



METHODS FOR IMPROVING THE PERFORMANCE OF CENTRIFUGAL PUMPS AND MEASURES FOR THEIR MODERNIZATION

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Abstract

This article analyzes methods for improving the performance of centrifugal pumps and measures for their enhancement. The main issues arising during pump operation, including abrasive wear, erosion, hydraulic losses, and structural deficiencies, are examined. In addition, possibilities for increasing pump efficiency are studied, such as improving impeller design, using wear-resistant materials, optimizing hydrodynamic processes, and implementing vibration monitoring and diagnostic systems. The results of this study contribute to improving the reliability and energy efficiency of centrifugal pumps.

Keywords: Centrifugal pump, impeller, abrasive wear, erosion, vibration, hydraulic efficiency, pump diagnostics.

Introduction

In industrial enterprises, especially in the oil and gas sector, pumps are important technological devices used for transporting fluids from one point to another. The efficient operation of pumps ensures the stability of production processes and



energy efficiency. Therefore, improving the performance of pumps is considered one of the important scientific and technical issues.

Pump performance refers to the ability of a pump to operate stably under specified technological conditions over a long period of time, to provide the required pressure and flow rate, and to maintain energy efficiency. Several key indicators are used to evaluate pump performance.

The main operating parameters of pumps include pump capacity (flow rate), pressure generation capability, efficiency coefficient, energy consumption, service life, and reliability level.

The main hydraulic characteristics of a pump are determined through its performance curve. The pump characteristic represents the relationship between flow rate, head (pressure), and efficiency.

Main Problems Occurring in Pumps

During pump operation, various mechanical and hydraulic problems may arise. These issues reduce pump efficiency and shorten its service life.

The main problems encountered in pumps include abrasive wear, erosion processes, cavitation, corrosion, vibration, and hydraulic losses.

Abrasive wear occurs due to the presence of solid particles in the fluid. These particles gradually erode the surfaces of the impeller and pump casing, resulting in reduced pump efficiency.

The erosion process occurs as a result of high-velocity fluid flow. This phenomenon is particularly pronounced when transporting heavy hydrocarbons. Cavitation occurs due to the formation of vapor bubbles inside the fluid. When these bubbles collapse, they generate strong impacts on pump components.

As a result of cavitation:

- the impeller surface is damaged,
- pump vibration increases,
- noise intensifies,
- pump efficiency decreases.

Therefore, in improving the performance of pumps, it is essential to reduce the influence of these negative factors.

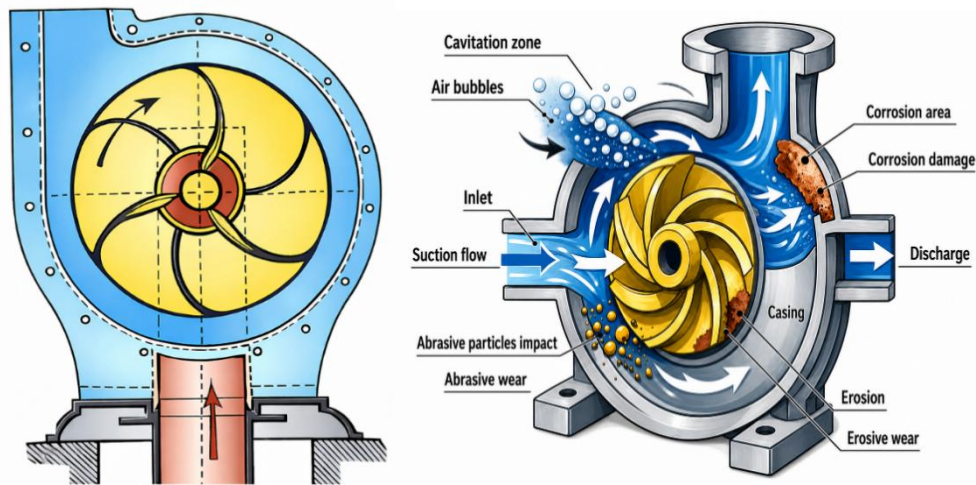


Figure 1. Schematic diagram of the impeller and spiral casing of a centrifugal pump

One of the most important directions for improving the performance of pumps is the enhancement of their design. Modern pump constructions are developed based on an in-depth study of hydrodynamic processes.

