



WORKING PRINCIPLE, OPERATING PRINCIPLE AND INDUSTRIAL APPLICATION OF CENTRIFUGAL PUMPS

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Abstract

Centrifugal pumps are widely used hydraulic machines designed to transport liquids by converting mechanical energy into hydraulic energy. Due to their simple construction, high efficiency, and reliable operation, centrifugal pumps are extensively applied in water supply systems, chemical industries, petroleum refining, agriculture, and power engineering. This article discusses the operating principle, construction, performance characteristics, advantages, disadvantages, and industrial applications of centrifugal pumps. The study also analyzes the factors affecting pump efficiency and operational reliability. The review demonstrates that centrifugal pumps remain one of the most important devices in modern engineering systems because of their adaptability and economic benefits.

Keywords: centrifugal pump, impeller, hydraulic energy, efficiency, fluid transportation, industrial applications.

Introduction

Fluid transportation is an essential process in many industrial and domestic systems. Pumps are mechanical devices used to move liquids from one location to another by increasing pressure and flow energy. Among different types of pumps, centrifugal pumps are the most common because of their compact structure, continuous operation, and high operational efficiency.

The development of centrifugal pumps has significantly improved industrial productivity and water management systems. These pumps are especially important in chemical engineering, oil and gas transportation, irrigation systems, and thermal



power plants. Their ability to operate continuously with relatively low maintenance requirements makes them economically advantageous.

The purpose of this article is to analyze the working principles, constructional features, operational parameters, and industrial significance of centrifugal pumps.

Materials and Methods

The article is based on a literature review of scientific publications, engineering manuals, and industrial reports related to centrifugal pumps. Comparative analysis methods were used to evaluate pump efficiency, operational parameters, and application areas.

The research focused on:

Structural components of centrifugal pumps;

Hydraulic principles of operation;

Efficiency and performance characteristics;

Industrial applications and operational challenges.

Results and Discussion

Operating Principle of Centrifugal Pumps

A centrifugal pump operates by transforming rotational mechanical energy into kinetic and pressure energy of a liquid. The primary working component is the impeller, which rotates inside the pump casing. When the impeller rotates, centrifugal force pushes the liquid outward from the center toward the outer edges of the impeller.

The pressure difference generated between the inlet and outlet causes continuous liquid movement through the system. The kinetic energy of the fluid is converted into pressure energy inside the diffuser or volute casing.

The efficiency of centrifugal pumps depends on several operating parameters such as flow rate, head, rotational speed, and fluid viscosity. Pump performance is usually represented by characteristic curves.

The hydraulic power of the pump can be calculated by:



$$P_h = \rho g Q H$$

where:

- P_h is hydraulic power,

- Q is flow rate,

- H is pump head.

The efficiency of a centrifugal pump is determined using:

$$\eta = \frac{P_h}{P_{input}} \times 100\%$$

High-efficiency pumps reduce energy consumption and operational costs.

Conclusion

Centrifugal pumps are among the most important hydraulic machines used in modern engineering systems. Their operating principle is based on the conversion of mechanical energy into hydraulic energy through centrifugal force. Due to their reliability, high efficiency, and relatively simple construction, centrifugal pumps are widely used in industrial, agricultural, and domestic applications.

The analysis shows that pump efficiency depends on operating conditions, construction design, and fluid properties. Proper maintenance and correct operating conditions are essential for preventing cavitation and extending pump service life. Future developments in pump technology are expected to focus on energy efficiency, automation, and intelligent monitoring systems.

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