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# Improving Impeller and Water Flow Section of Vane Pumps

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# Abstract

As a result of the research, it was found out that the blades of the working impellers of the pumps are eroded at the inlet and outlet. On the basis of software studies, the points of erosion caused by cavitation and sand particles at the entrance of the impeller and the points of operation of the impeller under heavy load have been determined. The operating points under heavy load are compared with working impellers in nature, and after comparison with software developments, it is determined that they are compatible with working impellers in natural conditions. To reduce cavitation and erosion processes in the impeller, the following impeller model is recommended (Figures. 6, 10.). The recommended impeller is shown in the inlet of the impeller to free water entry, prevent water shortage and reduce the level of cavitation. (Figures 6, 10, 11). The ingress of water into the impeller is freed and the continuous movement of water is restored, and the methods of preventing the processes of decay and holes formed in the impeller are given. Recommended methods of significantly reducing the level of wear in the input and output parts of the impeller are given.

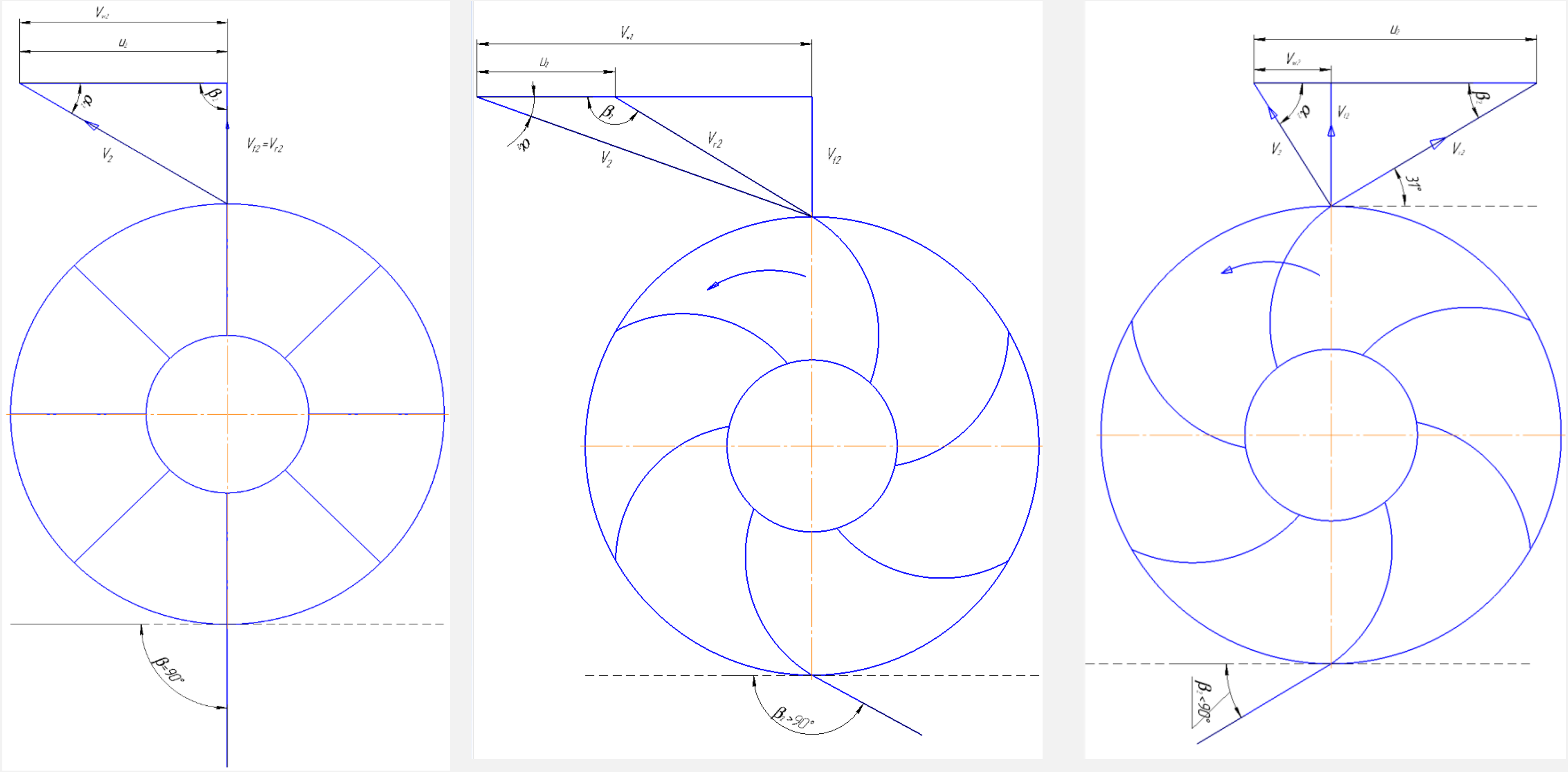
# INTRODUCTION

- Republic of Uzbekistan has 4.3 million irrigated areas, 1,683 pumping stations and devices provide water for 53% of cultivated areas. In addition, more than 8,047 small pumping stations and devices are used to supply water to another 25% of agricultural land where water consumer associations and farms operate. Out of the 11.0 billion kWh of electricity consumed on average per year in agriculture, 8.2 billion kWh is consumed by pumping stations, or 75% of the annual budget for the operation of the water management complex is spent on the operation of state pumping stations. In the course of the conducted research, it became known that there are different types of impellers, and it was determined that there are open, closed and semi-open impellers.

# MATERIALS AND METHODS

In order to comprehensively assess the effectiveness of irrigation pumps, the cases of pump failure as a result of mechanical impact when changing the hydraulic properties of the water intake facility are analyzed. On the basis of software drawings, the continuous movement of the flow in the pump was analyzed. Based on statistical processing of the received data, the initial version of the pump was prepared according to the optimal parameters, and the results of the experiments showed that the cavitation reduction can be reduced and the impellers of the pumps can be used without damage for a long time. [14,15]. Due to the fact that turbidity destroys all its parts when it passes through the pump together with water, the characteristics of the pumps change, water consumption and efficiency decrease.

# RESULTS AND DISCUSSION



a) b) c)

**FIGURE 2**. Impeller speed triangles

*a- radial curved blades i.e. impeller blades are straight*

*b- forward curved, i.e. turned in the direction of flow*

*c- a backward curved, i.e. an impeller blade turned against the flow direction*

# RESULTS AND DISCUSSION


stainless steel

In order to overcome the distortions in Figure 6, the imperfections in the impeller were studied. As a result of studies, it was found that there is an obstacle to the required water at the inlet of the impeller, that is, the required water does not reach the flow section.

