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Research of Working Process of Combined Centrifugal-Centripetal Stage by Numeral and Physical Experiments

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Abstract

The example of performance of numerical and physical experiment by definition of power parameters of the combined centrifugal-centripetal stage and its separately centripetal part is considered in the work.

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Keywords: Combined stage; physical experiment; numeral simulation; power parameters.

Increase of energy output of serial intermediate stage of CNS type pump, without change of its assembly-overall dimensions, gives chance to improve mass-overall factors of the pump in a whole.

Organization of combined process of energy transfer, namely, centrifugal-centripetal, in multistage pump design, is fundamentally new way of the given problem solution. This way provides installation of additional executive element - centripetal blade lattice and besides guide and outlet blades in centrifugal pump stage design.

Design and numerical analysis of performance characteristic of experimental model of centripetal pump stage gave chance to define the majority of geometrical parameters of centripetal blade lattice, and besides guide and outlet blades [1,2,3,4,5].

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Development of centripetal pump stage with maximum possible value of head and energy efficiency was the main objective of researches carrying out. Thus, flow modeling within flow part of centripetal stage was separately carried out for its elements.

At the present stage of the research numerical experiment was carried out to define energy parameters of centripetal pump stage for rated mode with feed - 180 m³/h and rotation speed of impeller - 3000 rev/min.

Technique and order of experiment carrying out did not differ from those described in paper [1].

Computational grid was developed in the component of program complex ANSYS of the university version and totaled 1701884 prismatic cells. Grid density was increased near rigid walls for appropriate description of boundary layer.

The size of variable Y was from 10 to 100 units that meet the requirements presented in the user's guide [6].
According to the calculation results the main energy parameters of centripetal pump stage were defined. So for feed of 180 m³/h for rotation speed of 3000 rev/min the stage develops head of 42.8 m and consumes power of 54.3 kW. Thus efficiency makes up 0.39.

On the basis of serial ЦЦС 180-1900 pump intermediate stage, and investigated, by numerical experiment, centripetal, combined centrifugal-centripetal impeller and besides guide and outlet vanes were created.
Physical experiment for definition of energy parameters of serial ЦНС 180-1900 pump intermediate stage, and besides combined centrifugal-centripetal pump stage was carried out at the Department of Applied Hydroaeromechanics of SumSU.

Section of executive part of the experimental stand for serial and combined stages test is presented in Figures 5 and 6 correspondingly.

![Fig. 5. Section of executive part of the stand with serial intermediate stage](image)

![Fig. 6. Section of executive part of the with combined stage](image)

The scheme of pressure tap \( p_1 \) and \( p_2 \) for definition of stages head characteristic is represented in Figures 5 and 6, thus feed was defined with the help flow-measuring meter and differential manometer. Power consumed by the stage was defined by the scheme of motor balance. Tests were carried out for rotation speed of drive motor of 1500 rev/min. According to the test results recalculation of performance characteristic of stages for rotation speed of 3000 rev/min was carried out.

Comparative characteristics of serial ЦНС 180-1900 pump intermediate stage and developed on its base combined centrifugal-centripetal one are presented in Figures 7,8,9.
Fig. 7. Comparison of head characteristics of serial - 1 and combined - 2 stages

Fig. 8. Comparison of power characteristics of serial - 1, and combined - 2 stages
By analyzing combined stage characteristic is possible to define separately parameters of its centripetal part. So according to the carried out tests results, centripetal pump stage as a part of combined stage for 180 m³/h mode creates additional head of 27.5 m and consumes power of 55 kW. Thus efficiency makes up 0.25.

Significant divergences in head definition for centripetal stage by numerical and physical experiments, are caused, first of all, by usage of the simplified scheme of numerical modelling carrying out. So, for example, volume losses in centripetal stage are not considered when carrying out of numerical experiment.

According to the program of the further research of performance characteristic of combined centrifugal-centripetal stage, development of work technique of carrying out of advanced numerical experiment is planned. Taking to the account of design features of combined stage when carrying out of numerical modelling gives a chance to achieve more exact results of its energy parameters definition. It will allow to create technique of designing of combined centrifugal-centripetal stage for different parameters, avoiding obligatory carrying out of physical experiment, which is expensive enough.

References