH, Austria
Desheng Zhang	Investigation on hydrodynamic characteristics and wake evolution mechanism of pump-jet propeller with front guide vane	Jiangsu University, China
Jianjun Feng	Characteristics of cavitation-induced vibration and pressure fluctuation in a bulb turbine	Xi'an University of Technology, China
Lei Zhu	Hydraulic Performance Advances of Pump Turbines in China: From the Perspective of Third-party Model Tests	China Institute of Water Resources and Hydropower Research, China
Lingjiu Zhou	Influence of narrow chambers and gaps on the stability of Reversible Pump-Turbines-from flow excitations to structural characteristics	China Agricultural University, China
Jie Liu	Pumped storage project development in China Three Gorges Corporation (CTG) and related key technologies	China Three Gorges Corporation, China
Jiaxing Lu	Research on the unsteady flow characteristics and pressure pulsations under part-load conditions in centrifugal pumps based on dynamic mode decomposition	Xihua University, China
Shengbing Li	The 1000mw units in BHT hydropower power station	Powerchina HuaDong Engineering Corporation limited, China
Diyi Chen	Safe and efficient operation and maintenance of hydropower units and dynamic programming of Wind-Solar-Hydro power storage system with carbon peaking and carbon neutrality goals	Northwest A&F University, China
Weijia Yang	Modelling and dynamic characteristics of variable-speed pumped storage plants	Wuhan University, China
Yiqun Xu	Study on Reliable Operation of Hydropower System and Turbine-Generator Units	Huaneng Lancang River Hydropower Inc, China
Håkan Nilsson	Studies of transient operation of hydraulic machines using Open FOAM	Chalmers University of Technology, Sweden
Christophe Nicolet	Hydro-Clone: Hydropower Plant Digital Twin from Commissioning to Long Term Monitoring of Hydraulic Transients	Power Vision Engineering Sàrl, Switzerland
Chisachi Kato	The present status of large-scale industrial simulations and its future	The University of Tokyo, Japan

Arun Kumar	Collaboration in Inter laboratory comparison globally for model testing	Indian Institute of Technology Roorkee, Indian
Long Meng	Technology for flexible operation: the variable speed pumped turbine in Chunchangba PSP—the first full-size frequency converter VSU in China	China Institute of Water Resources and Hydropower Research, China
Wen Yang	Research and application of key technologies for the large-scale high-efficiency corrosion-resistant and wear-resistant pumps	Sanlian Pump Industry Co., Ltd, China



**Figure 7.** On-site keynote speakers on the 13th August.

Note: Top row, from left to right, they are Li Yanpo, François Avellan, Yao Qiang, Liu Xueshan, Xavier Escaler, Qin Daqing, Christof Gentner. Bottom row, from left to right, they are Guo Xiaomei, Morten Kjeldsen, Jin-Hyuk KIM, Liang Quanwei, Mohamed Farhat, Li Chaoshun, Wang Zhengwei.



**Figure 8.** On-site keynote speakers of the conference on 15th August.

Note: Top row, from left to right they are Maria Collins, Zhang Desheng, Feng Jianjun, Zhu Lei, Zhou Lingjiu. Bottom row, from left to right they are Liu Jie, Lu Jiaying, Li Shengbing, Chen Diyi, Yang Weijia, Xu Yiqun.



**Figure 9.** Online keynote speakers on 15th August.

Note: From left to right, they are Håkan Nilsson, Christophe Nicolet, Chisachi Kato, Arun Kumar.



**Figure 10.** Keynote speakers in parallel sessions on 14th August.

Note: Left is Meng Long, right is Yang Wen.

Under the organization of 24 parallel session chairs, about 300 papers were reported by representatives from universities, enterprises, research institutes and other units on 19 topics that mentioned in section 2. Active and lively discussions & exchanges were carried out.

