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Water hydraulics — Water-hydraulic pumps — Methods of testing and representing basic steady-state performance

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee TC 131 (Fluid Power Systems), Sub-Technical Committee SC 8 (Product testing), Working Group WG 14 (Testing of water hydraulic pumps).

Introduction

Water hydraulics or water-hydraulic systems, hydraulic systems in which water has been used as the power transmitting medium in a fluid power system, have potential market demand in favour of easily-keeping cleanness, reducing the fluid cost and the machine size, and less fire risk. Applications of water hydraulics have been expanding to new fields requiring cleanness, in particular, the fields of cleaning, animals and plants, food, packaging, cosmetics, semiconductor, and others, thanks to the environmental cleanliness of water compared with alternative hydraulic fluids, such as oil.

There are no international standards specialized in water hydraulics though the water hydraulics is generally known. Since the technology of water hydraulics is one of emerging technologies, this kind of technology should be standardized in the collaboration within related countries including developing countries as well as developed ones in the stage of international standardization, particularly in the ISO/TC 131 (Fluid power systems), to accelerate the development of this technology.

The water-hydraulic pump is essentially one of the key components of water hydraulics. Developing an appropriate standard for water-hydraulic pumps, indeed methods of testing and representing basic steady-state performance, as the first standard, is therefore critical to business trade and/or product acceptance by consumers.

Japan, as a P-member of ISO/TC 131, re-proposes a new international standard for water hydraulics. This is a completely-newly-revised draft of the international standard titled “Water hydraulics – Water-hydraulic pumps – Methods of testing and representing basic steady-state performance.”-

Water hydraulics — Water-hydraulic pumps — Methods of testing and representing basic steady-state performance

1 Scope

This document specifies methods for determining the performance and the efficiency of water-hydraulic positive displacement pumps having continuously rotating shafts. This standard provides test equipment, test procedure under steady-state conditions and the presentation of test results.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4391, *Hydraulic fluid power — Pumps, motors and integral transmissions — Parameter definitions and letter symbols*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 8426, *Hydraulic fluid power — Positive displacement pumps and motors — Determination of derived capacity*

ISO 16345, *Water-cooling towers — Testing and rating of thermal performance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4391 and ISO 5598 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
water-hydraulic pump
positive displacement pump that transforms mechanical energy into water-hydraulic energy with water as the system fluid

3.2
hydraulic pump
(hydraulic) component that transforms mechanical energy into hydraulic energy

[SOURCE: ISO 5598:2020, 3.2.370]

3.3
fluid
fluid power medium, liquid or gas, used as the power transmitting medium in a fluid power system

[SOURCE: ISO 5598:2020, 3.2.316, modified – "liquid or gas" was replaced by ", liquid or gas,"]

3.4
steady-state
state in which a physical parameter does not vary appreciably with time

[SOURCE: ISO 5598:2020, 3.2.725, modified – "steady state" was replaced by "steady-state"]

3.5
steady-state operating conditions
operating conditions in which relevant parameters are in steady-state after a period of stabilization

[SOURCE: ISO 5598:2020, 3.2.726, modified – "steady state" was replaced by "steady-state"]

3.6
shaft speed, n
rotational speed of drive shaft of pump

3.7
flow rate
volume of fluid flow, at specified conditions, that crosses the transverse plane of a flow path per unit of time

[SOURCE: ISO 5598:2020, 3.2.303]

3.8
flow rate of the pump under test, q_v
flow rate measured at the outlet port of the pump under test

3.9
derived capacity, V_i
volume of fluid displaced by a pump or motor per shaft revolution, calculated from measurements at different outlet pressures (for pumps) or inlet pressures (for motors) under specified test conditions

[SOURCE: ISO 8426:1998, 3.3]

3.10
effective torque, T
usable torque at the shaft end, under specified conditions

[SOURCE: ISO 5598:2020, 3.2.248]

Note 1 to entry: This definition is used for a motor.

3.11
effective torque, T_e
torque necessary for driving the pump shaft, under specified conditions

Note 1 to entry: This definition is used for a pump. In this document, only this definition for a pump is used.

3.12
gauge pressure, p_e
measured absolute pressure minus atmospheric pressure

[SOURCE: ISO 5598:2020, 3.2.346]

Note 1 to entry: The value of "gauge pressure" shows either positive or negative.