**FIGURE 5.** Cavitation perforation of D-type pump impellers at the pump station of “Narpay”

# RESULTS AND DISCUSSION

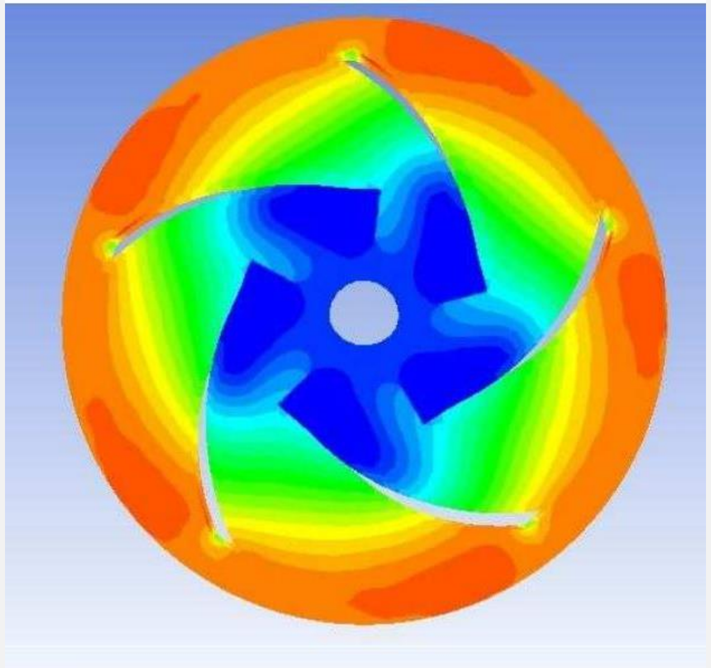


**FIGURE 7.** High pressure points in the exit zone of the impeller

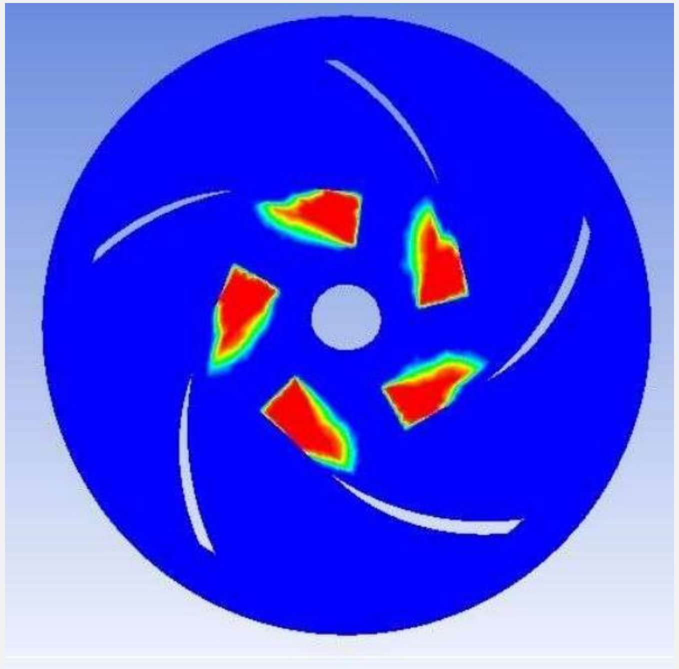


**FIGURE 8.** High pressure points at the inlet to the impeller

When impellers were analyzed based on field observations and software calculations, it was found that under the main load, erosion occurs in the inlet and outlet sections of the working parts. Based on software calculations, the parts working under heavy load were determined and it was determined that the load depends on the input and output angular velocities(Figures 7,8). To reduce these loads, the option of cutting the impeller and designing the inlet and outlet angles to match the pump flow part was recommended (Figures 9, 10, 11).

