INTERNATIONAL STANDARD

ISO 17769

First edition
2008-03-15

Liquid pumps and installation — General terms — Definitions, quantities, letter symbols and units

Pompes pour liquides et installations — Termes généraux — Définitions, grandeurs, symboles littéraux et unités

Reference number
ISO 17769:2008(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword ... **iv**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms and definitions ... **1**
3.1 General definitions ... **1**
3.2 Special terms for rotodynamic pumps ... **24**
3.3 Terms specific to reciprocating and rotary positive-displacement pumps ... **30**

4 Comparison between specific energies and their corresponding heads ... **34**

5 List of symbols and quantities ... **34**

6 List of letters, figures and symbols used as subscripts for creating and defining symbols ... **37**

Annex A (informative) **Figures illustrating the definitions** ... **41**

Alphabetical index ... **46**

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17769 was prepared by Technical Committee ISO/TC 115, *Pumps*.

Liquid pumps and installation — General terms — Definitions, quantities, letter symbols and units

1 Scope

This International Standard deals with terms, letter symbols and units related to the flow of liquids through rotodynamic and positive displacement liquid pumps and associated installations. It serves as a means of clarifying communications between the installation designer, manufacturer, operator and plant constructor.

This International Standard identifies the units in common usage but, all other legal units can be used.

This International Standard deals solely with conditions described by positive values for the rate of flow and pump head. The definitions are set out showing first the most common form of a quantity followed by some frequently used variants. Other variants can be constructed and appropriate symbols evolved using the symbols and subscripts shown. Prefixes such as “working” and “design” can also be applied to the defined quantities.

This International Standard is not concerned with terms, letter symbols and units referring to the component parts of rotodynamic and positive-displacement pumps and installations.

Whenever possible, symbols and definitions conform to those used in ISO 31-0 and ISO 1000, with further explanations where these are deemed appropriate. Some deviations have been incorporated for reasons of consistency.

2 Normative references

The following referenced documents are indispensable for the application 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 31-0, *Quantities and units — Part 0: General principles*

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 General definitions

3.1.1 General terms

3.1.1.1
pump
mechanical device for moving fluids including the inlet and outlet connections as well as, in general, the shaft ends

3.1.1.2
pump unit
assemblage of mechanical devices including the **pump** (3.1.1.1), the **driver** (3.1.17.23) together with transmission elements, baseplate and any auxiliary equipment

3.1.1.3
installation
arrangement of pipes, supports, foundations, controls, drives, etc. into which the pump or pump unit is connected in order to achieve the service for which it was acquired

3.1.1.4
system
those parts of an **installation** (3.1.1.3) that, together with the pump, determine the functional performance of the installation

3.1.1.5
conditions
all parameters (for example temperatures, pressures) determined by the application and the pumped liquid which affect the function and performance of the system

3.1.2 Prefixes usable with some terms in this International Standard

3.1.2.1
design
values used in the design of a pump for the purpose of determining the performance, the minimum permissible wall thickness and the physical characteristics of the different parts of the pump

NOTE It is recommended to avoid the use of the word "design" in any term (such as design pressure, design power, design temperature or design speed) in the purchaser's specifications. This terminology should be used only by the equipment designer and manufacturer.

3.1.2.2
rated
specified performance condition selected to ensure that the operating performance is achieved by the pump or pump unit when installed

3.1.2.2.1
rated conditions
conditions [**driver** (3.1.17.23) excluded] that define the guarantee values necessary to meet all defined operating conditions, taking into account any necessary margins

3.1.2.3
operating
one or several settings for which the pump is intended to be used

NOTE The operating settings should be within the allowable working range.

3.1.2.3.1
operating conditions
all parameters determined by a given application and pumped liquid

NOTE These parameters influence the type and materials of construction.

EXAMPLE Operating temperature, operating pressure.

3.1.2.4
pressure/temperature rating
pressure/temperature limit of a component at a given design and material

See Figure A.2.

