Discussion

W. J. Rheingans.[7] Cavitation is one of the most serious of the problems confronting designers of hydraulic equipment. Therefore any research work which tends to add to the general knowledge of the phenomena is extremely valuable and is welcomed by such designers.

The author apparently has developed an ingenious method for testing not only the cavitation characteristics but also for determining the lift and drag of various hydrofoils. The application of movable downstream walls seems to have solved the errors in unguided flow after passing through the blade section in cascade.

Although this method of checking airfoils apparently will give a great deal of information regarding their performance, the final criterion will be their operation when applied to ship propellers, pumps, or turbines.

If a definite correlation can be established between the data obtained in the test tunnel, and the performance of model or prototype runners, the test tunnel work should prove to be of great value in improving the design of hydraulic axial-flow equipment.

The data presented in the paper show that it requires a large number of tests and a tremendous amount of work to thoroughly explore each hydrofoil. However, it is hoped that the author can continue this type of investigation because of its possible effect on the improvement of future designs.

Author's Closure

The author wishes to express his appreciation of and present his answer to the understanding discussion given by Mr. W. J. Rheingans. The references at the end are being dealt with by the author at the moment, the first two of which already have been published. The remainder are now in press for the Reports of the Institute of High Speed Mechanics (vol. 3).

The author answered questions that came up during the discussion. These answers were based on the communication from Prof. R. T. Knapp,[8] who presented the paper in the absence of the author:

1 The cavitation is controlled by regulating the velocity of water flow, which is accomplished by varying the revolutions of the axial-flow pump (F in Fig. 2). The electric motor for driving the pump is of the shunt-commutator type, so that its speed can be varied and maintained as accurately constant as a d-c motor in the range of 238–684 rpm.

2 Practice concerning the air content of the water in the system is as follows:

The air content of water is almost the same as that of natural water,[9] namely, the degree of saturation is almost that of saturated solution as shown in Figs. 14 to 16, where a is the air content of the water used, a_s is the air content of air-saturated water at the water temperature. The measurement of air content in our experiment is made before and after each cavitation test by the method published previously.[10]

3 Lift and drag are measured only on the center profile. The type of balance is similar to the balance in St. Cyr.[11] It is hoped another opportunity will be offered to report on the details of the balance.

4 In answer to a question concerning the effect of the tunnel-wall boundary layer upon the performance of the cascade, the following is offered:

The boundary layer growing in the tunnel wall is controlled to be as thin as possible at the measuring section by the large two-stage contraction of flow resulting from the nozzles (nozzle D and that before F); i.e., the cross section of the canal is so contracted as to diminish from 1000×700 mm² to 600×160 mm² and further to 260×100 mm² in 1820 mm of the canal length, so that the velocity distribution becomes quite flat, as was stated in the section Velocity Distribution. The experiment of varying the thickness of boundary layer has not yet been conducted.

REFERENCES

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2 "Same Title (2nd Report)," by F. Numachi and S. Abe, Rep. I.H.S.M., Tōhoku University, Sendai, Japan, vol. 2, 1952, p. 21.

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4 "Same Title (4th Report), Tests on Three Cascade Profiles of Type 3 With Thickness Ratio of 8 Per Cent," by F. Numachi, S. Abe, and I. Chida, Rep. I.H.S.M., Tōhoku University, Sendai, Japan, vol. 3, 1953, No. 29.

[7] Manager, Hydraulics Section, Power Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

[8] Professor of Hydraulic Engineering, Hydrodynamics Laboratory, California Institute of Technology, Pasadena, Calif. Mem. ASME.

[9] "Über die Kavitationsentstehung mit besonderem Bezug auf den Luftgehalt des Wassers," by F. Numachi, *Ingenieur-Archiv*, vol. 7, 1936, p. 400.

[10] Ibid., p. 396.

[11] This can be found in "Handbuch der Experimentalphysik," by Wien-Harms, vol. 4, sect. 2, fig. 30, p. 160.