

P O L S K A A K A D E M I A N A U K
INSTYTUT MASZYN PRZEPLYWOWYCH

PRACE
INSTYTUTU MASZYN
PRZEPLYWOWYCH

TRANSACTIONS
OF THE INSTITUTE OF FLUID-FLOW MACHINERY

90-91

WARSZAWA—POZNAŃ 1989

P A Ń S T W O W E W Y D A W N I C T W O N A U K O W E

PRACE INSTYTUTU MASZYN PRZEPŁYWOWYCH

poświęcone są publikacjom naukowym z zakresu teorii i badań doświadczalnych w dziedzinie mechaniki i termodynamiki przepływów, ze szczególnym uwzględnieniem problematyki maszyn przepływowych

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THE TRANSACTIONS OF THE INSTITUTE OF FLUID-FLOW MACHINERY

exist for the publication of theoretical and experimental investigations of all aspects of the mechanics and thermodynamics of fluid-flow with special reference to fluid-flow machinery

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Warszawa 1989

Printed in Poland

ISBN 83-01-09017-0

ISSN 0079-3205

PAŃSTWOWE WYDAWNICTWO NAUKOWE - ODDZIAŁ W POZNANIU

Nakład 350+90 egz.	Oddano do składania 27 X 1987 r.
Ark. wyd. 27. Ark. druk. 19,5	Podpisano do druku w sierpniu 1989 r.
Papier offset. IV kl. B-1	Druk ukończono w styczniu 1990 r.
Zam. nr 2/90	K-8/295

DRUK ZAKŁAD POLIGRAFII WSP W ZIELONEJ GÓRZE

HYDROFORUM

KONFERENCJA NAUKOWO-TECHNICZNA

na temat

ZAGADNIENIA HYDRAULICZNYCH MASZYN WIROWYCH

Gdańsk-Władysławowo, 24-27 września 1985 r.

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HYDROFORUM

SCIENTIFIC-TECHNICAL CONFERENCE

on

PROBLEMS OF HYDRAULIC TURBOMACHINES

Gdańsk-Władysławowo, September 24-27, 1985

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ГИДРОФОРУМ

НАУЧНО-ТЕХНИЧЕСКАЯ КОНФЕРЕНЦИЯ

на тему

ПРОБЛЕМЫ ГИДРАВЛИЧЕСКИХ ТУРБОМАШИН

Гданьск-Владыславово, 24-27 сентября 1985 г.

Report

on the Second Discussion Meeting on

Problems of Hydraulic Machinery in the Government-Sponsored Program PR-8

The discussion was preceded by four communications delivered by co-workers of the Institute of Fluid-Flow Machinery of the Polish Academy of Sciences in Gdańsk.

The first communication contained general information about the research work on hydraulic machines done within the Government-Sponsored Program PR-8 entitled: „Complex Development of Power Engineering”, problems 2.5 and 6.4. Prof. Kazimierz Steller was the rapporteur. He informed that the Institute of Electrical Power Engineering and Automation of the Technical University of Gdańsk was the co-ordinator of the problem 2.5 entitled: „Devices and Methods of Operation of Water Power Plants” and Prof. Zbigniew Szczerba was the problem head. The work realized in 1981-85 had concerned:

- foundations for optimum investment decisions and optimum use of water power plants in an electric power system,
- working out series of types of water turbines for power output up to 2000 kW,
- electric equipment for water power plants.

Among the more important results obtained by the time of the Conference were:

- guidelines for determination of the appropriate level of power delivered by water power plants to the Polish electric power system,
- developing principles of financing small water power plants development,
- working out a program of reactivation and construction of small water power plants in Poland by the year 2000,
- standard designs of small water power plants,
- construction of a water turbines cavitation test facility,
- working out nomograms for tubular turbines basing on model research,
- working out the design an technology for a series of types of low-head Banki-Michell turbines,
- designing electro- and mechanohydraulic governors for Banki-Michell turbines,
- working out technical documentation of an automatic synchronizer,
- working out a water level measuring set.

Construction of small water power plants equipped with Banki-Michell turbines and starting production of these turbines in the Repair Works of the Power Generating Industry in Gdańsk are regarded as the most important achievements in practical applications.

