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ANALYSIS OF BASIC MECHANISMS AND REASONS OF BREAKDOWN OF COOLING SYSTEMS' PUMPS

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The most popular constructions of cooling system pumps and the main mechanisms and reasons of pumps failures considered.

Keywords: pump, breakdown, cavitation

This study (research grant № 14-05-0038) supported by The National Research University - Higher School of Economics' Academic Fund Program in 2014. Liquid cooling systems are increasingly used in modern radio-electronic equipments. Pumps are the main components of these systems. Two types of pumps are mainly used in liquid cooling systems:

- reciprocating piston pumps
- radial flow pumps.

Reciprocating piston pump (Figure 1) consists of piston, working chamber, admission and discharge valves.

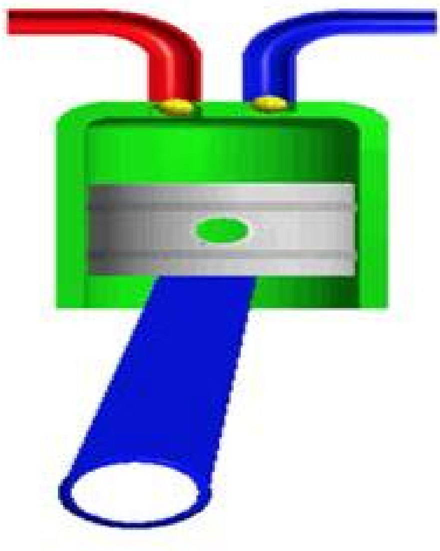

Figure 1 - Reciprocating piston pump

When the piston moves down, low pressure zone is created in the working chamber, admission valve opens and the fluid absorption occurs. When the piston moves upward the overpressure arises and the discharge valve opens, wherein the admission valve is closed. The fluid injection occurs.

Pulsation of pressure, which causes imbalance is the disadvantage of reciprocating piston pump. For all that valve shaft experiences heavy loads because of the irregularity of the torsion torque [1].

The fluid motion and the necessary pressure in radial flow pump (Figure 2) is created by the centrifugal force generated by the impact of blades of the impeller on the liquid. The impeller is fixed on the shaft inside the pump.

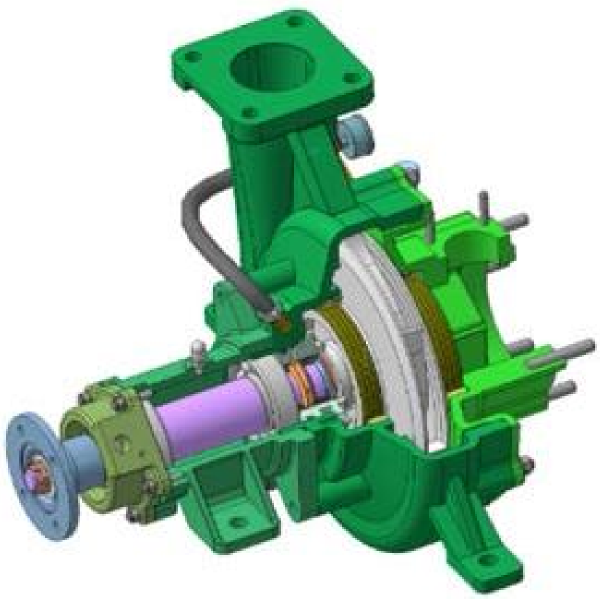

Figure 2 - Radial flow pumps

It has a helical shape and consists of two discs, which are bent in opposite direction of impeller rotation. When pump body is filled with liquid and impeller starts to rotate, the liquid in impeller channel will be shifted from the center. Underpressure arises in the central part. Fluid from inlet will flow into the central part, and fluid at the periphery will flow into the outlet pipeline [1].

Failures of both types of pumps can be classified as sudden and gradual[2-4]. The pump immediately stops working in case of sudden failure. The pump can continue to work in case of gradual failure, but its output pressure is significantly reduced.

For example, sudden failures include the destruction of thrust bearing of wheel of radial flow pump. Bearing damage may occur due to heavy load on the shaft, which may be due to damage, displacement or unbalancing of the shaft. Also these failures can lead to destruction of pump rotor [5].