3.1.2.5
normal
conditions at which usual operation is expected

3.1.2.6
allowable
limiting values and/or ranges of conditions for a pump as built, owing to the material and the design

3.1.2.7 Working

3.1.2.7.1
working
conditions existing at the moment when an event is noted or a quantity is measured

3.1.2.7.2
allowable working
limiting values and/or ranges of conditions at which the pump unit can be operated, owing to the material and the design

3.1.2.8
test
terms that describe the characteristics of the pump or fluid or the conditions that exist during an examination

3.1.2.9
nominal
appropriate rounded value of a magnitude to designate a component, a unit or a device

3.1.3 Rate of flow

NOTE These definitions refer to the quantities of liquid pumped.

3.1.3.1
mass rate of flow
q
mass of liquid discharged from the outlet area of the pump in a given time

NOTE 1 The mass rate of flow is expressed in units of kilograms per second, kilograms per hour, tonnes per hour (the tonne is considered a deprecated unit).

NOTE 2 It is preferable not to include in the mass rate of flow losses inherent to the pump, i.e. discharge necessary for the following, if they are taken from a point before the flow-measuring section:

a) hydraulic balancing of axial thrust;

b) cooling of bearings of the pump;

c) liquid seal to the packing;

d) leakage from fittings, internal leakage, etc.

NOTE 3 It is preferable to include in the mass rate of flow quantities used for other purposes, such as the following, if they are taken from a point before the flow-measuring section:

a) cooling of motor bearings;

b) cooling of gearbox (bearings, oil cooler), etc.

Whether and how these flows should be taken into account depends upon the location of their source and relationship to the flow-measuring section.

3.1.3.2
rate of flow
volume rate of flow
Q
volume of liquid discharged from the outlet area of the pump in a given time as given by Equation (1):

$$Q = \frac{q}{\rho} \tag{1}$$

where

q is the **mass rate of flow** (3.1.3.1);

ρ is the **density** (3.1.16.1), expressed in appropriate units of mass per volume.

NOTE 1 The rate of flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

NOTE 2 The symbol Q may be subscripted to designate the volume rate of flow occurring at any other observed point.

NOTE 3 In the quantities numbered 3.1.3.2 to 3.1.3.7, reference to “rate of flow” may be replaced by “mass rate of flow” in both the quantity and definitions.

3.1.3.2.1
optimum rate of flow
Q_{opt}
rate of flow at the point of best efficiency

NOTE The optimum rate of flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.2
rated flow
Q_r
rate of flow at the guarantee point, taking into account any necessary margin

NOTE The rated flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.3
normal flow
Q_n
rate of flow at which usual operation is expected

NOTE The normal flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.4
maximum flow
Q_{max}
greatest rate of flow that is expected at operating conditions

NOTE The maximum flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.5
minimum flow
Q_{min}
smallest rate of flow that is expected at operating conditions

NOTE The minimum flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.6
maximum allowable flow
$Q_{max,ad}$
greatest rate of flow that the pump can be expected to deliver continuously without risk of internal damage when operated at the rated speed and on the liquid for which it was supplied

NOTE The maximum allowable flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.7
minimum allowable flow
$Q_{min,ad}$
smallest rate of flow that the pump can be expected to deliver continuously without risk of internal damage when operated at the rated speed and on the liquid for which it was supplied

NOTE The minimum allowable flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.7.1
minimum allowable stable flow
$Q_{min,ad,st}$
lowest flow at which the pump can operate without exceeding the noise and vibration limits imposed in the order

NOTE The minimum allowable stable flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.2.7.2
minimum allowable thermal flow
$Q_{min,ad,therm}$
lowest flow at which the pump can operate without its operation being impaired by the temperature rise of the pumped liquid

NOTE 1 The minimum allowable thermal flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

NOTE 2 The user should specify the liquid properties, such as the specific heat and vapour pressure, according to the temperature per degrees Celsius.

