SLOVENSKI STANDARD
oSIST prEN 16480:2018

01-marec-2018

Črpalke - Centrifugalne črpalke - Minimalna zahtevana učinkovitost vodnih črpalk in metode za kvalifikacijo in verifikacijo

Pumps - Rotodynamic Pumps - Minimum required efficiency of water pumps and methods of qualification and verification

Pumpen - Kreiselpumpen - Geforderte Mindesteffizienz für Wasserpumpen sowie Methoden zur Qualifizierung und Verifizierung

Pompes - Pompes rotodynamiques - Rendement minimum requis des pompes à eau et méthodes de qualification et de vérification

Ta slovenski standard je istoveten z: prEN 16480

ICS:

23.080	Črpalke	Pumps

oSIST prEN 16480:2018 en,fr,de

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 16480

December 2017

ICS 23.080

Will supersede EN 16480:2016

English Version

Pumps - Rotodynamic Pumps - Minimum required efficiency of water pumps and methods of qualification and verification

Pompes - Pompes rotodynamiques - Rendement minimum requis des pompes à eau et méthodes de qualification et de vérification

Pumpen - Kreiselpumpen - Geforderte Mindesteffizienz für Wasserpumpen sowie Methoden zur Qualifizierung und Verifizierung

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 197.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. prEN 16480:2017 E

Contents **Page**

European foreword

This document (prEN 16480:2017) has been prepared by Technical Committee CEN/TC 197 "Pump", the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 16480:2016.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Introduction

Purpose and content of the standard

The water pumps within the scope of this European Standard are typically produced and sold by pump manufacturers as series of large to very large numbers. The performance characteristics of pumps of one size produced by a manufacturer show some scatter caused by manufacturing tolerances, but are described by mean values and curves which represent that size.

The total consumption of electric energy by water pumps installed in applications within the scope of this European Standard depends on the total number of installed pumps of each size and on its mean efficiency. The quality of a size in respect to its mean efficiency is quantitatively described by the Minimum Efficiency Index (MEI) which is defined and used in this standard. To achieve a certain value of the Minimum Efficiency Index (MEI), a corresponding minimum value of the mean efficiency of a size is required.

This European Standard defines – for each pump type and size within the scope of the standard - the minimum required value of efficiency depending on the value of the Minimum Efficiency Index (MEI). Also, this standard prescribes how the value of the Minimum Efficiency Index (MEI) of a pump size indicated by the manufacturer can be verified by an independent institution (e.g. in the frame of market surveillance). For the manufacturer of the pump size it is generally left free how to prove the indicated value of the Minimum Efficiency Index (MEI) of a size. Nevertheless, this standard describes also a method to prove by the manufacturer that the mean values of efficiency meet the requirements for indicating a certain value of the Minimum Efficiency Index (MEI).

Normally, the qualification of a pump size for a certain MEI value done by the manufacturer will be based on tests and evaluations made on a sample of pumps of this size. Tests and evaluations carried out for the purpose of qualifying the corresponding size should fulfil certain requirements:

— From the tests on the sample pumps, it becomes possible to predict for the corresponding size the confidence intervals within which the true mean values of efficiencies which are relevant for the qualification are enclosed with a sufficiently high probability. Only in that way, the qualification of the size in respect to a required and/or indicated value of Minimum Efficiency Index (MEI) will make sure that the aspired effect of energy saving will be reached.

— If a pump size has been qualified according to the criteria described in this European Standard, every test on one or more test pump(s) of the same size (with a full impeller diameter) which is carried out in the frame of a verification procedure should result with a very high probability in a confirmation of the qualification.

Caused by technical alignment procedures of the single pump components e.g. bearings or shaft seals the performance of the pump is gained after a certain running-in time.

Ways to prove and to verify the Minimum Efficiency Index (MEI) of a pump size

This European Standard describes different ways how manufacturers can achieve the qualification of a pump size for a certain value of the Minimum Efficiency Index (MEI) and how this qualification can be verified by an independent institution.

For the manufacturer it is generally left free to choose and apply appropriate methods to prove that the mean efficiency values of a size are at least equal to or higher than particular threshold values of efficiency. These particular threshold values of efficiency are related to the value of the Minimum Efficiency Index (MEI) to be indicated for the size. The way to determine these values of efficiency is described in this standard. If the way chosen by the manufacturer to prove the MEI value of a size deviates from the way mentioned in the next paragraph, the manufacturer has to document all tests, evaluations and/or calculations which are carried out and the methods which are applied to prove the justification of the indicated MEI value.

If the manufacturer decides to determine the mean performance values of the size by one of the methods described in Annex D of this standard, he has to carry out tests according to the requirements given in Annex C of this standard and evaluations as described in Annex C of this standard and to prove – as described in Clause 7 of this standard – that the criteria for the achievement of a certain value of the Minimum Efficiency Index (MEI) of the size are fulfilled. The test conditions, the results of test evaluation and the fulfilment of the criteria are documented and stored. The time period to keep documentation available for the authorities to prove conformity is fixed by the legal text.