The improvement of pump design is carried out in the following directions:

- optimization of the impeller geometry,
- selection of the number and angle of blades,
- improvement of the spiral casing geometry,
- streamlining of the flow direction.

The impeller is considered the main working component of the pump. The geometry of the impeller blades has a significant influence on the direction and behavior of the fluid flow.

Hydrodynamic studies show that blades positioned at an optimal angle can significantly increase pump efficiency.

In addition, a smooth internal surface of the pump casing reduces hydraulic resistance and energy losses.

Abrasive wear and erosion processes are among the most common problems in pumps. These processes lead to rapid deterioration of pump components. The main cause of abrasive wear is the presence of solid particles in the fluid. These particles move at high velocity and continuously impact the internal surfaces of the pump.

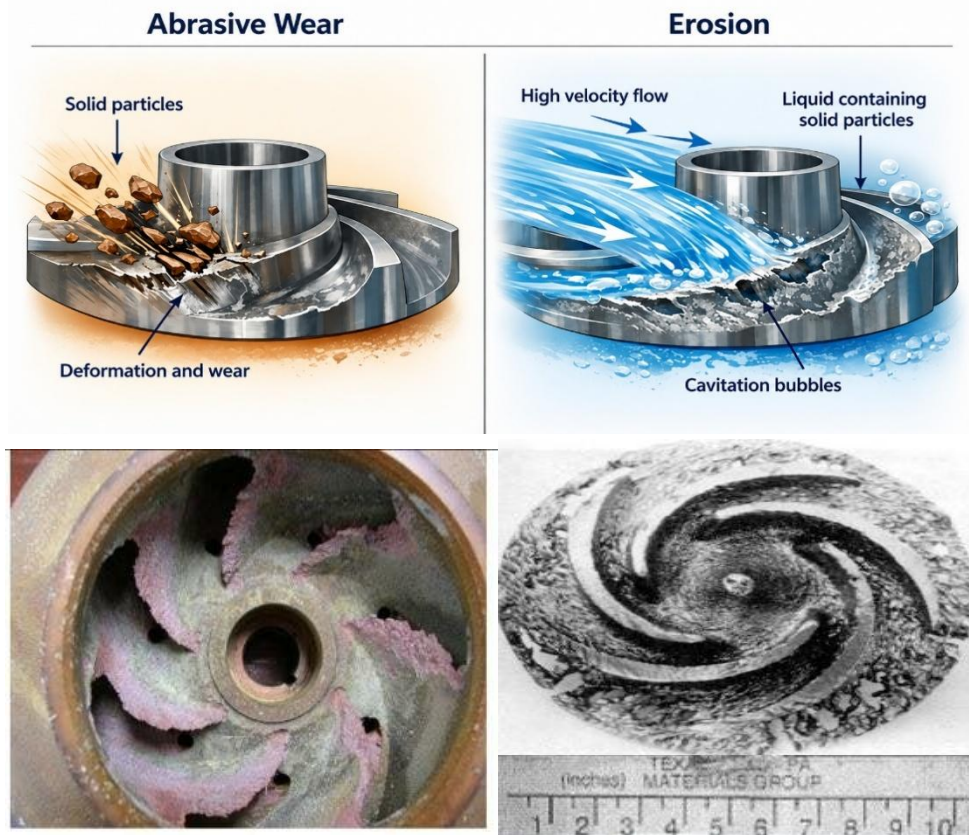


Figure 3. Damage caused by abrasive wear and erosion on the impeller of a pump

The figure illustrates severe wear and erosion marks formed on the impeller of a centrifugal pump due to the influence of abrasive particles. Solid particles contained in the fluid continuously impact the surface of the impeller blades, leading to gradual material degradation. As a result, the geometry of the blades changes, which causes a reduction in the hydraulic efficiency of the pump. Such wear has a negative impact on the service life and reliability of the pump. Therefore, the use of wear-resistant materials is of great importance for pumps operating in abrasive environments.

