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STUDY OF PUMPING UNIT OPERATING PARAMETERS IN ORDER TO REDUCE ENERGY COSTS UNDER OPERATING CONDITIONS

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ABSTRACT

The overall energy consumption depends to a large extent on the pumping equipment. The efficiency of a pumping station is often lower than the efficiency of the individual pumps installed in it. The reason for the low energy efficiency lies in the mismatch between the operating characteristics of the equipment as well as its improper management. To improve the efficiency of pumping plants it is necessary to reduce the cost of operating the pumping equipment, increase its reliability and longevity, this requires the correct selection of the operating modes of the plant and the parameters of the external network.

Optimization of the operating modes of pumping units is possible through real measurements of the operating parameters of specific brands with the use of control and measuring equipment directly at the sites during operation.

In the article the results of research of mode parameters of pumping installations and results of experimental works on determination of optimum operating modes of centrifugal pump of WCP 25-60G brand are given.

KEYWORDS

Centrifugal pumps, economical operation, energy efficiency improvement, optimal operation mode of pumping equipment, head and delivery, pressure and flow characteristics of the pump, pressure and flow rate of liquid.

Introduction

Centrifugal pumps are powerful energy-consuming machines and therefore their efficient economic operation is a very important task. The economical operation of pumping equipment is determined by the efficiency value during operation. It is therefore necessary to analyse the actual pressure and energy characteristics of pumps during operation and develop measures to improve them. [1]

One of the most effective ways to increase availability and save energy in pumping units operating under variable load is the use of a controlled electric drive (CED). Analyses of the operation of

pumping units have determined that the degree of utilisation does not exceed 16-26% of their potential. At the same time, most of the potential of the pumping unit remains unused. [2]

The main issues of selection of optimal operating modes of pumping equipment depending on the operating conditions have not been thoroughly investigated. Research and determination of optimal operating modes of pumping units under various operating conditions is an actual scientific and practical problem, the solution of which leads to increased reliability and efficiency of pumping equipment.

PROBLEM DISCUSSION

To increase the efficiency of pumping units it is necessary to reduce the cost of operating the pumping equipment, increase its reliability and durability, this requires the correct selection of the operating modes of the unit and the parameters of the external network.

The basis for increasing the efficiency of centrifugal pumps is to improve the operating modes depending on the operating conditions, which greatly affect the efficiency of the centrifugal pump. [3,7]

Because the operating characteristics of a pump for an installed system are determined by the location of the intersection point of the pump and mains data curves, the location of this point must be changed in order to change the operating parameters of the pump. Therefore, in order to change the mode of operation of the pump, the pump characteristic or the system characteristic must be changed.

MATERIALS AND METHODS

If pumping systems are not regulated, their efficiency cannot be achieved for different operating ranges. During operation of a pump with a higher than required head and a more powerful motor, there is an increase in energy loss. [5] In which case the equipment is usually replaced by another one with even higher head and more powerful electric motor, but this does not lead to positive effects and the result will remain the same, this is explained by the graph shown in Fig. 1.

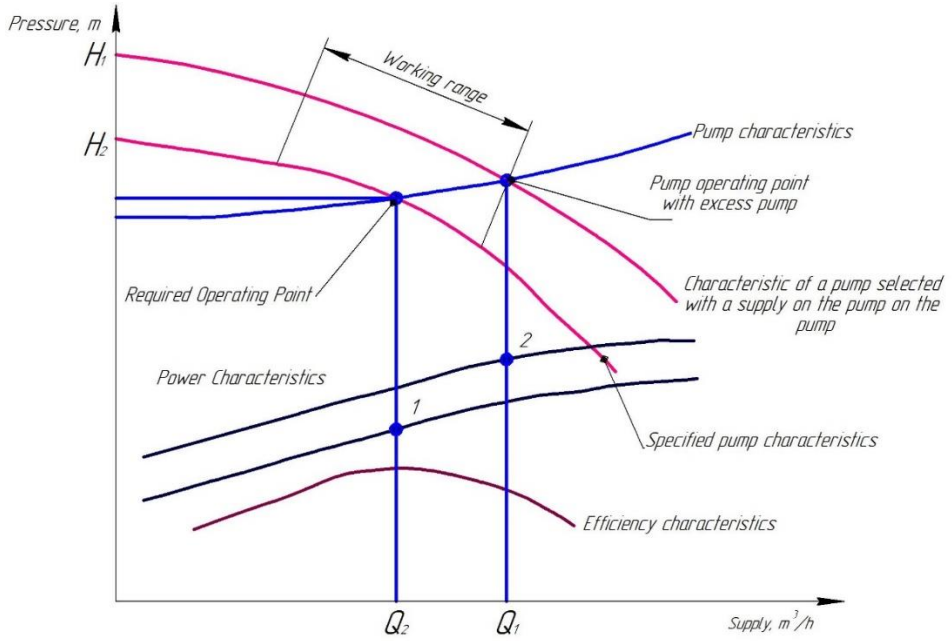

Figure 1. Operation mode of pumping units

From the figure it can be seen that when two pumps with different capacities Q_1 and Q_2 are operating at the required head H_1 and H_2 , the intersection point with the external network characteristic is slightly different in value. Selection of the pump for conditions at the required capacity, which is less than Q_1 and Q_2 is the best option is the mode of operation the operating point, defined by the intersection of the pump characteristic and the system characteristic, is shifted to the right and is within the operating range (point 2). In this case, the pump operation is characterised by the design flow rate and the optimum value of power consumption. [4]

RESULTS AND DISCUSSION

The study of the pressure characteristic of the centrifugal pumping unit was carried out on the test bench of hydraulic installations - dynamic pumps (SGU-DN-5LR), which contains a pumping unit, pressure and flow meters, control elements and controllers. [6]

Experimental studies of the centrifugal pump pressure characteristic were carried out for three operating modes at different drive powers of the unit (Table 1).