Next the rapporteur reviewed the work done within the problem 6.4 entitled: „Modern Methods of Designing Power Machines and Devices” of which the Institute of Fluid-Flow Machinery of the Polish Academy of Sciences in Gdańsk was the co-ordinator and Prof. Tadeusz Gerlach the head.

Research carried out within the range of hydraulic machinery in the period 1981—85 concerned:

- methods of designing hydraulic machinery, especially CAD,
- methods of hydraulic machinery operation taking into consideration transients.

Among the more important results were:

- computational programs for analysis of flow through hydraulic machines,
- methods of cavitation prediction in stationary cascades of hydraulic machines,
- research methods of cavitation detection and cavitation intensity assessment,
- programs for analysis of water hammer in closed conduits,
- a new method of high speed pumps control and the axial thrust relief,
- new design of fluid couplings.

The most important industrial implementation achievements include:

- fluid couplings for delivery control of boiler feed pumps for power units of the Belchatów Power Plant (manufacturer: ZAMECH Mechanical Works in Elbląg);
- fluid couplings for brown coal fan mills starting and regulation (manufacturer: ZAMECH Mechanical Works in Elbląg) and for driving belt conveyors used in the mining and power industry (manufacturer: WIROMET Mechanical Works of Mining and Power Industry in Mikołów);
- drafts of two Polish Standards concerning cavitation erosion (drafts accepted by the Polish Committee for Standardization of Measures and Quality Control).

The rapporteur mentioned that the detailed information about results of the above-mentioned work, especially work realized within the problem 6.4, was given in sectional reports and communications.

About other results, therein about results of work realized within the problem 2.5, information was given by Prof. Jan Brosch, Eng. Zdzisław Reymann, M.Sc., and Eng. Wojciech Myszkowski, M.Sc.

Prof. Jan Brosch spoke on the work on improvement of hydraulic turbomachine design fundamentals carried out mainly within the problem 6.4. In his talk he reviewed this work and informed about the results obtained. The speaker pointed out three computational programs for analysis of flow through blade systems having been developed and a comparison of calculations results with results of an experiment having been made. Recapitulating his presentation he emphasized usefulness of cooperation of the Research and Development Centre of Industrial Pumps with scientific centres working out modern methods of impeller pump design.

Eng. Zdzisław Reymann, M.Sc., spoke on activity of the Institute of Fluid-Flow Machinery of the Polish Academy of Sciences in the field of small hydro power development. The contents of this talk are presented in this issue on pages 149—162.

Eng. Wojciech Myszkowski, M.Sc., characterized a mechano-hydraulic controller of angular velocity of small power generating set developed in the Institute of Fluid-Flow Machinery of the Polish Academy of Sciences in Gdańsk. Particularly, he described the laboratory model RM-01L and the prototype RM-02/40 for Francis turbine of 40 kW power. He also presented the criterion of selection of controller elements and parameters as well as the stability limits and optimum transitional run $\omega(t)$ condition.

The program communications were completed by Eng. Ryszard Mieczkowski, M.Sc., from the Institute of Power Systems Automation. His talk concerned water turbines governors worked out at the Gdańsk Division of the Institute of Power Systems Automation. To begin with he presented the electrohydraulic RTBA governor for Banki-Michell turbines co-working with asynchronous generators. A prototype of this governor has been installed in a small water power plant at Osowo Lęborskie. Next the speaker characterized the model of an electrohydraulic RTBS governor fitted to work with a Banki-Michell turbine equipped with synchronous generators. The figure given below shows its schematic. Among others he pointed out the use of an electrohydraulic converter instead of electrohydraulic servo-valves used in the RTBA regulator for change of the guide ring adjustment.

Afterwards he informed about construction of control units for large power controllers and about production of hydraulic units of automatics started at the Repair Works of the Power Generating Industry in Gdańsk. Discussing the production problems he indicated difficulties with setting new products to practical operation.