# RESULTS AND DISCUSSION

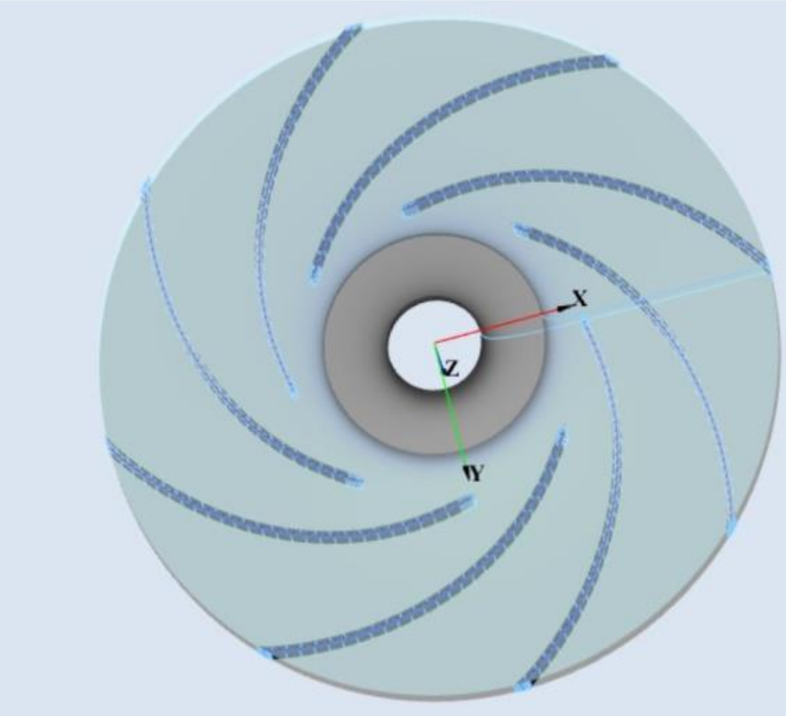



**FIGURE 9.** 8-blade impeller drawn by software

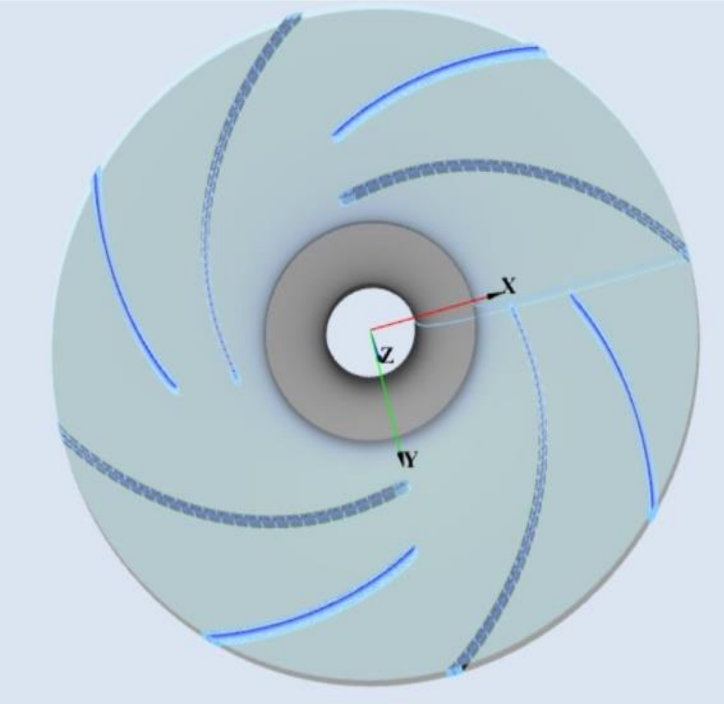



**FIGURE 10.** As a result of my software research, the version of the 8-bladed impeller blades with the water inlet cut in the odd places

In order to overcome the distortions in Figure 6, the imperfections in the impeller were studied. As a result of studies, it was found that there is an obstacle to the required water at the inlet of the impeller, that is, the required water does not reach the flow section. After that, a new view of the impeller was prepared on the basis of software calculations. In this case, the entrance parts of the impeller blades located in odd places were cut by 12% and the dynamics of the water was restored(Figures 6, 10).