Table 1 Experimental measurement results

Name parameter	Mode I.						
	Experience Number.						
	1	2	3	4	5	6	7
Pressure $p_{вх1}$ at the pump inlet H1, KPa.	-4	0	1				
Pressure $p_{н1}$ at the pump outlet H1, KPa.	4	14	21				
Delivery Q_H pump H1, l/min.	11,5	5,1	0				
Pump head H_1 , H_{H1} m	0,81	1,427	2				
Pump drive power (W)	46	46	46				
Parameter name	Mode II.						
	Experience Number.						
	1	2	3	4	5	6	7
Pressure $p_{вх1}$ at the pump inlet H_1 , KPa.	-10	-4	0	1	1		
Pressure $p_{н1}$ at the pump outlet H_1 , KPa.	7	17	27	37	39		
Delivery Q_H pump H1, l/min.	16,7	11,8	7,7	1,8	0		
Pump head H_1 , H_{H1} m	1,73	2,1	2,752	3,67	3,874		
Pump drive power (W)	67	67	67	67	67		
Name parameter	Mode III.						
	Experience Number.						
	1	2	3	4	5	6	7
Pressure $p_{вх1}$ at the pump inlet H_1 , KPa.	-20	-13	-7	-2	1	2	
Pressure $p_{н1}$ at the pump outlet H_1 , KPa.	13	23	33	43	53	55	
Pump delivery Q_H pump H_1 , l/min.	23,4	19,2	14,8	9,7	2,6	0	
Pump head H_1 , H_{H1} m	3,364	3,67	4	4,587	5,3	5,4	
Pump drive power (W)	93	93	93	93	93	93	

Fig. 1 shows the results of laboratory studies of the dependence of the change in the head (H) on the delivery (Q) at different pump drive powers.

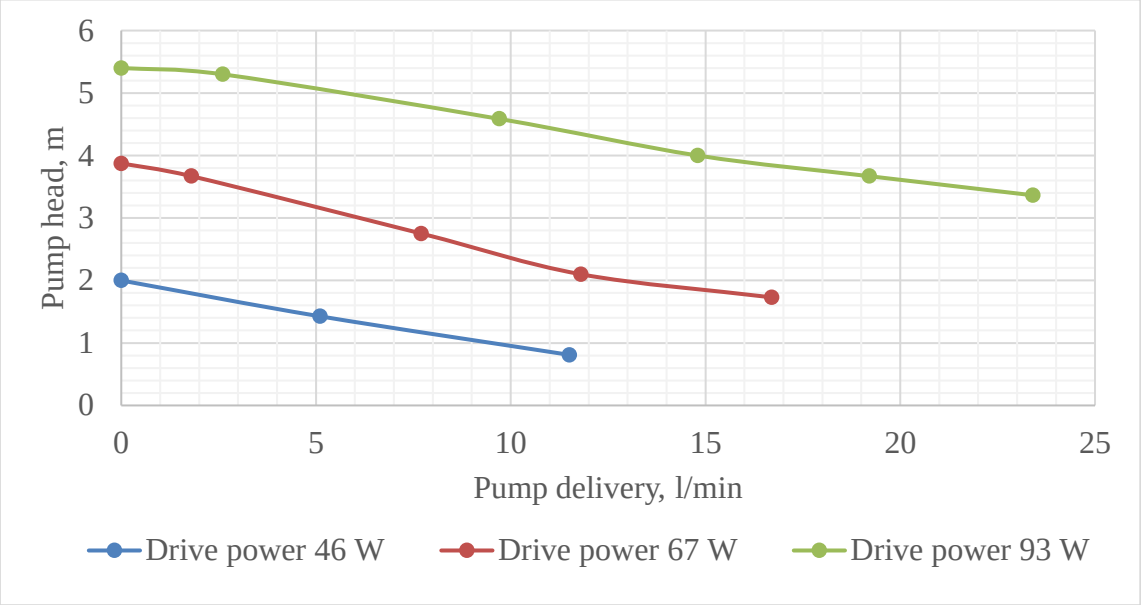

Fig. 2. Dependence of change of head (H) on delivery (Q) of a centrifugal pump at different drive powers

The graphs show that a decrease in discharge height, i.e. head, leads to an increase in pump capacity. In the first mode, with a drive power of 46 Watt, reducing the head by 0.5 metres, the pump delivery increases by 4.5-5 l/min.

At the second and third modes also increase of productivity is observed at the expense of decrease of pump head at the constant values of power at the drive of the installation. Based on the results of the conducted research it is determined that the increase of centrifugal pump delivery is possible without increasing the power at the drive by changing the pressure characteristic.

CONCLUSION

The results of this research prove that changing and adjusting one of the operating characteristics of a pump unit leads to a change in another parameter. Thus, based on the operating conditions, by increasing or decreasing the head, it is possible to obtain the required flow rate without changing the drive power.

One of the optimal directions for increasing the energy efficiency of a pumping unit may be a method of regulating the operating modes of the unit without changing the power at the drive.

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