The following figure presents the distribution of fluid velocity in the channels of a centrifugal pump impeller. The color scale indicates the magnitude of the fluid velocity, where blue represents low velocity, while green and yellow indicate higher velocity regions. The cases (a), (b), (c), and (d) allow comparison of flow behavior under different operating conditions of the pump. Streamlines clearly illustrate hydrodynamic processes between the impeller blades as well as the

formation of vortex zones. Analysis of velocity distribution plays an important role in improving pump hydraulic efficiency and reducing energy losses.

In improving pump performance, reducing hydraulic losses plays a crucial role. Hydraulic losses occur due to resistance along the flow path.

Hydraulic losses are classified into the following types:

- friction losses
- local resistance losses
- turbulence-induced losses

To reduce losses in pump systems, it is necessary to:

- design pipeline systems optimally,
- reduce sharp bends,
- properly select pipe diameter,
- regularly clean filters.

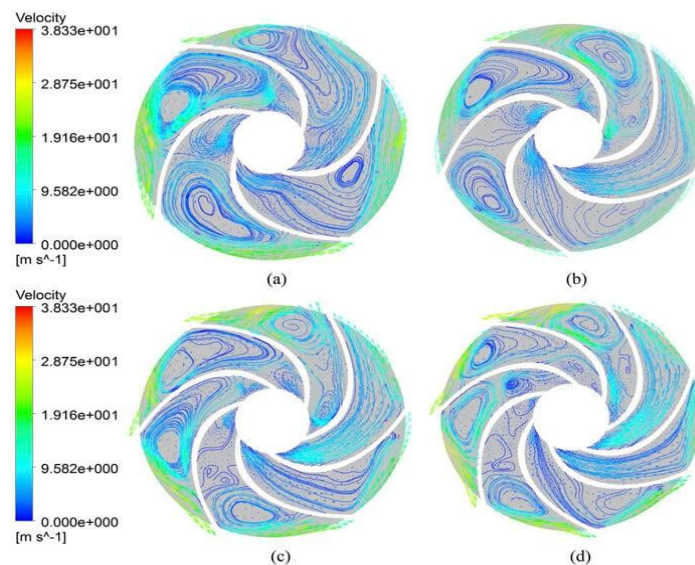


Figure 4. “Velocity distribution field of fluid in the impeller of a centrifugal pump”

Conclusion

Improving the operating efficiency of pumps plays a crucial role in enhancing energy efficiency in industrial enterprises and ensuring the stability of production processes.

Research shows that pump performance can be improved in the following main directions:



- improvement of pump design;
- reduction of abrasive wear and erosion;
- reduction of hydraulic losses;
- implementation of modern monitoring systems.

These measures make it possible to extend the service life of pumps, reduce energy consumption, and improve overall production efficiency.

References

1. Karassik, I. J., et al. *Pump Handbook*, 4th Edition, McGraw-Hill, 2008.
2. API Standard 682 — *Mechanical Seal for Pumps, Third Edition*, American Petroleum Institute, 2014.
3. Stoeckl, M. & Eppinger, R., *Selection of Barrier Fluids for Mechanical Seals*, Journal of Petroleum Engineering, 2018, Vol. 11(3), pp. 45–56.
4. Buronov, F. (2025, July). Kinetics and mechanism of vapor phase vinyl acetate synthesis reaction from ethylene. In AIP Conference Proceedings (Vol. 3304, No. 1, p. 040105). AIP Publishing LLC.
5. Saidov, S., & Buronov, F. (2024). DISTILLATION SYSTEMS. International scientific journal of Biruni, 3(2), 195-201.
6. Buronov, F. E. (2023). KINETICS AND MECHANISM OF THE VAPOR-PHASE SYNTHESIS OF VINYL ACETATE FROM ETHYLENE. *Sanoatda raqamli texnologiyalar / Цифровые технологии в промышленности*, 1(1), 131-138.
7. Karassik I.J., Messina J.P., Cooper P., Heald C.C. *Pump Handbook*. – 4th ed. – New York: McGraw-Hill, 2008.
8. Gülich J.F. *Centrifugal Pumps*. – Berlin: Springer, 2014.
9. Brennen C.E. *Hydrodynamics of Pumps*. – Cambridge University Press, 2011
10. Буронов, Ф. (2021). Винацетат синтезида катализатор самарадорлигининг математик модели. *Збірник наукових праць SCIENTIA*. May, 21, 2021.
11. Буронов, Ф. (2024). To study the operation of the fractionating apparatus in increasing the efficiency of separation of hydrocarbon fractions (Doctoral dissertation, “RESPUBLIKA JANUBIDA GEOLOGIYA, KON-METALLURGIYA VA NEFT-GAZ SOHALARINING ISTIQBOLLARI”).