The independent institution carries out tests on pumps of the size in question according to the requirements given in 5.2 to 5.4 of this standard as well as evaluations as described in 5.5 of this standard and applies the methodology and procedure described in Clause 4 of this standard.

For an independent institution, two ways are possible and specified by this standard to verify the value of Minimum Efficiency Index (MEI) indicated by the manufacturer:

1) If the documentation of the qualification is presented by the manufacturer to the independent institution on request, the procedure of verification executed by the independent institution is based on the documentation of tests and evaluations done and documented by the manufacturer. In this case, the documentation will be checked by the independent institution in respect to being in accordance with requirements and criteria given in this standard.

2) If no documentation is presented by the manufacturer on request or if the documentation presented by the manufacturer on request is not accepted as proof of the indicated value of MEI, the independent institution carries out tests on pumps of the size in question according to the requirements given in Annex C of this standard as well as evaluations as described in 5.5 of this standard and applies the methodology and procedure described in Clause 4 of this standard.

Relevance of clauses of this standard for manufacturers or independent institutions

Clause 4 describes nominal values of minimum required efficiency for a certain value of the Minimum Efficiency Index (MEI) and is generally relevant when applying this standard.

Section 5 specifies test procedures, test conditions and evaluations and has to be applied

— by a manufacturer in the case that he decides to determine mean values of a size by tests on sample pumps of this size (e.g. by methods described in Annex D),

— by an independent institution in the case that the Minimum Efficiency Index (MEI) of a pump size should be verified by the procedure described in Clause 7.

Clause 6 describes the procedure to be applied by a manufacturer in order to determine particular threshold values of efficiency for a certain value of the Minimum Efficiency Index (MEI) of a size and to prove the justification of this MEI value by the fulfilment of criteria for the mean efficiency values.

Clause 7 describes the methodology and procedure to be applied by an independent institution in the case that the Minimum Efficiency Index (MEI) of a size indicated by the manufacturer should be verified by third party tests on pumps of this size.

Annex C is concerned with mean values of a pump size which are relevant for manufacturers to prove that a pump size achieves a certain value of the Minimum Efficiency Index (MEI).

1 Scope

This document specifies performance requirements (methods and procedures for testing and calculating) for determining the Minimum Efficiency Index (MEI) of rotodynamic glanded water pumps for pumping clean water, including where integrated in other products.

The pump types and sizes covered by this standard are described in the Annex A. These pumps are designed and produced as duty pumps for pressures up to 16 bar for end suction pumps and up to 25 bar for multistage pumps, temperatures between −10 °C and +120°C and 4" or 6" size for submersible multistage pumps at operating temperatures within a range of 0 °C and 90 °C.

In addition this standard specifies how the value of the Minimum Efficiency Index (MEI) of a pump size indicated by the manufacturer can be checked by market surveillance.

Even if it is left free to the manufacturer of a pump size, how to prove the rated value of the Minimum Efficiency Index (MEI), nevertheless this standard specifies a method to prove that this rated value meets the requirements within the confidence intervals with a sufficiently high probability.

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.

EN ISO 9906, *Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3 (ISO 9906)*

ISO 31, *General principles concerning quantities, units and symbols*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 9906 and the following 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 http://www.iso.org/obp

3.1.1 List of quantities with definitions[1)]

3.1.1.1
reynolds number
dimension less number that gives a measure of the ratio of inertial forces to viscous forces and consequently quantifies the relative importance of these two types of forces for given flow conditions. In this standard, it is defined by the relation:

$$\mathrm{Re} = \frac{D_{imp} \cdot u}{\nu}$$

where u is the peripheral velocity at the outer impeller diameter D_{imp}

3.1.1.2
(volume) rate of flow
external rate of flow of the pump, i.e. the rate of flow discharged into the pipe from the outlet branch of the pump

NOTE 1 to entry: Losses or abstractions inherent to the pump, i.e.:

— discharge necessary for hydraulic balancing of axial thrust;

— cooling of bearings of the pump itself;

— water seal to the packing;

NOTE 2 to entry: Leakage from the fittings, internal leakage, etc., is not to be reckoned in the rate of flow. On the contrary, all derived flows for other purposes, such as cooling of the motor bearings; cooling of a gear box (bearings, oil cooler), etc. are to be reckoned in the rate of flow.

NOTE 3 to entry: Whether and how these flows shall be taken into account depends on the location of their derivation and of the section of flow-measurement respectively.

3.1.1.3
driver power input
power absorbed by the pump driver

3.1.1.4
pump efficiency

$$\eta = \frac{P_{\text{hyd}}}{P_2} = \frac{\textit{Hydraulic output}}{\textit{Pump power input}}$$

3.1.1.5
driver efficiency

$$\eta_{\text{dr}} = \frac{P_2}{P_1} = \frac{\textit{Pump power input}}{\textit{Driver power input}}$$

[1)] 3.1.1 gives specific definitions of terms - in deviation of EN ISO 9906 - used in this European Standard, together with any associated symbols which have been allocated and is based on ISO 31.