3.1.3.3
balancing rate of flow
Q_B
rate of flow that is extracted to activate a balance device

NOTE The balancing rate of flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.4
leakage rate of flow
Q_L
rate of flow leaking from shaft seals

NOTE The leakage rate of flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.5
inlet rate of flow
Q_1
rate of flow passing the inlet area of the pump from the inlet side of the installation

NOTE The inlet rate of flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.6
outlet rate of flow
Q_2
rate of flow passing the outlet area of the pump into the outlet side of the installation

NOTE The outlet rate of flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.3.7
intermediate take-off rate of flow
$Q_{3,4,...}$
rate of flow passing through one or more intermediate take-off points

NOTE The intermediate take-off rate of flow is expressed in units of cubic metres per hour, cubic metres per second, litres per hour, litres per second.

3.1.4 Height

NOTE These definitions refer to the physical position of the observed point.

3.1.4.1
reference plane
any horizontal plane that can be used as the datum for height measurement

NOTE 1 A physical reference plane is more practical than an imaginary one for measurement purposes.

NOTE 2 The manufacturer should indicate the position of the reference plane as defined with respect to precise reference points on the exterior of the pump.

3.1.4.2
height
z
elevation of an observed point above a reference plane

NOTE 1 The height is expressed in units of metres.

NOTE 2 The height is positive if the observed point is higher than the reference plane.

NOTE 3 The symbol z may be subscripted to designate the height of any observed point.

3.1.4.3
height of the inlet connection
z_1
height of the centre of the inlet connection of the pump

NOTE The height of the inlet connection is expressed in units of metres.

3.1.4.4
height of the outlet connection
z_2
height of the centre of the outlet connection of the pump

NOTE The height of the outlet connection is expressed in units of metres.

3.1.4.5
height of the inlet-side measuring point
z_1'
height of the manometer connection in the pipe at the inlet side of the pump

NOTE 1 The height of the inlet-side measuring point is expressed in units of metres.

NOTE 2 Where an annular pressure chamber or several pressure tappings in the circumference of the pipe are used, the height shall be taken at the centre of the measuring profile.

3.1.4.6
height of the outlet-side measuring point

z_2'

height of the manometer connection in the pipe at the outlet side of the pump

NOTE 1 The height of the outlet-side measuring point is expressed in units of metres.

NOTE 2 Where an annular pressure chamber or several pressure tappings in the circumference of the pipe are used, the height shall be taken at the centre of the measuring profile.

3.1.4.7
height of the inlet side of the installation

z_{A1}

height of the liquid level on the inlet side of the installation or of the centre of the inlet manifold

See Figure A.1.

NOTE The height of the inlet side of the installation is expressed in units of metres.

3.1.4.8
height of the outlet side of the installation

z_{A2}

height of the liquid level on the outlet side of the installation or of the centre of the outlet manifold

See Figure A.1.

NOTE The height of the outlet side of the installation is expressed in units of metres.

3.1.4.9
height of the inlet manometer

z_{1M}

height of the zero or centre position of the inlet manometer or other point, as defined by the manometer calibration

See Figure A.1.

NOTE The height of the inlet manometer is expressed in units of metres.

3.1.4.10
height of the outlet manometer

z_{2M}

height of the zero or centre position of the outlet manometer or other point, as defined by the manometer calibration

See Figure A.1.

NOTE The height of the outlet manometer is expressed in units of metres.

3.1.4.11
level difference

$z_{x\text{-}x}$

difference in the height between two points

NOTE 1 The level difference is expressed in units of metres.

NOTE 2 The level difference is positive if the value at the point shown after the hyphen is greater than the value at the point shown before the hyphen.

3.1.5 Heads

NOTE These definitions refer to the energy of the fluid.

3.1.5.1
head
H
energy per unit mass of fluid divided by gravitation acceleration

NOTE 1 The head is expressed in units of metres.

NOTE 2 The head is considered as the height of a column of fluid at rest exerting a pressure on its bottom surface equivalent to the energy per unit mass being acted upon by the acceleration due to gravity.

