Development of comprehensive diagnostics for a pump unit of a machine irrigation pumping station

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Abstract. The article is devoted to the development of a comprehensive diagnostic system for a pump unit of a machine irrigation pumping station. The system consists of a microprocessor-based device, analog modules, a computer, and the following condition assessment algorithms: evaluation of the electric motor thrust bearing based on temperature; assessment of the upper motor crosshead based on low-frequency radial vibration; assessment of the upper motor crosshead based on low-frequency vertical vibration (1–25 Hz); assessment of the upper motor crosshead based on high-frequency vertical vibration; assessment of the stator winding and core of the electric motor based on temperature; and assessment of the upper and lower guide bearings of the electric motor based on temperature.

INTRODUCTION

At present, special attention in the Republic is being paid to the issues of comprehensive diagnostics of the condition of electrotechnical equipment at large pumping stations (PS). Successful solutions to these issues lead to a reduction in the number of severe equipment failures and provide station personnel with retrospective technological information for the analysis and planning of equipment operation, maintenance, as well as for improving reliability and economic efficiency [1–6]. Currently, comprehensive diagnostics of the technical condition of pumping station equipment is one of the most relevant tasks for increasing the reliability of their operation, as well as for the monitoring and control of pumping stations [7–10].

EXPERIMENTAL RESSEARCH

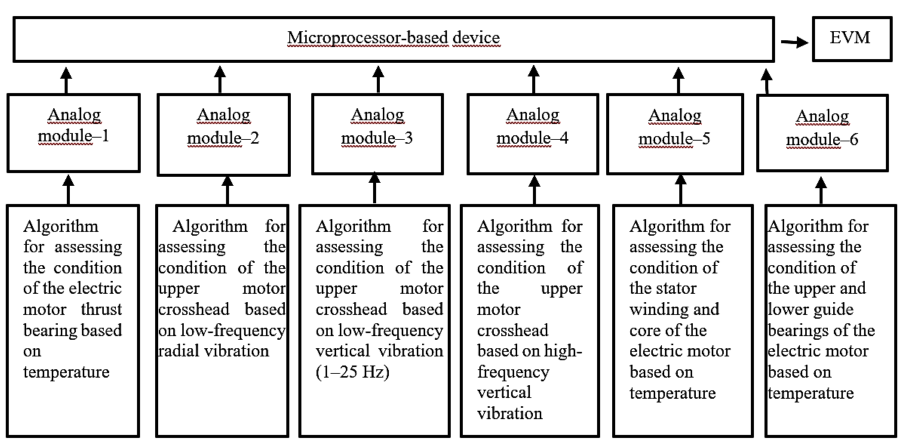

FIGURE 1. Diagram of comprehensive diagnostics of a pump unit in a machine irrigation pumping station

Taking this into account, a comprehensive diagnostic scheme for a pump unit of a machine irrigation pumping station has been developed. The scheme includes a microprocessor-based unit, a computer, analog modules, and algorithms for assessing the condition of the pump unit components (Figure 1). To perform comprehensive diagnostics, analog temperature and vibration signals obtained from sensors are fed to the analog modules, which convert them into digital form for processing by the microprocessor-based unit. The microprocessor unit compares the current parameter values with their nominal values; when deviations from the nominal values exceed permissible limits, the differences are transmitted to the computer, and a corresponding message is displayed on the operator's screen. In addition, control commands for eliminating the detected faults are generated according to the algorithms presented in [10–11].

Let us consider the algorithms for assessing the condition of the pump unit components shown in Figures 2–4.