Eng. Marian Hoffmann, M.Sc., from the Ministry of Mining and Power Industry supplemented the information about governors pointing to the prototype of an RTFA regulator for Francis turbines driving asynchronous generators that has been worked out at the Institute of Power Systems Automation. He also informed about mechanohydraulic controllers developed at the Research and Development Centre of Chemical Raw Materials Mining CHEMKOP in Kraków, pointing to their suitable functional properties and to their practical use in small water power plants in the South of Poland. Then Eng. M. Hoffmann presented his opinion about proposals of the Department of Fluid Dynamics of the Institute of Fluid-Flow Machinery, Polish Academy of Sciences, on the use of some propeller pumps in hydro power engineering. He based his negative opinion in this point on information obtained from FLYGT firm (Sweden). According to him this firm backed out from plans to adopt pumps for turbine operation. Eng. M. Hoffmann gave also his opinion on siphon turbines. He was critical of turbines with a vertical shaft and those with the runner immersed in head water. He pointed to weaknesses of this solution, preferring the solution with the turbine runner not immersed and situated close to the tail water.

The statement of Eng. M. Hoffmann in the point of use of impeller pumps for small hydro power needs and in the point of siphon turbines caused a rejoinder pointing to existence of other opinions.

Prof. Ryszard Rohatyński from the Technical University of Wrocław dealt with computer aided design of hydraulic machines. To begin with he pointed to unsatisfactory use of computer methods in design practice and to difficulties occurring when working up and adapting computational programs for engineers' needs. He emphasized the fact that introduction of computer methods to practice requires changes both in the designing organization and in the consciousness of design engineers. Pointing to significant weight of calculations in flow machinery design process he expressed an opinion of insufficient reflection of this fact in financial means for development work. In this connection Prof. R. Rohatyński appealed for increase of means for development of computer aided design of machinery.

Eng. Bogdan Sienkiewicz, M.Sc., from the Southern Power Generating District devoted his talk to small hydro power problems discussing them in the context of tasks realized within the Government-Sponsored Program PR-8. First of all he ascertained that the use of propeller and Banki-Michell turbines worked out by now is limited and that these turbines do not provide sufficiently for the small hydro power needs. He presented an opinion that plants with turbines of a few MW power constructed within central plans do not require to be specially provided by the Government-Sponsored Program. The investors will meet themselves the difficulties that might occur. It is different with the so-called small hydro power. Help of the Government-Sponsored Program is necessary here, especially in case of reconstruction of small hydro power plants. This concerns first of all the turbines which should be fitted for existing water plants and foundations. Traditionally designed turbines provided for installment in an open chamber are of particular interest and not tubular turbines which require expensive building work. The Province of Bielsko-Biała may be an example of usefulness of such a procedure. 71 turbines including 34 machines of a standard design are needed in order to set in operation the existing hydro plants in this part of Poland. One has not dealt with the afore mentioned turbines within the PR-8 Program. Their technical documentation and prototypes should be made in the Central Research and Development Program. Kaplan and propeller turbines of 0.5, 0.65 and 0.9 m tip diameter are mainly concerned in this respect.

Next Eng. B. Sienkiewicz discussed economical premises for small hydro power development. He pointed out the lack of sufficient recognition of these affairs within the Government-Sponsored Program PR-8. In his opinion lack of economical arguments makes the reconstruction of inactive water power plants difficult or even impossible.

The Chairman of the meeting explained that also economical problems were dealt with within the Government-Sponsored Program PR-8. He also pointed out that elaborations on economical subjects may be obtained from the Head of the problem 2.5.

Eng. Stanisław Jaźwiński, M.Sc., from the Warsaw Pump Factory talked about deferents of technological progress in pump construction, about possibilities and usefulness of impeller pumps use for turbine operation and about some achievements of factories in designing and production of new products. Speaking about technological progress he pointed to technological obstacles, especially to difficulties with steel castings and with instrumentation which a present productive worker requires. He emphasized also too low participation of conceptional work costs in product costs. Discussing a possibility of use of pump industry products for small hydro power engineering he pointed to propeller turbine 25P21 produced for the shipbuilding industry and fitted for two-way flow. He offered help of the Warsaw Pump Factory in adapting impeller pumps for use in small water power plants. While discussing achievements of the factory he referred to the use of computer methods used for designing the casing and the balancing system of boiler feed pumps. He referred also to the paper of Prof. M. Zarzycki and others where pump constructions developed at the factory were shortly described.