# RESULTS AND DISCUSSION

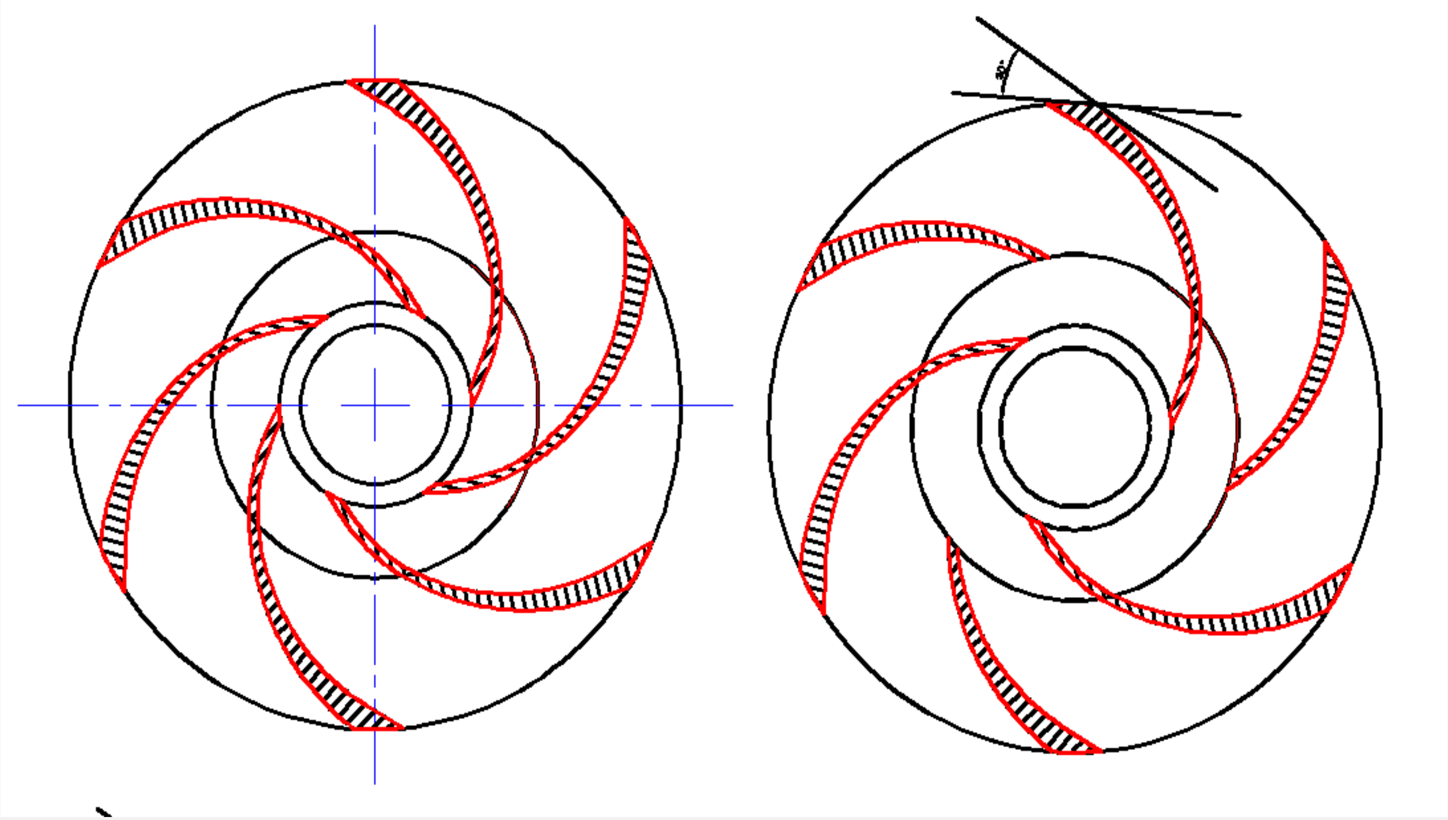


**FIGURE 6.** Uncut and cut views of the impeller

As a result, the cavitation phenomenon, vibration and noisy operation of the pump have been significantly reduced. Water consumption increased and pump capacity decreased by 4%. In the backward curved blades, i.e. the blades are bent against the direction of flow, the angle is $\beta_2 < 90^0$ small, $ctg\beta_2$ positive, and therefore the pressure decreases at the outlet, $V_{w2}$ is minimized