Gradual failures include decline of the outlet pressure of the pump, which can be caused by the imbalance of pump wheel and cavitation effect during operation. Cavitation is disruption of the continuity of fluid flow due to lower pressure.

A large amount of bubbles, which consist of liquid and gas vapour, exuded from the solution, are generated in cavitation zone. When the pump operates, cavitation zone bubbles combine and form large bubbles, which in liquid form flow into the working zone of pump with high pressure.

The process of instant collapse of bubble is accompanied by water hammering. Cavitation phenomena in a radial flow pump reduce its efficiency, inlet and outlet pressure, lead to vibration and noise during operation. Cavitation in a centrifugal pump depends on the fluid flow rate and feed rate Q.

At the speed rate about 20 m/s the pressure drop in the pump is 0,8-2,5 kg/centimeter. As result the cavitation zone is formed in the pump. Then the feed rate is about $Q = (0{,}8\text{-}Q_{optimum})$ cavitation zone not formed. Then the feed rate is about $Q = (1{,}2\text{-}1{,}25)\cdot Q_{optimum}$ cavitation zone begin to forming. At the feed rate more than $Q = (1{,}40)\cdot Q_{optimum}$ the pump lose about 10 percents of performance [6].

All these factors may contribute to vibration during operation of the pump, which can cause damage of sealing ring and gasket. The damage causes the leak of a liquid. Causes of the leak depend on mode of use, environmental conditions and type of liquid. If the liquid is water, then it will not cause any consequences. If the liquid is Petroleum, Oils and Lubricants (POL), then the leak can lead to fire.

Failures of reciprocating piston pumps are similar to failures of radial flow pumps.

Pump failures can also be results of incorrect assembly of pump and improper maintenance. In case of improper maintenance, gaskets and seals may be installed improperly, that leads to a leak. Improper assembly of the pump can lead to the failure of mechanical components of the pump.

Thus, factors of impact of structural and technological performance, conditions and modes of operation, and also maintenance conditions must be entered into the mathematical model of the failure rate of the pump.

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INTERNAL EARTH STRUCTURE RENEWAL BY MEANS OF CORE IN INCLINED BOREHOLES ANALYSIS.

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In the work minerals distribution three-dimensional model construction methods on the basis of the data about minerals distribution in each point of the set boreholes system and three variables interlineation functions methods are stated. The construction methods of three variables interlineation functions polinomial formulae in the inclined boreholes system, spline-interlineation functions on inclined boreholes system, placed both in the same plane and in an arbitrary way, as well as three variables interlineation functions formulae with the use of global interpolation formulae by Donald Shepard and Oleg N. Lytvyn generalizations are given. The properties of the constructed mathematical models, as well as the prospects of their use for the exploration of mineral resources are explored.

Keywords: mathematical model, interlineation, cores, inclined boreholes.

Introduction

Directional drilling is gradually becoming the main type of drilling both overland and at sea with the penetration of boreholes from stationary platforms. At the same time there is a tendency to the increase of requirements to accuracy of bottom boreholes hitting in the given point and on the compliance of project profile boreholes drillings. Therefore, it is necessary to ensure an effective control of the boreholes spatial position [1].

Mineral exploration is a well-known method, which is based on the analysis of the boreholes cores content, drilled in different points of the regions surface. In the works [2-5] the general method of constructing the spatial mathematical models of minerals distribution on the basis of the vertical boreholes cores content data and interlineation functions of three variables $f(x,y,z)$ - the distribution of minerals in each point (x,y,z) - is proposed and studied. In these works the assumption that all the boreholes are vertical is essentially used.

It should be noted that the research methodology of mineral resources and the adoption of the appropriate recommendations on the basis of cores drilling data are studied in details in O. N. Lytvyn , N. I. Shtepa , O. O. Lytvyn's monograph [7] (see bibliography to it). But the cases of the data use of mathematical modeling from the inclined boreholes cores were not studied in the monograph and relevant sources. In this work we believe that the information on the distribution of mineral resources is set on a system of both vertical and inclined special geometric shape boreholes.