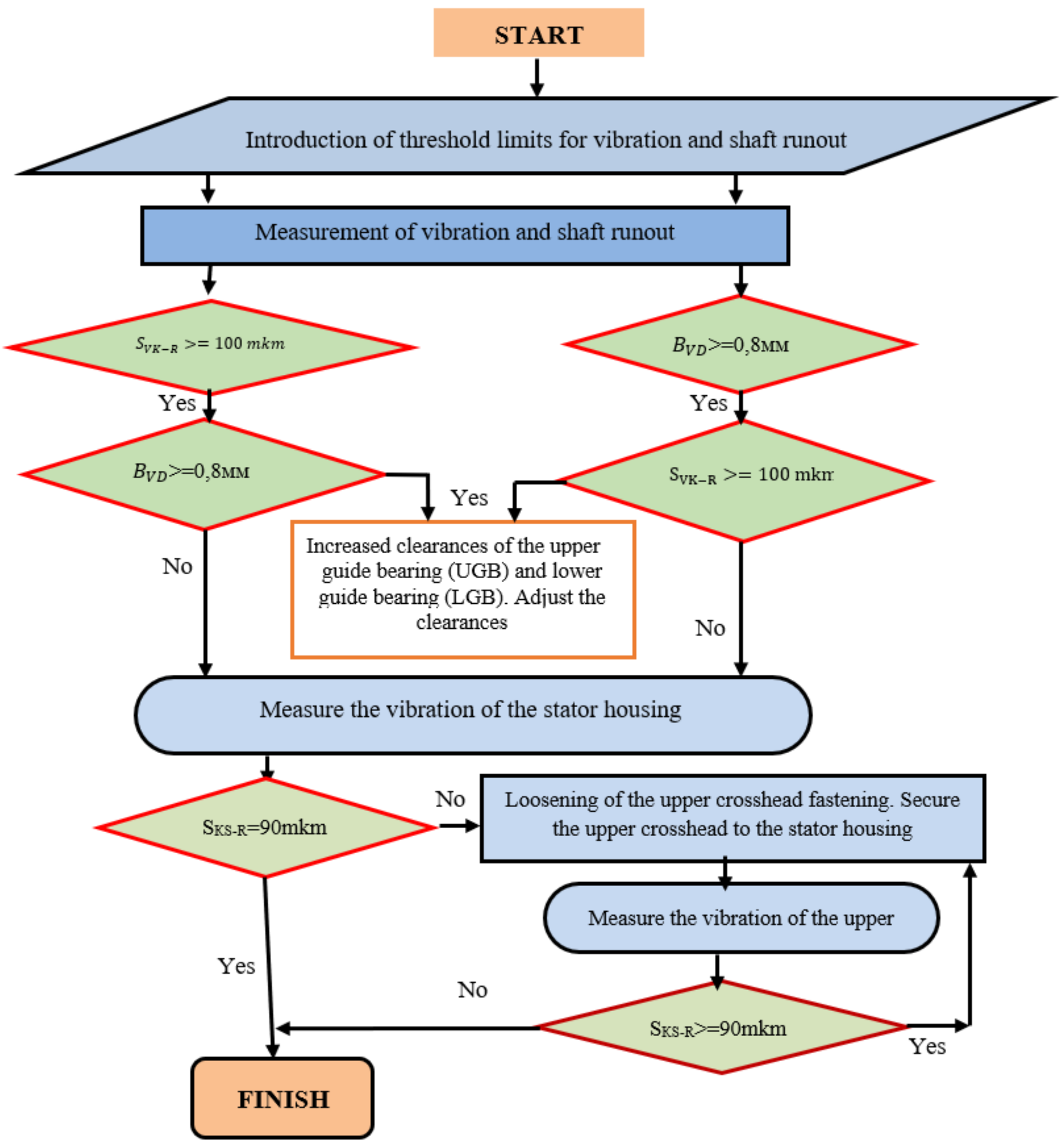

FIGURE 2. Algorithm scheme for assessing the condition of the upper crosshead of the electric motor based on radial low-frequency vibration.

1. Algorithm for Assessing the Condition of the Upper Crosshead of the Electric Motor Based on Radial Low-Frequency Vibration [12-15]. The operation of the diagnostic algorithm for radial low-frequency (rotational) vibration begins with the input of initial data: shaft runout in the region of the upper guide bearing (UGB) and radial low-

frequency vibration of the upper crosshead [16-19]. The occurrence of faults is determined by exceeding the permissible threshold values of radial low-frequency vibration. An increased vibration level may be caused by the faults shown in Figure 2.