# RESULTS AND DISCUSSION

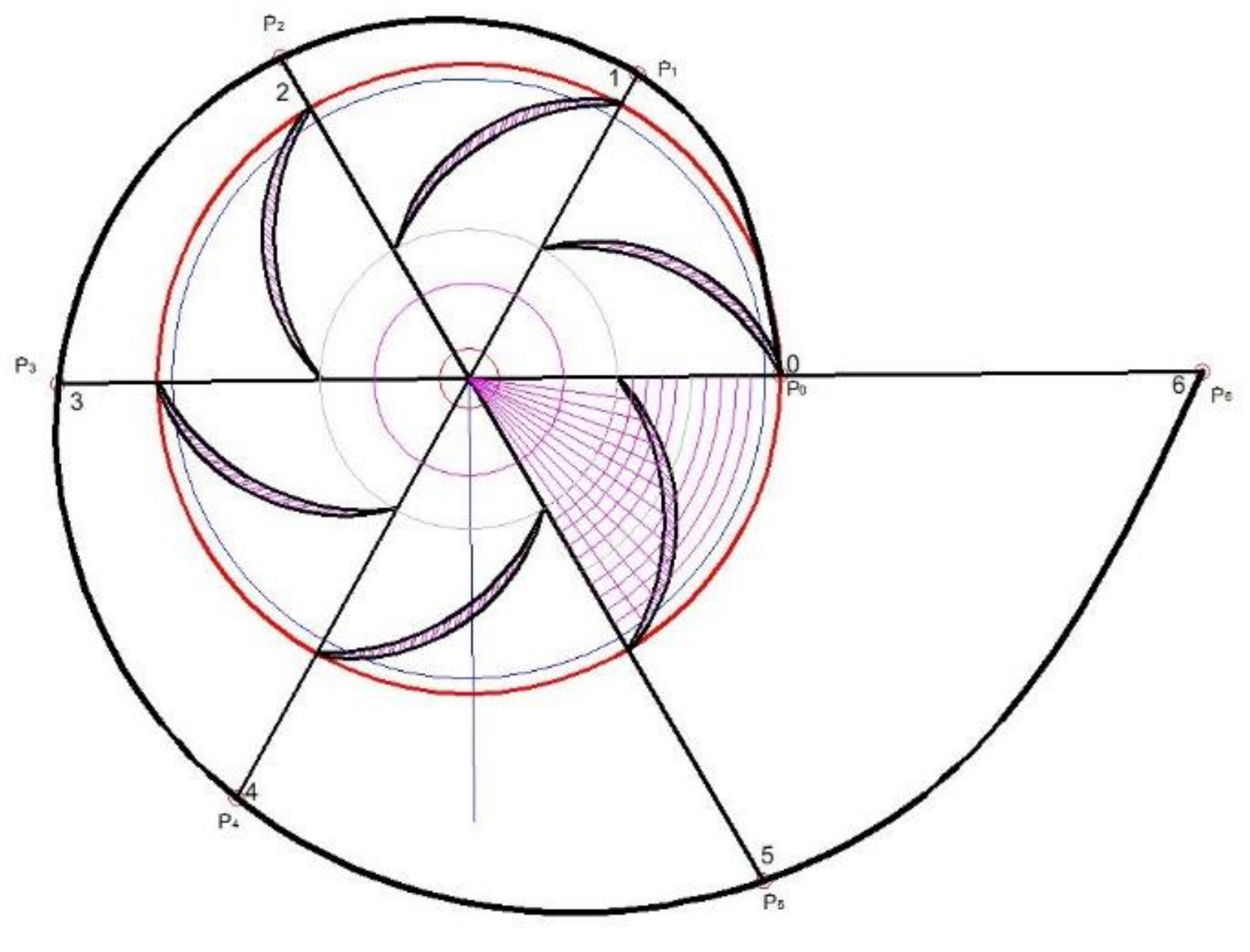



**FIGURE 11**. Redesign of the pump flow part in proportion to the impeller

On the basis of direct field research and questionnaires, analytical studies, systematic analysis and measurement work carried out in repair shops of impellers of pumps, it became clear that the causes of high pressure in the inlet part of the impeller are the non-dynamic centrifugal force in the impeller, i.e. the violation of water continuity in the flow part, which causes these problems. it was found that the reasons for the exit were not taken into account in the design of the impeller and shell. To eliminate this disproportion, the pump impeller was redrawn to match the flow part (Fig. 11).

