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Self-Starting Electric Motor Pump Stations

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ABSTRACT: The article discusses the main processes occurring during the self-launch of pumping units of pumping stations of systems of machine-driven irrigation lifting, ensuring the rational use of electricity, pumping power equipment and irrigation water. The features of transients during emergency shutdown of pumping units from the power system and self-starting are shown, techniques are given to determine the optimal self-starting modes. The results of experimental studies carried out at pumping stations of meliorative pumping stations are presented. Technical solutions for the modernization of pumping units are proposed, allowing the use of self-starting mode at meliorative pumping stations.

KEY WORDS: self-starting, transient process, meliorative pumping stations, pumping unit, electrical equipment, start-ups, emergency shutdowns, pipeline, free run-out, stop, power equipment, electric drive, asynchronous motor, power system, power line, self-starting device.

I. INTRODUCTION

One of the main consumers of electricity in Uzbekistan are pumping stations in the agricultural sector. Of the 47 billion kWh / year of electricity generated, an average of 8 billion kWh / year, or about 16%, is spent on covering the loads of 1,588 state land-reclamation pumping stations currently on the balance sheet of the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan. In recent years, an increasing number of small pumping stations owned by farms and tenants has led to the fact that the energy costs of pumping stations are becoming even more significant.

The use of pumping units, taking into account the specific features of irrigated agriculture, made it possible to solve complex engineering and reclamation tasks. The construction and commissioning of large machine canals with unique cascades of pumping stations and complex hydraulic structures made it possible to transfer the runoff of high-water rivers to large irrigated arrays located in the lower reaches of low-flowing rivers of Zaravshan, Kashkadarya, Surkhandarya, Isfayramsay, etc., where there is a shortage of water and systematically repeating rivers, repeating, and there is a shortage of water and systematically repeating rivers. hampered the development of agriculture.

With the help of pumping stations, 2.418 million hectares of 4.3 hectares of irrigated land are being irrigated. Every year, about 59 billion m3 of irrigation water is pumped by all pumps, with 27 billion m3 being pumped by the main pumping stations, and 32 billion m3 by the second and subsequent rises.

The largest pumping stations in the Amu-Bukhara, Sherabad, Karshi, Dzhizak, Amu-Zangsky canal complex were built and put into operation, which made it possible to drastically increase the water supply of the old irrigated lands and develop hundreds of thousands of hectares of new lands. About 2000 m3 / c of water is pumped through pumps only on these five channels, and the power of the main electric motors is 1.2 million kW.

II. SIGNIFICANCE OF THE SYSTEM

As is known, transients are more dangerous for electrical equipment, including pumping installations, than steady ones. The main damage and accidents of pumping units occur during transients, starts, stops, which, in accordance with the work schedule, can be assigned several times a day, as well as during emergency shutdown of electric motors from the power system. There are significant dynamic loads on the elements of structures and hydro-power equipment: hydraulic shock, a sharp change in the force effects on the impeller and the drive system of the blades, accompanied by pulsations of water flow and vibration. Therefore, when operating pumping stations, it is necessary to comprehensively take into account the operation of the pressure path and the process equipment and designate the schemes and composition of facilities, based on calculations and analysis of transients taking into account the static and dynamic characteristics of pumps and electric motors.

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Pumping installations of an open irrigation system operate on pipelines of relatively short length, ending in siphon outlets. With a planned shutdown of the pump unit at the beginning of the adjustment valve is closed, then the drive motor is disconnected from the network. Due to this, the pump unit stops and does not rotate in the other direction.

III. LITERATURE SURVEY

With [1,2] emergency shutdowns due to the fact that the adjusting valve is not closed, when there is no non-return valve or it does not work, the water in the pipeline after the unit is turned off will go back. At the beginning of work, the frequency of rotation of the unit decreases and reaches zero, then under the action of water in the pipeline, the direction changes, the rotation goes in the other direction, and the value of the return hijacking speed becomes more nominal. When the pump rotates in the other direction, the pump seals fail. This leads to a violation of the pump sealing system. Therefore, after such a regime, before starting, they remove the pump plugs, remove the burnt glands, and block new glands. The vacuum pump is started to prepare the pump for start-up as the adjusting valve does not close tightly, filling the collector with water is required.