NOTE 3 The symbol H may also be subscripted to designate the head occurring at any observed point.

3.1.5.1.1
pressure head
$H_{\mathrm{M}x}$
head corresponding to the pressure shown on a manometer observed at point x

NOTE The pressure head is expressed in units of metres.

3.1.5.1.2
velocity head
H_U
head corresponding to the kinetic energy in the fluid observed at the point indicated by the subscript

NOTE The velocity head is expressed in units of metres.

3.1.5.1.3
total head
$H_{\mathrm{t},x}$

head observed at point x, corresponding to the sum of the height, pressure head and velocity head of the fluid at point x, as given by Equation (2):

$$H_{\mathrm{t},x} = z_x + \frac{p_x}{\rho_x g} + \frac{U_x^2}{2g} \tag{2}$$

where

- p_x is the gauge pressure observed at point x;
- z_x is the height of point x;
- ρ_x is the density at point x;
- U_x is the mean velocity at point x;
- g is the acceleration due to gravity.

NOTE 1 The total head is expressed in units of metres.

NOTE 2 Atmospheric pressure at point x should be added into the above equation to convert it to absolute pressure.

3.1.5.1.3.1
installation total head
$H_{\mathrm{t,A2\text{-}1}}$
difference between the total head at the outlet side of the installation and the total head at the inlet side of the installation, as given by Equation (3):

$$H_{\mathrm{t,A2\text{-}1}} = H_{\mathrm{t,A2}} - H_{\mathrm{t,A1}} \tag{3}$$

NOTE The installation total head is expressed in units of metres.

3.1.5.1.3.2
pump total head
$H_{t,2\text{-}1}$
difference between the total head at the outlet side of the pump and the total head at the inlet side of the pump

See Figure A.1.

NOTE 1 The pump total head is expressed in units of metres.

NOTE 2 Frequently, the symbol H is used instead of $H_{t,2\text{-}1}$.

NOTE 3 The total differential head of the pump may be regarded as the useful mechanical output per unit mass of rate of flow imparted by the pump to the pumped fluid divided by the acceleration due to gravity.

NOTE 4 The equations for calculating total heads assume that pressure varies hydrostatically at the point of observation and that the compressibility of the liquid being pumped is negligible. If compressibility is significant, it is preferable to derive alternative equations.

3.1.5.1.3.3
pump unit total head
$H_{t,gr2\text{-}1}$
difference between the total head at the outlet side of the pump unit and the total head at the inlet side of the pump unit

NOTE The pump unit total head is expressed in units of metres.

3.1.5.2
static head
H_{stat}
portion of total head at an observed point in an installation that is independent of rate of flow

NOTE The static head is expressed in units of metres.

3.1.5.3
loss of head
$H_{Jx\text{-}x}$
difference in the head between two points

NOTE 1 The loss of head is expressed in units of metres.

NOTE 2 The loss may be expressed as total head, pressure head or velocity head.

3.1.5.4
height of the NPSH datum plane
z_D
difference between the **NPSH datum plane** (3.2.2.1) and the **reference plane** (3.1.4.1)

See Figure A.1.

NOTE The height of the NPSH datum plane is expressed in units of metres.

3.1.5.5
net positive suction head
NPSH
margin of the absolute value of the total head above the head equivalent to the vapour pressure of the liquid at the particular temperature, referred to the **NPSH datum plane** (3.2.2.1), as given by Equation (4):

$$\mathrm{NPSH} = H_1 - z_D + \frac{p_{amb} - p_v}{\rho_1 g} \quad (4)$$

where

H_1 is the **head** (3.1.5.1) at observation point 1;

z_D is the **height of the NPSH datum plane** (3.1.5.4), expressed in metres;

p_{amb} is the **atmosphere pressure** (3.1.9.2), expressed in pascals (bar);

ρ_1 is the **density** (3.1.16.1) at observation point 1;

g is the gravitational acceleration, expressed in metres per square second.

NOTE 1 The net positive suction head, NPSH, is expressed in units of metres.