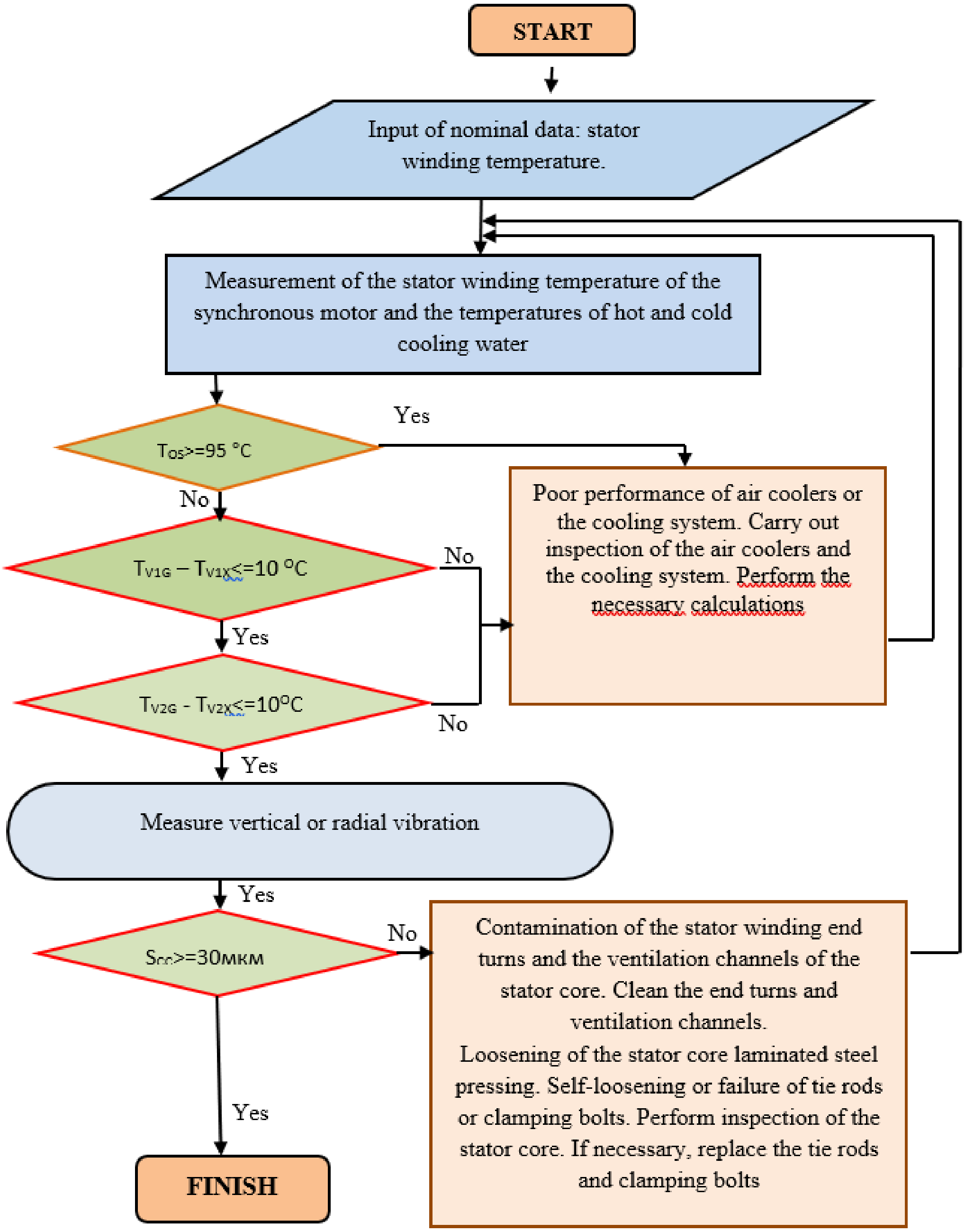

FIGURE 3. Algorithm scheme for assessing the condition of the stator winding and core of the electric motor based on temperature.

2. Algorithm for Assessing the Condition of the Stator Winding and Core of the Electric Motor Based on Temperature [20-24]. The operation of the diagnostic algorithm for the temperature of the stator winding and core begins with the input of initial data: stator winding temperature. The occurrence of faults is identified when the temperature of the stator winding exceeds the permissible values [25-29]. Possible causes of faults are shown in Figure 3.