**Table 2.** Parallel session information.

Topic	Session Chair	Affiliation
Pump-turbines	Yongguang Cheng	Wuhan University
Pump-turbines	Lei Han	Harbin Institute of Technology
Pump-turbines	Christof Gentner	GE Renewable Energy
Pump-turbines	Deyou Li	Harbin Institute of Technology
Pumps	Lei Tan	Tsinghua University
Pumps	Xiaomei Guo	Zhejiang University of Water Resources and Electric Power
Pumps	Yonggang Lu	Jiangsu University
Pumps	Xun Sun	Shandong University
Pumps& Vortex breakdown	Ji Pei	Jiangsu University
Storage Pumps	Huan Cheng	Dongfang Electric Machinery Company Limited
Storage Pumps	Zhigang Zuo	Tsinghua University
Hydraulic turbines	Mohamed Farhat	EPFL
Hydraulic turbines	Wenquan Wang	Sichuan University
Hydraulic turbines	Daqing Zhou	Hohai University
Hydraulic turbines	Long Meng	China Institute of Water Resources

		and Hydropower Research
Hydraulic turbines	Wei Yan	Andritz (China) Co., Ltd.
Cavitation and Multiphase flow	Xavier Escaler	Universitat Politècnica de Catalunya
Cavitation and Multiphase flow	Shuaihui Sun	Xi'An University of Technology
Sediment erosion& Ocean energy & Small and micro hydropower	Xijie Song	Yangzhou University
Smart grid and digital twin&Sustainable hydropower & Vibration and fatigue loading	Jiaxing Lu	Xihua University
Measurement techniques and signal processing & Model tests and laboratory tests	Morten Kjeldsen	Flow Design Bureau AS.
Computational fluid dynamics and fluid structure interaction & Energy storage and flexibility	Li Cheng	Yangzhou University
Multi-field coupling & Selected topics	Beibei Xu	Northwest A&F University
Selected topics& Intake system	Joon Yong Yoon	Hanyang University



**Figure 11.** Some Parallel Report Sites.

At the closing ceremony on 15th August, Wang Zhengwei, professor of Tsinghua University and chairman of the Symposium, made a summary of the conference. A total of 392 papers were submitted for this conference, and 301 papers were accepted to be presented on the conference, 292 papers are going to be published in the conference proceedings. After the recommendation and review of all the session chairs and of the conference committees, 22 excellent papers were finally selected, which can be seen in appendices C.





**Figure 12.** Excellent Paper Award Ceremony.

At the end of the closing ceremony, Young-Ho LEE, professor of Korea Ocean University and co-chairman of the Symposium, announced that the next IAHR Asian Working Group Symposium on Hydraulic Machinery and Systems will be held in Jeju Island, South Korea in 2025. We look forward to meet everyone again two years later and make new development on hydraulic machinery and systems!



**Figure 13.** Announcement of the next IAHR-AWG symposium.

On 16th August, the participants visited the "Xinjiang Three Gorges" Altash Water Conservancy Project. The project has overcome the world-class problems of high dams, high slopes, high seismic intensity and deep overburden, the participants have seen the results of governance and cascade development of the Yarkand River Basin.





**Figure 14.** Visit to Altash Water Conservancy Project, 16th August.

Finally, the local organizing committee would like to extend sincere gratitude to the universities and companies listed in appendices A and many others that help to organize this Symposium, without whose help this symposium could never have been so successful.

Thanks very much to all committee members (name list in appendices B) for their kind support and help in various aspects of this conference, such as promoting the event, inviting attendees, reviewing abstracts and papers, hosting sessions, etc.

And also, the organizing committee would like to express special thanks to The Chinese Ministry of Education, Xinjiang Foreign Affairs Office and the Kashgar government for their support to this international conference. Thanks to the leaders and volunteers of Kashgar University for their friendly support to this event.

**Appendices A: Organization**



(a) Tsinghua University



(b) CNNC-Xinhua Hydropower Company Limited

**Figure 1.** Host.



(a) Dongfang Electric Machinery Co., Ltd.



(b) Harbin Electric Machinery Co., Ltd.



(c) Jiangsu University



(d) Xi'an University of Technology



(e) Zhejiang University of Water Resources and Electric Power



(f) Hohai University



(g) Andritz (China) Co., Ltd.



(h) Xihua University



(i) Northwest A&F University

**Figure 2. Co-organizers.**



(a) China Electricity Council



(b) Chinese Hydraulic Engineering Society



(c) China Society for Hydropower Engineering

**Figure 3. Supporting Organizations.**

## Appendices B: Committee members

### Organizing committee

Anfu Zhang (Xinhua Hydropower Company Limited, China)

Baohu Zhang (Xinhua Hydropower Company Limited, China)

Baoshan Zhu (Tsinghua University, China)

Bhola Thapa (Kathmandu University, Nepal) - Co-chair

Chisachi Kato (The University of Tokyo, Japan) - Co-chair

Chunan Yang (Tsinghua University, China) - Secretary

Diyi Chen (Northwest A&F University, China)