# RESULTS AND DISCUSSION

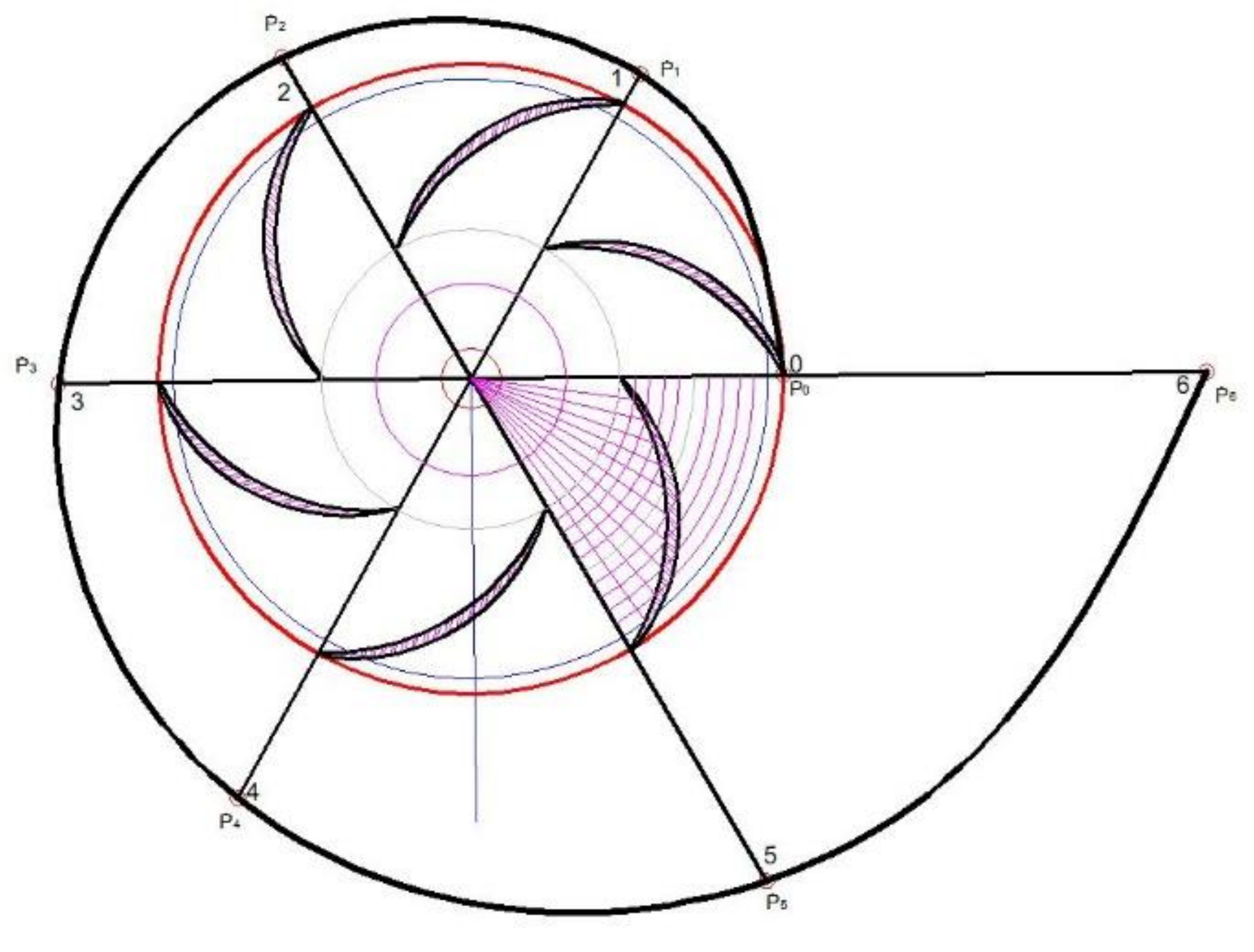



**FIGURE 11**. Redesign of the pump flow part in proportion to the impeller

In this case, the main focus was on adjusting the pump vanes to the diameter of the impeller, the number of vanes was selected based on the diameter of the vane, a cylindrical vane was created, and the pump was designed by dividing each vane into a separate section in the flow section. As a result, flow continuity in the pump was ensured, FIK was increased by 4% (Fig. 11). On the basis of my analysis, it was clear that back-bent blades, i.e. blades turned against the direction of flow, are preferred because of the highest FIK potential energy and the formation of cavitation is much lower. In earlier designed pumps, it was found that the flow section did not match the number of blades when divided into sections. As a result, water shortage occurred, cavitation phenomenon was observed, and the pumps worked with malfunctions (Fig. 5).

# CONCLUSIONS

1. As a result of the research, it was found that the impellers of the pumps are eroded at the entrance and the exit of the blades.
2. As a result of the analysis, it became clear that the aggregates of the “Narpay” pumping station are mainly caused by turbidity in the size range of 0.5-0.01 mm.
3. On the basis of software studies, the wear of the impeller due to cavitation and sand particles at the entrance and the operating points of the impeller under heavy load were determined.
4. The determined heavy-duty operating points were compared with the operating impellers in nature.
