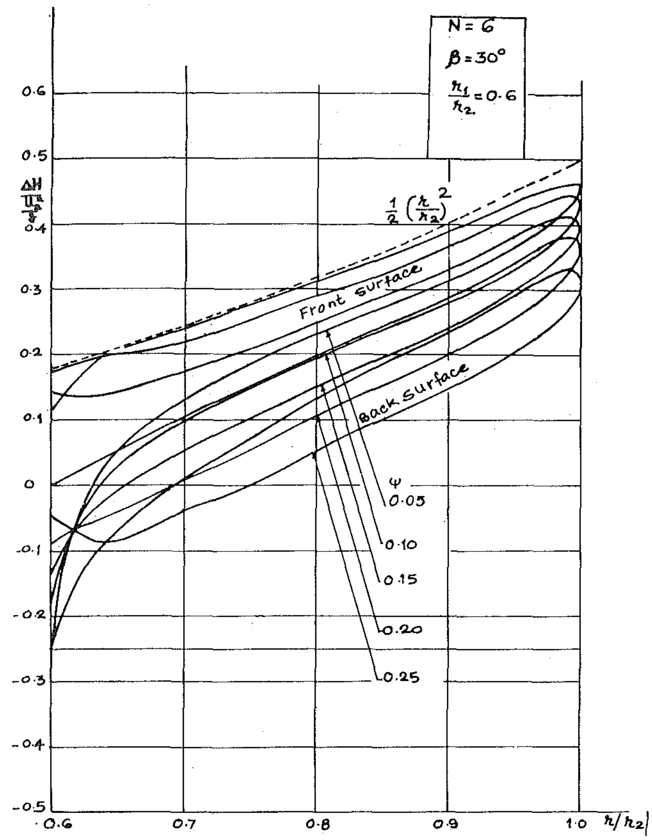

Fig. 9 The pressure distributions along the vane surface of the impeller with 6 vanes

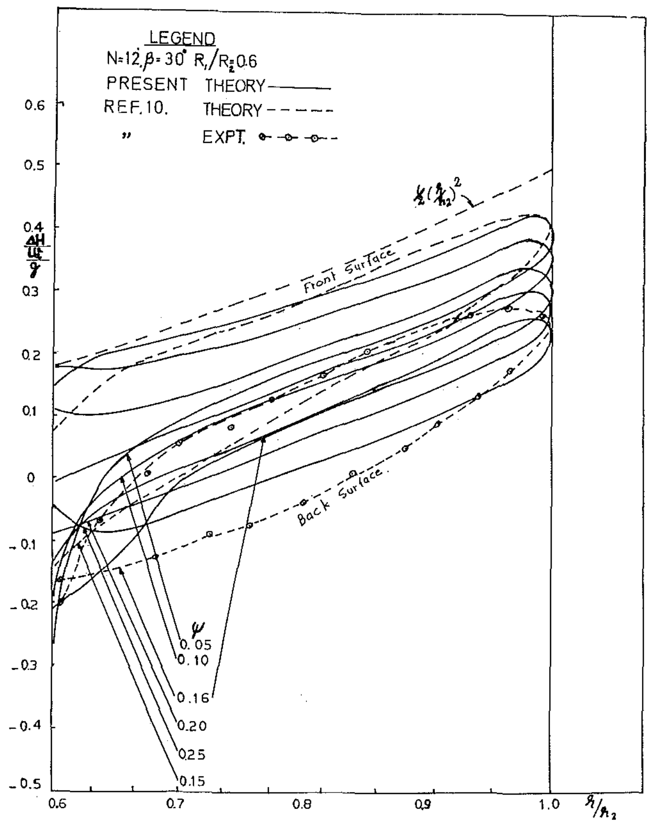

Fig. 10 Theoretical and experimental pressure distribution along the vane surface of impeller with 12 vanes

References

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DISCUSSION

S. Yedidiah[2]

While the paper is very interesting and informative, there seems to be missing a certain link between theory and practice.

From Figs. 7 and 8 of the paper it follows that the difference of pressure on both sides of the vanes *increases* with a reduction in flow rate. This is in complete contrast with the experimental findings presented by Acosta and Bowerman in reference [5]. Included in this discussion is a copy of Fig. 15 from that paper. We see here clearly that the pressure on both sides of the vanes *decreases* with a reduction in flow rate.

The experimental results presented by Acosta and Bowerman have also a theoretical justification.

If we consider the blades as a means to transfer energy [12, 13][3], we arrive at the following conclusion:

$$Pd = \rho \frac{Q}{ZB} \left(\frac{dCu}{dr} + \frac{Cu}{r} \right) \tag{35}$$

Where Pd = difference of pressure on both sides of the vanes

Z = number of vanes

B = width of vanes

Cu = velocity of whirl

ρ = density of liquid

It has been shown in reference [12] that, except for the non-overlapping portions of the vanes, the value of Cu can be expressed by

$$Cu = U - Cm \cot \beta \tag{36}$$

where Cm is the meridional velocity of the liquid.