Gang Wang (Xinhua Hydropower Company Limited, China)

Honggang Fan (Tsinghua University, China)

Huating Song (Xinhua Hydropower Company Limited, China)

Jianhua Deng (Xinhua Hydropower Company Limited, China)

Juan Yang (China Electricity Council, China)

Lei Tan (Tsinghua University, China)

Leilei Xu (Xinhua Hydropower Company Limited, China)

Shuhong Liu (Tsinghua University, China)

Xianwu Luo (Tsinghua University, China)

Xiaojie Qi (Xinhua Hydropower Company Limited, China)

Xingxing Huang (Future Energy Research Institute of S.C.I. Energy, Switzerland) - Overseas Coordinator

Yan Chang (China Electricity Council, China)

Yan Liu (Tsinghua University, China/U.K.) - Secretary

Yexiang Xiao (Tsinghua University, China)

Yongyao Luo (Tsinghua University, China)

Young-Ho Lee (Korea Maritime and Ocean University, Republic of Korea) - Co-chair

Zhengwei Wang (Tsinghua University, China) - Symposium Chair

Zhigang Zuo (Tsinghua University, China)

Zhiqiang Jin (Xinhua Hydropower Company Limited, China)

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Chisachi Kato (University of Tokyo, Japan) – Vice Chair

Eduard Egusquiza (Universidad Politécnica de Cataluña, Spain)

François Avellan (EPFL, Switzerland)

Stuart Coulson (Voith Hydro, United States of America)

Ole Gunnar Dahlhaug (NTNU, Norway)

Bhupendra K Gandhi (Indian Institute of Technology, Roorkee India)

Carl Höegström (VATTENFALL, Sweden)

Young-Ho Lee (Korea Maritime and Ocean University, Republic of Korea)

Andrej Lipej (University of Novo mesto, Slovenia)

Sergio Óscar Liscia (FUNDACIÓN FACULTAD DE INGENIERÍA, Argentina)

Bernd Nennemann (Andritz Hydro Ltd. Canada)

Pavel Rudolf (Brno University of Technology, Czechia)

Qing-Hua Shi (Dongfang Electrical Machinery Co., Ltd., China)

Romeo Susan-Resiga (Politehnica University Timisoara, Romania)

Geraldo Lúcio Tiago Filho (Universidade Federal De Itajubá, Brazil)

Laurent Tomas (Alstom, France)

Zhengwei Wang (Tsinghua University, China)

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Youngho Lee (Korea Maritime & Ocean University, Korea)

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(4) Vice Secretary General

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(6) Members

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Jie Liu (China Three Gorges Corporation, China)

Joon Yong Yoon (Hanyang University, Korea)

Jun Matsui (Yokohama National University, Japan)

Kazuyoshi Miyagawa (Waseda University, Japan)

Kwang-Yong Kim (Inha University, Korea)

Kyoung-Yeop Kim (Tech University of Korea, Korea)

M. Rafiuddin Ahmed (University of South Pacific, Fiji)

Qinghua Shi (Dongfang Electric Machinery Company Limited, China)



Quanwei Liang (Dongfang Electric Machinery Company Limited, China)  
Rennian Li (Lanzhou University of Technology, China)  
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Weidong Shi (Nantong University, China)  
Won-gu Joo (Yonsei University, Korea)  
Xiaobing Liu (Xihua University, China)  
Xingqi Luo (Xi'an University of Technology, China)  
Yiqing Cai (China Electricity Council, China)  
Young-Do Choi (Mokpo National University, Korea)  
Young-Seok Choi (Korea Institute of Industrial Technology, Korea)  
Youn-Jea Kim (Sungkyunkwan University, Korea)