5. After comparing the results of the comparisons with the software developments, it was determined that they correspond to impellers in natural conditions.
6. To reduce cavitation and erosion processes in the impeller, the following models of the impeller and pump flow part were recommended (Figs. 6, 10, 11).
7. Through the recommended impeller, water ingress at the inlet of the impeller is freed and water shortage is prevented, the cavitation level is reduced by 7% (Fig. 6).
8. Water access to the impeller is freed and continuous movement of water occurs.
9. The wear at the inlet and outlet of the recommended impeller is significantly reduced.

# REFERENCES


1. O. Ya. Glovatsky, R. R. Ergashev, A. A. Abdullaev, J. I. R. Results of software modeling of the vane pump flow section. Irrigation. and Reclamation 4, 28–33 (2021).
2. Lennemann E. Flows in a blade impeller pumps, Trans. ASME J. of Engineering for Power, – Canada (2001).
3. T. Majidov, J. Rashidov. Consideration of local conditions in the selection of melioration pumps // "Uzbekistan agriculture and water management" magazine. - Tashkent, - Special issue. - B. 30-32. (2019)
4. T.Sh. Majidov, M.S. Berdiev, J.I. Rashidov Effects of abrasive sands on pump working parts and their analysis., pp. -389-392. (2013)
5. Sh.R. Rustamov J.I. Rashidov. Research of impellers of centrifugal pumps // "Agro ilm" magazine. - Tashkent,. - No. 5[68]. - B. 65-67. (2020)
6. Rustamov Sh.R., Doctor of Philosophy (PhD) Dissertation Abstract in Engineering Sciences of Hydrotechnics and Reclamation Construction. 1–4, Tashkent, (2018).

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# Questions?

## Thank you for your attention!

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