IV. METHODOLOGY

The number of installed pumping units at meliorative pumping stations varies widely (2-16 pieces). The drive motors of the pumps are powered by a step-down substation of the pumping station. At these substations, two-winding and three-winding transformers are used. The number of simultaneously self-starting motors of a pumping station is determined on the basis of the allowable value of the mains voltage decrease at the time of self-starting. Knowing the mains voltage and the resistance of the power source, we determine the magnitude of the recovering voltage on the motors. When the pumps are vertical, axial, where there are no valves, any voltage deviation is associated with rotation in the other direction, which negatively affects the work of the thrust bearing, on the mounting of the pump and motor windings. All this is associated with the consumption of scarce materials, requires a lot of time and qualified repairmen. If the pump is working with suction, then during the interruption of power it can lose water, turn on unfilled. Experience shows that the loss of a column of water occurs, as a rule, only when the rate drops below 50%. After each redemption or landing voltage network pumps are turned off. A lot of time is required to restore the station to its initial working condition. A simple pumping station during the period of intensive irrigation is unacceptable, therefore, it is of great technical and economic importance to reduce the downtime of pumping units of a pumping station using self-starting. Calculations of self-starting currents for asynchronous motors should be performed both during design and during operation of power facilities.

V. EXPERIMENTAL RESULTS

A number of programs have been developed for calculating this mode for industrial enterprises, that is, development is proceeding along the path of a software implementation of a mathematical model [3]. Organizations involved in this area use different methods of software implementation.

When power is applied, the self-starting mode of electric motors is used when the rotational speed increases. Self-start will be successful if the pumping units involved in this mode unfold to the operating speed within the allowable time. The success of the self-start depends on the interruption time of the power supply, the parameters of the supply circuit, the total power of the electric motors not disconnected and their loading, the mechanical characteristics of the mechanisms and other factors.

In all cases, the implementation of self-start should be reasonable. The main task of self-starting is to maintain the efficiency of the pumping station during short-term repayment. If the power of the power supply system is sufficient, all pumping installations for which it is necessary can participate in a simultaneous self-start. If the limited power of the power supply system does not allow this, then several steps of self-starting are provided for, that is, alternate self-starting of several groups of pumping units. This also raises the question of the mutual influence of the power supply system and the engines of pumping units involved in self-starting. A more significant limitation in the use of self-starting pumping stations is caused by the fear of the possibility of a water hammer in the discharge pipe when a loaded pump is suddenly turned on.

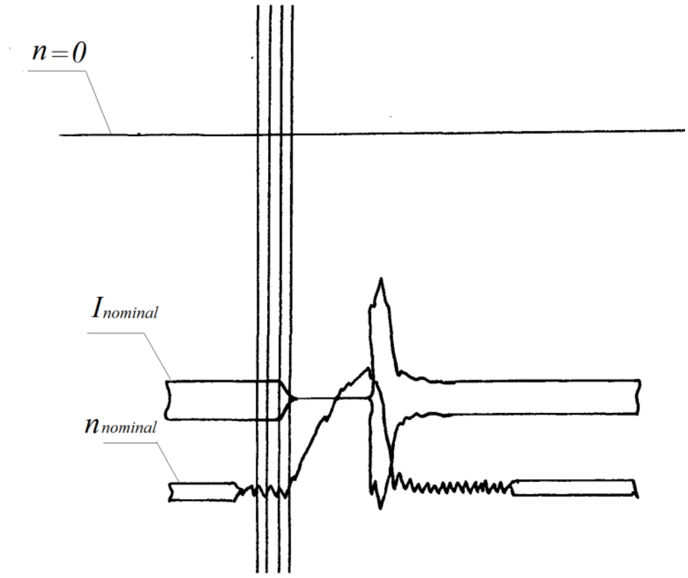

Fig.1. Self-starting at $t_{shutdown}$ = 1.5 s

In the proposed work, the on-state time of the engine at redemptions is determined using a sensor, a recording pressure gauge installed at the pump outlet (Fig. 1) or by calculation based on the four square characteristics of the pump and the parameters of the pump unit. The self-starting zone is within the range of the change in pressure from the nominal value to the minimum value. In this work, after the redemption, the disappearance of the voltage in the network, you can determine the allowable self-starting zone of the engine based on:

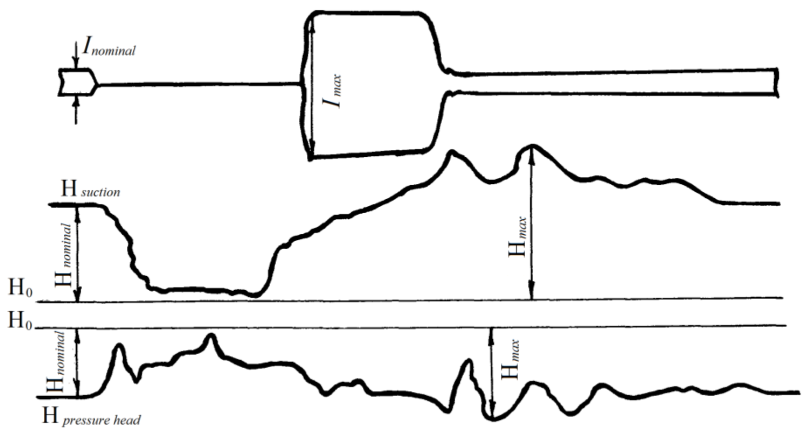

Fig.2. Self-start when $t_{shutdown}$ = 4.5 s

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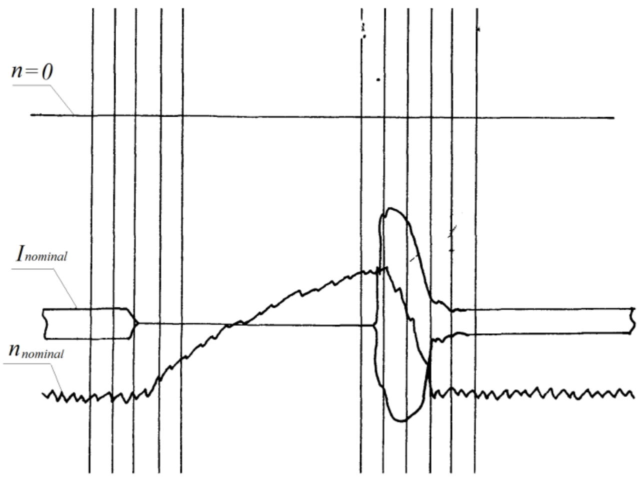

Fig.3. Self-start at t_{shutdown} = 2.2 s

a) the design data of the pump station and the four square characteristics of the pump (by calculation);
b) measuring the pressure using sensors or a recording manometer installed at the outlet of the pump (to improve accuracy) or an exemplary manometer (Fig. 2);
d) characteristics of the after-run of the pump unit, by which the zone for a successful self-starting is determined (Fig. 3).
Increases the reliability of the pump unit as a whole, reduces downtime, reduces the consumption of scarce materials. Using the method allows you to free the labor of skilled workers or professionals, because there is no possibility of creating an emergency at pumping stations [4,5].
High-voltage power lines of Amu-Zang pumping stations and electric motors are operated in difficult climatic conditions. During the irrigation season, redemptions of network voltage and short-term decrease in network voltage are observed. This leads to the shutdown of all pumping stations and pumping stations.
The pumping station of the first lift is equipped with horizontal centrifugal pumps of the type 24NDS with a grinded diameter of the DRC impeller = 375 mm. As a drive motor, three-phase asynchronous motors of the DAZO type are used. The first-stage pumping station consists of 16 24NDS type pumps with impeller diameter of 875 mm and DAZO-15-59-10 asynchronous motors in the same quantity.
The pumping station of the second stage consists of similar pumps (24NDS with DRC = 375 mm) in the same number of 16 pieces, but the electric motors of the type DAZO-15-69-10 are used as the electric drive. All of these pumping station engines are powered by a single substation. These engines are powered by a TDTN-2500/110/6/6 type transformer №1.

VI. CONCLUSION AND FUTURE WORK

Experimental oscillograms of the process of self-starting under natural conditions at the pump station Amu-Zang of the first ascent of the second stage were removed. The processes of self-starting of one pumping unit No. 11 were oscillographic at different values of the time delay, which varied from 1.5-3 seconds. The rotational speed of the pump, the stator current I, the run-down time and the self-start time were recorded. The results of the oscillogram of the field study are shown in Fig.1. and fig.3. From the oscillogram, it can be seen that the multiplicity of the starting current and the duration of the self-start increase with increasing repayment time.
An increase in the exposure time leads to an increase in the multiplicity of the starting current and the duration of the start. The results of the field study show that the minimum starting current will be with a decrease in the repayment time to 1.5-2 seconds. The shorter the power interruption, the less the motors have time to brake, the less their starting currents and the higher the initial voltage on the tires after the backup power is turned on and, consequently, the faster the motors start to self-start.
The materials of the article and recommendations given in it can be the basis for innovative projects dedicated to improving the operational reliability and energy efficiency of electric motors of pumping unit drives.

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