12. Буронов, Ф. Э., & Курбанов, А. Т. (2017). Математическая модель процесса перемешивания буровых растворов и смесей. In Новые технологии-нефтегазовому региону (pp. 246-248).
13. Buronov, F. (2025, July). Kinetics and mechanism of vapor phase vinyl acetate synthesis reaction from ethylene. In AIP Conference Proceedings (Vol. 3304, No. 1, p. 040105). AIP Publishing LLC.
14. Eshburievich, B. F., Rakhmonovich, Y. T., & Shamsiddin, H. S. (2026). INVESTIGATION OF GAS PURIFICATION PROCESSES FROM H₂S AND CO₂ USING MEA AND DEA AMINES. *Universum: технические науки*, 9(2 (143)), 10-17.
15. Buronov, F., & Fayzullayev, N. (2022, June). Synthesis and application of high silicon zeolites from natural sources. In AIP Conference Proceedings (Vol. 2432, No. 1, p. 050004). AIP Publishing LLC.
16. Ortikov, N., Fayzullaev, N., Hamidov, D., & Buronov, F. (2023). Study of methane carbonate conversion process in fixed catalyst layer in different membrane reactors. In E3S Web of Conferences (Vol. 402, p. 14013). EDP Sciences.
17. Normurot, F., & Firdavsiy, B. (2021). The Effect of Catalytic Activity of Catalyst (Carrier) Nature in the Synthesis of Vinyl Acetate. *International Journal of Human Computing Studies*, 3(10), 16-19.
18. Saidov, S., & Buronov, F. (2024). DISTILLATION SYSTEMS. *International scientific journal of Biruni*, 3(2), 195-201.
19. Буронов, Ф., Рахматов, Х., Юлдашев, Т., & Жураев, Э. (2021). DESCRIPTION OF THE INDUSTRIAL PROCESS ETHYLENE ACETOXYLATION.
20. Buronov, F., & Fayzullaev, N. (2021). ACTIVE CATALYSTS FOR PRODUCING VINYL ACETATE MONOMERS. *Universum: технические науки*, (5-6), 79-81.
21. Дустов, А. Ю., Султонов, Н. Н., & Буронов, Ф. Э. (2020). Расширение шуртанского ГХК с производством дополнительного полиэтилена. *Международный академический вестник*, (3), 96-99.
22. Buronov, F. E. (2018). Abdiraximov IE Prirodnyye bitумы i tyajelyye nefti, problemy ixosvoyeniya. *Fundamentalnyye i prikladnyye issledovaniya: ot teorii*



к практике: материалы II международной научно-практической конференции, приуроченной/Т. 3.

23.Рахматов, Х. Б., Султонов, Н. Н., & Бурунов, Ф. Э. (2018). Исследование процесса конверсии сульфата калия из хлорида калия Тюбегатанского месторождения и мирабилита Гумрукского месторождения. Техника. Технологии. Инженерия, (1), 35-39.

24.Бурунов, Ф. Э., & Курбанов, А. Т. (2017). Применение бипланетарного механизма при депарафинизации нефтей и нефтепродуктов. In Новые технологии-нефтегазовому региону (pp. 42-44).

25.Firdavsiy, B., & Farhod, S. (2021). Mathematical model of the efficiency of the catalyst in the synthesis of vinyl acetate. Universum: технические науки, (5-6 (86)), 82-85.

26.Buronov, F. (2025, July). Kinetics and mechanism of vapor phase vinyl acetate synthesis reaction from ethylene. In AIP Conference Proceedings (Vol. 3304, No. 1, p. 040105). AIP Publishing LLC.