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# Economical Operation for Centrifugal, Mixed Flow and Axial Flow Pump Systems

离心泵、混流泵与轴流泵系统经济运行

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# Economical Operation for Centrifugal, Mixed Flow and Axial Flow Pump Systems

## 1 Scope

This Standard specifies the basic requirements, judgment and evaluation methods, test methods and energy-saving management measures of the economical operation for centrifugal pumps, mixed flow pumps and axial flow pump systems driven by AC motors.

This Standard is applicable to centrifugal pumps, mixed flow pumps and axial flow pump systems driven by AC motors in use. The design of reconstruction, expansion and new centrifugal pump, mixed flow pump and axial flow pump system can be implemented by reference.

## 2 Normative References

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this document.

GB/T 9481 Axial-Flow Pump of Medium-Small Size - Types and Basic Parameters

GB/T 13007 Centrifugal pump - Efficiency

GB/T 13008 Technical Specification for Mixed and Axial Flow Pumps

GB/T 13466 The General Principles of Economic Operation for AC Driven Fan (Pump Air Compressor) System

GB/T 13468 Measurement and Calculation Methods of Electric Energy Balance for Pumped Liquid Transportation Systems

GB/T 16666 Monitoring and Testing for Energy Saving of Motor-Pump Liquid Transport System

GB 17167 General Principle for Equipping and Managing of the Measuring Instrument of Energy in Organization of Energy Using

**4.2.4** The selection of the pump shall meet the following requirements:

a) Satisfy the use head and flow of the system;

b) The selection of the pump shall comply with the provisions of GB/T 9481, GB/T 13007, GB/T 13008 and other relevant standards;

c) The design operating point shall be in the economic working area specified by the pump manufacturer.

**4.2.5** Under a variety of working conditions and production process conditions, the matching pump shall be selected according to the system load characteristics. The selection of multiple pumps for combined operation shall meet the requirements of series and parallel technical conditions.

**4.2.6** When multiple pumps are used in combined operation, on the basis of satisfying process, safe and reliable operation, high-efficiency pumps shall be used to bear the basic load, so as to minimize the power consumption of the unit liquid.

**4.2.7** When multiple units are operated in parallel, pumps with equal head characteristics shall be used. When operating in series, pumps with equal flow characteristics shall be used. When speed control devices are used for control and adjustment, the pump series/parallel operation rules shall be satisfied; and the series and parallel operation mode in the high-efficiency energy-saving zone of the variable frequency pumps should be used.

**4.2.8** According to the requirements of the production process, reasonably determine the pipe material and pipe diameter of the pipe network system.

**4.2.9** The pipe network configuration plan and transportation distance shall be reasonably determined under the conditions of optimizing the production process.

**4.3 Requirements for installation, commissioning and acceptance of the pump systems**

**4.3.1** The installation shall be carried out by a dedicated installation technician in accordance with the installation provisions of the manufacturer.

**4.3.2** The determination of the installation site and location shall fully consider the convenience of operation and management; and reserve necessary maintenance space.

**4.3.3** After installation of the pump system, online debugging shall be carried out to check whether the pump is out of the high-efficiency zone where the pump is allowed to operate; and perform the test in accordance with Clause 6.

the inclination shall be no less than 0.5%;

c) The suction pipeline layout and flow rate of large centrifugal pumps, axial flow pumps and mixed flow pumps shall be selected so that the suction medium does not produce vortex, cavitation, etc.;

d) The bottom valve should not be used in the suction pipeline;

e) In order to ensure the suction performance of the pump, the medium flow rate of the suction pipe for conveying clean water at room temperature shall be less than 2m/s.

**4.4.2.10** The discharge pipeline shall meet the following requirements:

a) For the connection between the branch pipe and the main pipe, an oblique connection should be used instead of a straight connection;

b) No additional resistance valve or micro resistance valve should be used;

c) The discharge pipeline shall adopt economical flow rate, and the flow rate of clean water at room temperature shall be 2m/s~3m/s.