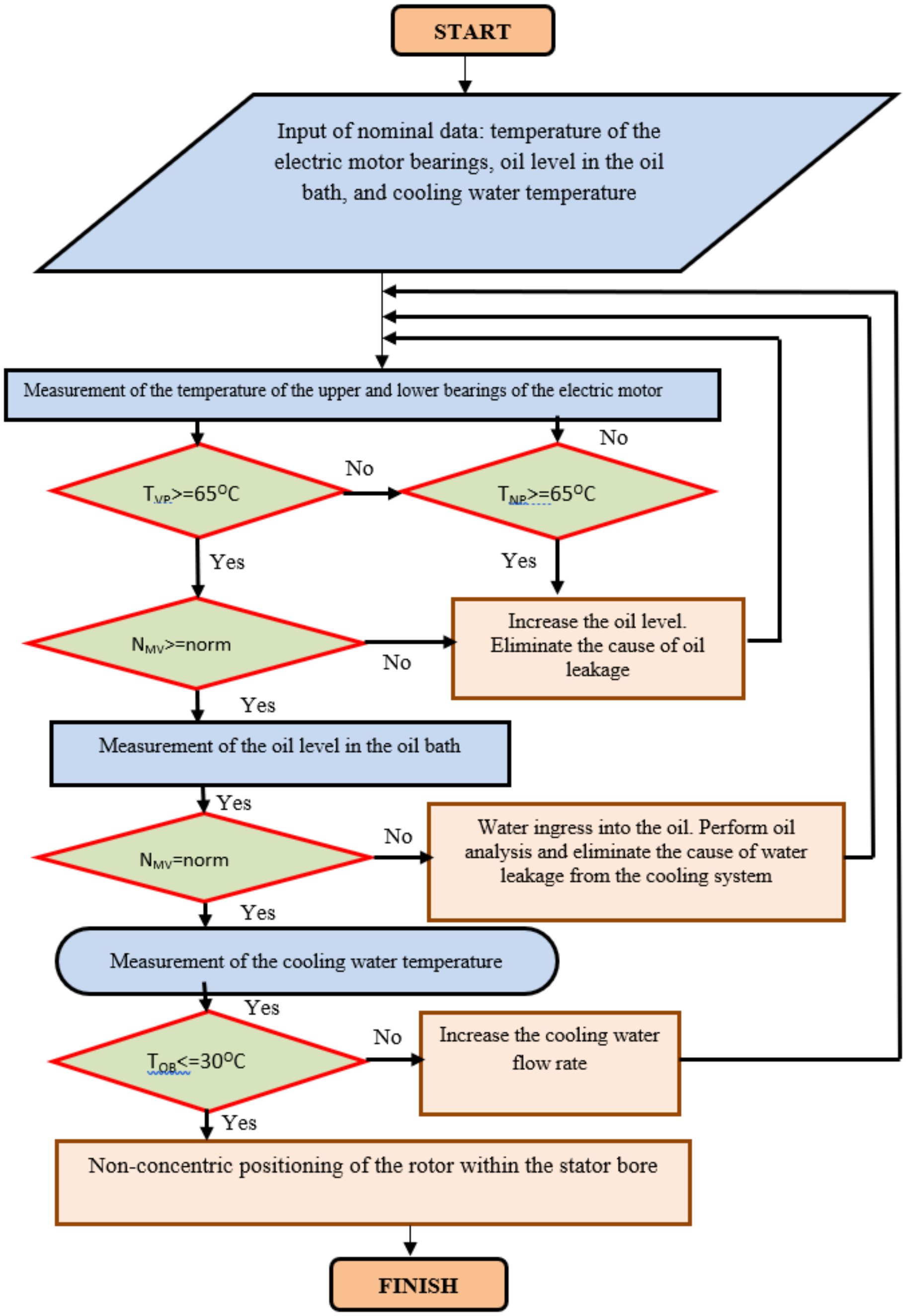

FIGURE 4. Algorithm scheme for assessing the condition of the upper and lower guide bearings of the electric motor based on temperature.

3. Algorithm for Assessing the Condition of the Upper and Lower Guide Bearings of the Electric Motor Based on Temperature [30-34]. The operation of the diagnostic algorithm for the temperature of the upper and lower guide bearings of the electric motor begins with the input of initial data. The occurrence of faults is determined by exceeding the permissible temperature limits of the guide bearings in Figure 4.

CONCLUSIONS

1. The developed comprehensive diagnostic system for the condition of electrotechnical equipment at large

pumping stations enables a significant reduction in the number of severe equipment failures and provides station personnel with retrospective technological information for analyzing and planning equipment operation, maintenance, and for improving reliability and economic efficiency.

2.The developed comprehensive diagnostics of the technical condition of pumping station equipment represents one of the most relevant tasks for enhancing the reliability of their operation, as well as for effective monitoring and control of pumping stations.

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