NOTE 2 The NPSH is referred to the NPSH datum plane, whereas inlet total head NPSHA is referred to the centre of the inlet branch.

NOTE 3 A derogation has been given to allow the use of the abbreviation NPSH (upright and not bold) as a symbol in mathematical equations as a consequence of its well established, historical use in this manner.

3.1.5.5.1
net positive suction head available
NPSHA
minimum **NPSH** (3.1.5.5) available at the inlet area of the pump as determined by the conditions of the installation for a specified rate of flow

NOTE 1 The net positive suction head available, NPSHA, is expressed in units of metres.

NOTE 2 A derogation has been given to allow the use of the abbreviation NPSHA (upright and not bold) as a symbol in mathematical equations as a consequence of its well established, historical use in this manner.

3.1.5.5.2
net positive suction head required
NPSHR
minimum **NPSH** (3.1.5.5) at the pump inlet connection required to give rated or operating performance at the specified conditions

NOTE 1 The net positive suction head required, NPSHR, is expressed in units of metres.

NOTE 2 The minimum value may be determined by one of a number of different criteria, such as visible cavitation, increase of noise and vibration (due to cavitation), defined head or efficiency drop or limitation of cavitation corrosion.

NOTE 3 If the criterion used is not indicated, it should be assumed to be **NPSH3** (3.1.5.5.3).

NOTE 4 A derogation has been given to allow the use of the abbreviation NPSHR (upright and not bold) as a symbol in mathematical equations as a consequence of its well established, historical use in this manner.

3.1.5.5.3
net positive suction head required for a drop of 3 %
NPSH3
NPSH (3.1.5.5) required for a drop of 3 % in the total head of the first stage of the pump as a standard basis for use in performance curves

NOTE 1 The net positive suction head required for a drop of 3 %, NPSH3, is expressed in units of metres.

NOTE 2 A derogation has been given to allow the use of the abbreviation NPSH (upright and not bold) as a symbol in mathematical equations as a consequence of its well established, historical use in this manner.

3.1.6
specific energy
e
energy per unit mass of liquid, as given by Equation (5):

$$e = Hg_x \qquad (5)$$

where

H is the height, expressed in metres;

g_x is the gravitational acceleration at point x, expressed in metres per square second.

NOTE The specific energy is expressed in units of joules per kilogram or square metres per square second.

3.1.7 Cross-sectional areas

NOTE These definitions refer to the size of flow passages.

3.1.7.1
inlet area of the pump
A_1
free cross-sectional area of the entry opening in the inlet connection of the pump

NOTE 1 The inlet area of the pump is expressed in units of square metres.

NOTE 2 In the case of pumps with no inlet connection, the inlet area should be defined by examination.

3.1.7.2
outlet area of the pump
A_2
free cross-sectional area of the orifice in the outlet connection of the pump

NOTE 1 The outlet area of the pump is expressed in units of square metres.

NOTE 2 In the case of pumps with no outlet connection, the outlet area should be defined by examination.

NOTE 3 For pipe casing, submerged and other similar pumps with an ascending pipe-line as part of the pump, the cross-sectional area of the pipeline may be stipulated as the outlet area of the pump.

3.1.7.3
inlet area of the installation
A_{A1}
free cross-sectional area at a mutually agreed section of the inlet side of the installation where the area, height and pressure are known

NOTE The inlet area of the installation is expressed in units of square metres.

3.1.7.4
outlet area of the installation
A_{A2}
free cross-sectional area at a mutually agreed section of the outlet side of the installation where the area, height and pressure are known

NOTE The outlet area of the installation is expressed in units of square metres.

3.1.8 Velocity

NOTE These definitions refer to the speed of movement of liquid.

3.1.8.1
mean velocity at point x
U_x
rate of flow divided by the channel cross-section at point x, as given by Equation (6):

$$U_x = \frac{Q_x}{A_x} \tag{6}$$

NOTE The mean velocity at point x is expressed in units of metres per second.