*Scientific committee*

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Alfredo Guardo Zabaleta (Polytechnic University of Catalonia, Spain)  
Arun Kumar (Indian Institute of Technology Roorkee, India)  
Beibei Xu (Northwest A&F University, China)  
Bin Ji (Wuhan University, China)  
Chaoshun Li (Huazhong University of Science and Technology, China)  
Chirag Trivedi (Norwegian University of Science and Technology, Norway)  
Christian Bauer (TU Wien, Vienna)  
Christophe Nicolet (Power Vision Engineering Sàrl, Switzerland)  
Christof Gentner (GE Renewable Energy, Switzerland)  
Chun Xiang (Zhejiang University of Water Resources and Electric Power, China)  
Dazhuan Wu (Zhejiang University, China)  
Desheng Zhang (Jiangsu University, China)  
Deyou Li (Harbin Institute of Technology, China)  
Diyi Chen (Northwest A&F University, China)  
Dunzhe Qi (Water conservancy project construction center of Ningxia Autonomous Region, China)  
Eduard Doujak (TU Wien, Austria)  
Evgeniia Georgievskaja (Center of Design and Technological Innovation LLC, Russia)  
Fei Zhang (Pump-storage Technology & Economic Research Institute of State Grid Xinyuan Company Ltd., China)  
Guangjie Peng (Jiangsu University, China)  
Guoyi Peng (Nihon University, Japan)  
Guoyu Wang (Beijing Institute of Technology, China)  
Håkan Nilsson (Chalmers University of Technology, Sweden)  
Hironori Horiguchi (Osaka University, Japan)  
Hongxun Chen (Shanghai University, China)  
Hongying Luo (Tibet institute of Agriculture and Animal Husbandry, China)  
Huashu Dou (Zhejiang Sci - Tech University, China)  
Ji Pei (Jiangsu University, China)  
Jiegang Mou (China Jiliang University, China)  
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Jinwei Li (China Institute of Water Resources and Hydropower Research, China)  
Jin-Hyuk Kim (Korea Institute of Industrial Technology, Korea)  
Jixing Yu (China Institute of Water Resources and Hydropower Research, China)  
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Kai Lin (CSG PCG Engineering Construction and Management Branch Co., China)

Lei Cao (CCCC National Engineering Research Center of Dredging Technology and Equipment Co., Ltd., China)

Li Cheng (Yangzhou University, China)

Lingjiu Zhou (China Agricultural University, China)

Long Meng (China Institute of Water Resources and Hydropower Research, China)

Luoping Pan (Tianjin Institute of Hydroelectric and Power Research, China)

Michel Cervantes (Luleå University of Technology, Sweden)

Min He (Shanghai Kaiquan Pump Group Co. Ltd., China)

Mohamed Farhat (Swiss Federal Institute of Technology Lausanne, Switzerland)

Morten Kjeldsen (Flow Design Bureau AS., Norway)

Motohiko Nohmi (Ebara Corporation, Japan)

Pengcheng Guo (Xi'an University of Technology, China)

Qiuli Zhao (China Electricity Council, China)

Ran Tao (China Agricultural University, China)

Ruofu Xiao (China Agricultural University, China)

Sailesh Chitrakar (Kathmandu University, Nepal)

Satoshi Watanabe (Kyushu University, Japan)

Soo-Hwang Ahn (Yonsei University, Korea)

Stefan Riedelbauch (University of Stuttgart Machinery, Germany)

Sung-Min Kim (Sungkyunkwan University, Korea)

Tae-Gyu Hwang (Korea Hydro Power Industry Association, Korea)

Takeo Tokumiya (Toshiba Energy Systems & Solutions Corporation, Japan)

Wei Han (Lanzhou University of Technology, China)

Wenquan Wang (Sichuan University, China)

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Wensheng Ma (Chongqing Pump Industry Co., Ltd., China)

Xavier Escaler (Universitat Politècnica de Catalunya, Spain)

Xiaomei Guo (Zhejiang University of Water Resources and Electric Power, China)

Xin Liu (China Huaneng Clean Energy Research Institute, China)

Xingxing Huang (Future Energy Research Institute of S.C.I. Energy, Switzerland)

Xun Sun (Shandong University, China)

Yanpin Li (North China University of Water Resources and Hydropower, China)

Yong Cho (Korea Water Resources Corporation, Korea)

Yongguang Cheng (Wuhan University, China)

Yongxue Zhang (China University of Petroleum (Beijing), China)

Ye Zhou (China Institute of Water Resources and Hydropower Research, China)

Yuan Zheng (Hohai University, China)

Yuka Iga (Tohoku University, Japan)

Yun Zeng (Kunming University of Science and Technology, China)

Zhenggui Li (Xihua University, China)

Zhenyue Ma (Dalian University of Technology, China)

Zhipeng Li (Changsha University of Science and Technology, China)

Zhongdong Qian (Wuhan University, China)

Zuchao Zhu (Zhejiang of Sci - Tech University, China)

### **Appendices C: Excellent papers**

- [1] Evolution of Runner Forces during Simultaneous Pump-Trip Transient Process of Two Pump-Turbines, Liu Ke, Cheng Yongguang, Ding Jinghuan, Wang Xi.
- [2] Analysis of cavitation pressure fluctuation of mixed flow pump based on Welch power spectrum, Wentao Xu, Li Cheng, Weixuan Jiao, Can Luo.