3.13
pump overall efficiency, η_t
ratio of the power transferred to the liquid, at its passage through the pump, to the mechanical input power

$$\eta_t = \frac{q_v \left(p_{e,o} - p_{e,i} \right)}{2\pi n T_e}$$

[SOURCE: ISO 5598:2020, 3.2.603]

3.14
pump volumetric efficiency, η_v
ratio of the effective output flow rate to the derived output flow rate

$$\eta_v = \frac{q_v}{V_i n}$$

[SOURCE: ISO 5598:2020, 3.2.605, modified – symbols were replaced by the above]

3.15
hydromechanical pump efficiency, η_m
ratio of the derived torque to the effective torque

$$\eta_m = \frac{V_i \left(p_{e,o} - p_{e,i} \right)}{2\pi T_e}$$

[SOURCE: ISO 5598: 2020, 3.2.378, modified – "ratio of the derived displacement" was replaced by "ratio of the derived torque"]

3.16
inlet gauge pressure of pump under test, $p_{e,i}$
measured gauge pressure at or near the suction port of a pump under test

Note 1 to entry: The value of "inlet gauge pressure of pump under test" shows either positive or negative.

3.17
outlet gauge pressure of pump under test, $p_{e,o}$
measured gauge pressure at or near the delivery port of a pump under test

3.18
free air
(hydraulic) any compressible gas, air or vapour trapped within a hydraulic system that does not condense, emulsify or dissolve

[SOURCE: ISO 5598:2020, 3.2.335]

3.19
tap water
water supplied through pipes or tubes to taps/faucets

3.20
total dissolved solids (TDS)
weight of inorganic and organic matter in true solution per unit volume of water

[SOURCE: ISO 16345:2014]

4 Symbols and units

For the purposes of this document, the symbols and units listed in Table 1 apply. In Table 1, as the unit of Derived capacity and Shaft speed, m^3 and s^{-1}, besides m^3/rev and rev/s, may be used.

Table 1 — Symbols and units

Description	Symbols	Unit
Flow rate of the pump under test	q_v	m^3/s
Derived capacity	V_i	m^3/rev
Shaft speed	n	rev/s
Effective torque	T_e	N·m
Inlet gauge pressure of pump under test	$p_{e,i}$	Pa
Outlet gauge pressure of pump under test	$p_{e,o}$	Pa
Temperature	θ	K
Pump overall efficiency	η_t	-
Hydromechanical pump efficiency	η_m	-
Pump volumetric efficiency	η_v	-

5 Water

Tap water can be used for the working fluid of water-hydraulic systems including a water-hydraulic pump. Contents of tap water used in water hydraulics shall satisfy the criteria specified in Table 2.

Table 2 — Contents of tap water used in water hydraulics

Item	Unit	Criteria
Concentration of hydrogen ion	pH	5,8 ~ 8,6
Hardness (Ca, Mg etc.)	mg/L	300 or less
Chloric ion	mg/L	200 or less
TDS	mg/L	500 or less
General bacteria	Count/mL	100 or less

6 Tests

6.1 Requirement

6.1.1 General

Installations shall be designed to prevent air entrainment during operation and then measures shall be taken to remove free air from the system before testing.

The tank height level should be designed to be higher than the pump suction port, in order to prevent the reduction of the suction pressure.

Tap water shall be supplied through a filter with the specified filtration performance (10 microns) during supplying tap water to a hydraulic tank.

Figure 1 illustrates the basic circuit for the test of a water-hydraulic pump. The figure does not incorporate all the safety devices necessary to protect against damage in the event of any component

fracture or fragmentation. Those who are responsible for carrying out the test shall give due consideration to safeguarding both personnel and equipment.

6.1.2 Installation of the unit under test

The test circuit shall be constructed in accordance with Figure 1.

6.1.3 Test fluid

Working fluid of water hydraulics shall be tap water. Additives shall not be added additionally.

6.1.4 Temperature

Tests shall be carried out at a stated test fluid temperature. The test fluid temperature shall be measured in a tank or at the pump inlet. The position of the temperature measurement shall be determined by the manufacturer and user of the pump under test. Water temperature shall be controlled by heat exchanger within the range recommended by the manufacturer. Measurements shall be made at temperature levels, 20 °C to 40 °C .

The test fluid temperature shall be maintained within the limits stated in Table 3. The temperature tolerance (either A, B, or C) shall be recorded.

Table 3 — Indicated test fluid temperature tolerance

Temperature accuracy class (see Annex A)	A	B	C
Temperature tolerance (°C)	±1,0	±2,0	±4,0

6.2 Test circuit

The test circuit shown in Figure 1 shall be used.

The shut-off valve (Key 14 of Figure 1) is closed and the shut-off valve (Key 13) is opened when the inlet port of the pump under test is pressurized by a boost pump (Key 7). The inlet pressure of the pump under test is adjusted by a pressure relief valve (Key 8).

The water level in a tank from the pump inlet port shall be kept up within a range (e.g. 0.8m to 1.0m). A boost pump (Key 7) may be provided to keep the inlet pressure within an acceptable range, which shall be determined by the manufacturer and user of the pump under test, in case there is a demand for pressurized inlet port as a measure to prevent the occurrence of cavitation.