In an impeller of constant width

$$Cm = \frac{K}{r} \tag{37}$$

[2] Worthington Pump International, Planning Division, Mountainside, N. J. Mem. ASME.

[3] Number [12, 13] in brackets designate Additional References at end of discussion.

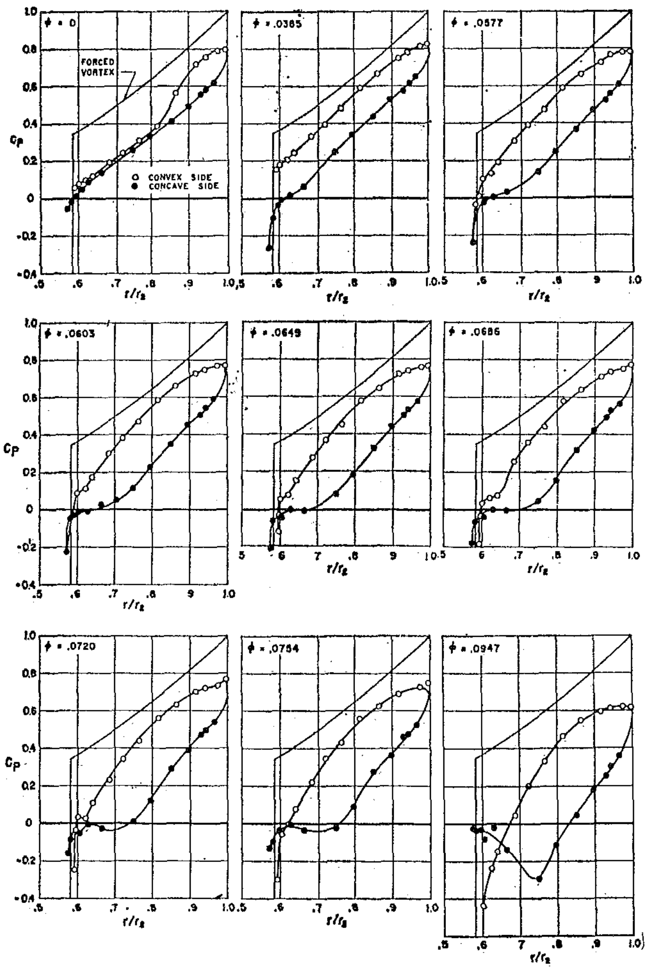

Fig. 15 Static-pressure distribution on vanes of 12.5-dig impeller for several flow rates

where K is a constant. In an impeller with log-spiral blades cot β is also constant.

Hence, for an impeller with log-spiral vanes of constant width, equation (36) becomes

$$Cu = \omega r - \frac{M}{r} \tag{38}$$

where M is a constant. Substituting this value of Cu in equation (35) we get

$$Pd = 2\omega\rho \frac{Q}{ZB} \tag{39}$$

Equation (39) shows clearly that the difference of pressure *decreases* with the reduction in flow rate in complete agreement with the test results presented in reference [5].

Additional References

12 Yedidiah, S., "Energy Transfer in Centrifugal Pumps," ASME Paper No. 67-FE-22.

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Authors' Closure

We thank Mr. Yedidiah for his interest in the paper. Pressure difference equation (39) given by Yedidiah is correct and hence his conclusion that difference of pressure decreases with the reduction in flow rate. However his statement in his first paragraph that "Pressure on both sides of the vanes decreases with a reduction in flow rate," is not correct. In fact the pressure on both sides of the vane increases with reduction in flow rate (see Fig. 15 of reference [5]). It is the pressure difference between the front and back surface of the vane which decreases with a reduction in flow rate. Figs. 7 and 8 in our paper represent the dimensionless velocity distribution on the front and back surface of the impeller vane and not difference of pressure as mentioned by Yedidiah. From equation (33), it is clear that increase in velocity results in decrease in the pressure at any point on the blade. In other words decrease in velocity (or flow coefficient) results in increase in the pressure on both sides of the impeller vane which is shown in Figs. 9 and 10. This is in very good agreement with the experimental results of Acosta and Bowerman [5] as quoted in Fig. 15. The decrease in the differential pressure between the front and back surface of the vane with a reduction in flow coefficient is a function of the surface roughness of the impeller apart from other variables. The values plotted by us in Figs. 9 and 10 are for an ideal fluid and the results given in Fig. 15 are for a real case and hence the degree of variation of the differential pressure in the two cases. Nevertheless the trend still exists.