- [3] Investigation on flow structure and pressure fluctuation of gas-liquid two-phase flow in a mixed flow pump, Yadong HAN, Guoying WU, Yuanhang LIN, Lei TAN.
- [4] Analysis of axial forces pulsation in an high-pressure decoking pump, Yanpi Lin, Shengjun Xu, Zhandong Chen, Zhicong Wei, Xiaojun Li, Zhuchao Zhu.
- [5] Numerical Investigation on the Spatiotemporal Correlation between Hydraulic Loss and Vortex at Turbine Mode of a Pump-turbine, Y L Qin, D Y Li, H J Wang, Z S Liu, X Z Wei, X H Wang and Y J Song.
- [6] Numerical and experimental study of tip leakage vortex structures and dynamics in a mixed-flow waterjet pump, B Gong, H L Zhu, X H Chen, J L Yin, N Li, D Z Wang.
- [7] Analysis and Discussion on High Insulation Performance of 20 kV Generator Motor Stator in the Large Pumped Storage Unit, Z Zhou, T Liu, H Y Chen, Z X Cao and H C Li.
- [8] Study of intensity index for extraordinary stress on blade during start-up of Francis turbine, T Mukai, M Nakazono, K Tezuka, T Hasunuma and J Matsui.
- [9] Influence of sediment concentration on erosion characteristics of hydraulic machinery materials, SONG Guohua, SUN Shuaihui, YANG Junfeng, LI Shaoyi, LI Meng, WANG Kai, WU Pengbo, ZHAO Yifan and GUO Pengcheng.
- [10] Analysis of oil film flow characteristics and lubrication performance of thrust bearing of 1000MW Hydraulic Turbine Unit, Yishu Shi, Siyuan Wu, Xingxing Huang, Xingmin Liu, Zhengwei Wang.
- [11] Analysis of pressure pulsation in a multi-stage double suction centrifugal pump, Wenjie Peng, Ji Pei, Shouqi Yuan, Wenjie Wang.
- [12] Stress measurement of runner blade for a Francis prototype turbine, Dengfeng Cao, Martin Dodge, Ye Zhou and Juan Liu.
- [13] Mechanism study on the control of cloud cavitation by leading-edge tubercles on NACA0015, G S Zhao, N Liang, L L Cao and D Z Wu.
- [14] Research on incipient and critical cavitation of a Francis turbine, Jing Yang, Liang Yao, Jie Liu, Bo Yue, Zhe Ma, Yong Sun, Zhengwei Wang.
- [15] Validation of the steady and unsteady simulation based on an axial-flow pump, Duc-Anh Nguyen, Sung Kim, Soon-Young Jeong and Jin-Hyuk Kim.
- [16] Research on Online Monitoring Technology of Cavitation in Hydraulic Machinery, Zhao Yue, Li Renfei, Guo Yitong, Zhao Yingnan, Liu Zhiliang, Su Wentao and Sun Yongxin.
- [17] Analysis of the cause of the 40Hz frequency component in spiral casing of a high head pump turbine, W B Jia, Z W Guan, Q W Liang, Y Liu, Z N Wang, H Cheng, Q Y He.
- [18] Vibration Characteristic Analysis of Pump-turbine head cover based on Fluid-Solid Coupling, J P ZHOU, Y M FAN, Q Y HE, S J WANG, H L ZHAO, F SUN and Q TANG.
- [19] Effects of cavitation on the vortex shedding behind a truncated hydrofoil subjected to forced oscillation, Jian Chen and Xavier Escaler.
- [20] Cavitating flow around a low aspect ratio NACA0012 hydrofoil with regular grooves, M Tsoy, S Skripkin and A Kravtsova.
- [21] On the Water Jet Quality at Part-Load Operation of Pelton turbines, Bernhard Semlitsch.
- [22] Experimental Study of the Effects on Performance of Francis Turbine due to Sediments in Flow, Ravi Poudel, Junde Shi, Zilong Zhao, Zhongdong Qian, Zhiwei Guo, Sailesh Chitrakar and Bhola Thapa.

Note: All appendices ranking in no particular order.