Prof. David Rachman from the University of Strathclyde referred to the talk of Eng. B. Sienkiewicz and informed about the way of reactivating small water power plants in the United States of America. The reconstruction of machine equipment is based there on the old documentation given by the manufacturer of these machines. He proposed to use a similar procedure in Poland. Instead of working out new documentation based on old standards, he proposes to apply to these European firms, which once delivered turbines, for technical documentation. Prof. D. Rachman devoted the second part of his talk to general remarks on a subject of engineers education and co-operation of science with industry. He

presented an opinion that in almost all technical universities too little importance is attached to education of full value design and process engineers. In his opinion too weak connection of science with industry is one of the reasons of such state. Lack of this connection causes mutual distrust and lack of understanding and decrease of the number of engineers with skills required for responsible work. Great Britain and the United States may be an example. In USA only some of engineers, doctors and professors (about 40 000 persons) are entitled to carry out responsible work in the State Sector. He finished his talk with a proposal on co-operation of science and industry and with a statement that both of them are responsible for this co-operation.

Eng. M. Hoffmann, presented his opinion about some problems discussed by Eng. B. Sienkiewicz. To begin with he stated that building or reconstruction of small water power plants runs properly if permitting circumstances have been created by authorities, engineering associations and power industry. The Province of Olsztyn may be an example; an investor of a small power plant is supported there and gets means for reconstruction of a swelling stage. Speaking about profitability of laying out means for small power engineering, he pointed to usefulness of an economical conduct, that is charging small firms with tasks and active participation of the investor in some assembly and building work. Referring to the talk of Eng. B. Sienkiewicz he informed that within the Government-Sponsored Program PR-8 work intending to determine the extra-power generation economical effect resulting from building or reconstruction of swelling stages is approaching completion. He also informed that a recommendation of the Minister of Mining and Power Generating Industry and of the Minister of Environmental Protection and Water Resources directed to provincial administration how to utilize funds of water economics for reconstruction of swelling stages is being prepared.

The last talk, of Prof. Kazimierz Steller, was — first of all — information about the assumptions of the Central Research and Development Program concerning the hydro power engineering problems (direction 5.1.7). To begin with he mentioned that the choice of practical application and cognitive aims, was determined by demand, proposals made by different institutions and economic units and by conclusions from past work within the Government-Sponsored Program PR-8 "Complex Development of Power Engineering". In the last case usefulness of continuation or finishing the initiated work was taken into consideration. Next he discussed shortly the proposed realization aims, viz.:

- working out and practical application of basic and auxiliary equipment for small water plants (turbines, generators, governors, automatic systems and others),
- working out and practical application of auxiliary equipment for large power plants, especially pumped-storage water power plants (control systems and governors, slowing down and starting systems, special automatic systems),
- technical improvement of water power plants operation increasing their reliability and operation efficiency, improvement of machines repair and optimum utilization of water power plants in the electric power system,
- working out and practical application of a system of computer-aided design and analysis of water turbines and reversible machines design,
- developing assumptions and techno-economic analysis for taking decisions in a question of hydro power development on different levels: from the Government to the Investor,
- examining the usefulness of power utilization of the Lower Vistula in new economic circumstances.

To end with prof. K. Steller conveyed a short piece of information about the Central Program of Basic Research "Selected Cognitive Problems of Power Engineering" for 1986-1990. He limited his presentation to indicating the groups of research tasks within Direction 3: "Processes of Energy Conversion in Flows" (for co-ordination by the Institute of Fluid-Flow Machinery of the Polish Academy of Sciences in Gdańsk) and to giving a short characteristics of the task which might arise an interest of the audience, that is

- Selected Flow Problems in Machinery Design,
- Investigation of Steady and Unsteady Flow in Hydraulic Machinery and Equipment,
- Investigation of Cavitating Flows.

*Worked out based on a magnetic tape record by
Marek Targan and Kazimierz Steller*