**4.4.3 Economical operation of the system**

**4.4.3.1** Applicable control and regulation systems shall be adopted according to the user's flow and head requirements.

**4.4.3.2** For long running time, large load changes and discontinuous operation conditions, a regulating device system including a variable frequency speed regulating device should be used. The application technical conditions of the variable frequency speed regulating device shall comply with the provisions of GB/T 21056.

**4.4.3.3** When the flow rate variation is less than 20%, or the annual operating time is less than 4000h, the following flow adjustment methods should be adopted, including:

a) The throttling method can be used for small centrifugal pumps;

b) For mixed flow pumps and axial flow pumps, the flow rate and head can be adjusted through changing the installation angle of the blades or adjusting the inlet guide blades;

c) When the change range of flow rate is less than 10%, the variable flow constant pressure method shall be adopted;

d) Voltage reduction and power saving technology can be used when the motor is lightly loaded.

**4.4.3.4** The equipment and pipe network that transport high (low) temperature medium

**4.5.2.3** For pumps with a capacity of 100kW and above, economic indicators of the systems should be tested regularly.

### 4.5.3 Requirements for finding and troubleshooting faults

**4.5.3.1** Once a failure occurs, the cause of the failure shall be analysed and eliminated in time; and the results of the failure shall be recorded in detail.

**4.5.3.2** The following should be recorded when the system fails:

a) Failure overview (time of failure, description of failure and failure phenomenon, working conditions and environmental conditions at the time of failure, name of the person who discovered the failure);

b) The nature of the failure;

c) The fault characteristics of the product performance (the measured value of the fault parameter and the minimum required value of the parameter);

d) Analytical opinions and suggested corrective measures related to failures.

**4.5.3.3** The following failure maintenance information shall be recorded:

a) Failure verification (the used instruments and methods, description of observation results);

b) Repair instructions (the taken measures, repair date, name of maintenance personnel);

c) Description of the replaced parts (part name, model, supplier, failure cause and classification opinions).

# 5 Judgment and Evaluation Method of Economical Operation for Pump Systems

## 5.1 The calculation and judgment program of the economical operation for pump systems

### 5.1.1 Calculation procedures

The calculation of the relevant indicators of the economical operation for the pump system shall be carried out according to the following procedures:

a) Calculate the operating efficiency of motors, pumps and other equipment in use according to 5.2.1;

### 5.4 Judgment and evaluation of the unit

During the recording period, compare the actually-measured operation efficiency of unit with the rated efficiency of the unit. If the ratio is greater than 0.85, the unit is deemed to be operating economical; if the ratio is between 0.70 and 0.85, the unit is deemed to be operating reasonably; if the ratio is less than 0.70, the unit is deemed to be operating uneconomical.

### 5.5 Judgment and evaluation of the system

**5.5.1** If all equipment and units in the system meet the economical operation requirements specified in 5.3 and 5.4 at the same time, then the system shall be considered to be operating economical. If all equipment and units in the system meet the reasonable operation requirements specified in 5.3 and 5.4, and there are no uneconomical operation items, then the system shall be considered to be operating reasonable. If one of all equipment and units in the system is judged to be uneconomical, then the system shall be considered to be operating uneconomical.

**5.5.2** If the power consumption per ton by 100 meters of liquid transported by the system meets the qualified index requirements in GB/T 16666, then the system shall be considered to be operating economical. If it does not meet the qualified index requirements in GB/T 16666, the system shall be considered to be operating uneconomical.

## 6 Test Method for Economical Operation for Pump Systems

### 6.1 Test conditions

The test shall be carried out under the following conditions:

a) No changes shall be made to the pump system before the test;

b) The test shall be carried out under typical working conditions;

c) The system shall be tested under stable voltage, temperature and pressure.

### 6.2 Requirements for measuring instruments

**6.2.1** The measurement range of the measuring instrument shall meet the measurement requirements of the relevant parameters of the pump system; and it should be ensured that the usual measured value is within the range of 1/2 ~ 2/3 of the relevant instrument.

**6.2.2** The accuracy of measuring instruments within the used range shall meet the

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