3.1.1.6
overall efficiency

$$\eta_{tot} = \frac{P_{hyd}}{P_1} = \frac{Pump\ power\ output}{Driver\ power\ input}$$

3.1.1.7
specific speed
dimensional number characterising the impeller type (radial, semi-axial, axial) of rotodynamic pumps

$$n_s = n_N \cdot \frac{\sqrt{Q_{BEP}}}{H_{BEP}^{0.75}}$$

Note 1 to entry: For multistage pumps, H_{BEP} is the head per stage which results from dividing the total pump head at the point of best efficiency by the number of stages i

Note 1 to entry: The specific speed of an individual pump or the mean specific speed of a pump size is a (dimensional) value which characterizes the impeller shape (radial, semi-axial, axial) of the pump or the size. The numerical value of the specific speed is defined by an equation given in 3.2.7 by using special units for the quantities contained in this equation. As described in Clause 4, the specific speed is one of the parameters which the nominal values of minimum required efficiency depend on.

3.1.1.8
minimum efficiency index (MEI)
value which determines the minimum required efficiency for the qualification criteria and, thereby, is a measure of the quality of a pump size in respect to efficiency

Note 1 to entry: dimensionless scale unit for hydraulic pump efficiency at BEP, PL and OL

Note 2 to entry: The MEI is the result of a statistical analysis of the performances of a large number of commercial pump sizes, and corresponds to the various "quartiles" of the statistical distribution.

For example, MEI = 0,40 corresponds to the efficiency performance level that 40 % of the pumps on the market do not meet [7].

3.1.2 General definitions

3.1.2.1
qualification
procedure where the manufacturer of the pump size proves, by appropriate methods, the fulfilment of the efficiency criteria defined in this standard

Note 1 to entry: Generally, the qualification criteria refer to the mean values of the size which are valid for the full impeller diameter and which will be determined by tests and evaluations on pumps of the respective size. These mean efficiency values and their confidence intervals are compared to nominal values of minimum required efficiency. Also these values depend on parameters (see Clause 4) the values of which partly result from the tests and are determined with some uncertainty or tolerance. Therefore, so-called particular threshold values of efficiency are determined and used in the frame of the qualification procedure for comparison with the mean values.

3.1.2.2
verification
procedure where an independent institution checks the result of the qualification procedure, in the frame of market surveillance

Note 1 to entry In this case, the tests and the evaluation of the test data are carried out according to Clause 5 of this European Standard. The approval decision is taken according to the procedure described in Clause 7 of this European Standard.

3.1.2.3
independent institution/market surveillance
organisation mandated by the market surveillance for verification of MEI values indicated by manufacturers

Note 1 to entry these organisations are generally called independent institutions whatever the special type of the institution (non-governmental organization (NGO), neutral institute, market surveillance authorities or similar) may be.

Note 2 to entry neutral institutions or similar organisations can also be mandated by a manufacturer for the qualification procedure, in this case they are not considered as independent institution when applying this standard.

3.1.2.4
minimum required efficiency $\eta_{min,requ}$
value of efficiency that have to be reached in order to fulfil a particular MEI value

Note 1 to entry: the value of minimum required efficiency depends on certain properties of the pump size (pump type, nominal speed of rotation, flow rate at best efficiency point and specific speed) and on the Minimum Efficiency Index (MEI). For one size, different minimum required efficiencies are relevant at best efficiency point, at specified part load and overload operating points, respectively.

3.1.2.5
particular threshold values of efficiency ($\eta_{threshhold}$)
values calculated from the minimum required efficiency by subtracting a total tolerance

3.1.2.6
pump size
range of pumps characterized by certain dimensions (e.g. nominal diameter of discharge flange and nominal impeller diameter for end-suction and multistage pumps, number of stages for multistage pumps, nominal outer casing diameter in the case of submersible multistage pumps) and given in his catalogues by the manufacturer

Note 1 to entry: In a Q-H-chart each pump size covers a certain range of Q- and H-values. Within this range each duty point can be served by a pump of the corresponding pump size by adapting its Q-H-curve by impeller trimming, i.e. by cutting down the outer impeller diameter to an appropriate value. The upper limit of the Q-H-range covered by one pump size is determined by the full diameter of the impeller corresponding to this size.

3.1.2.7
full impeller diameter of a pump size
impeller with the maximum diameter for which performance characteristics are given for a pump size in the catalogues of a water pump manufacturer

3.1.2.8
best efficiency point, BEP
operating point where the greatest value of pumps efficiency is obtained, at nominal speed of rotation

3.1.2.9
part Load PL
particular operating point in the range of operating points with lower flow than best efficiency point, at nominal speed of rotation

3.1.2.10
overload OL
particular operating point in the range of operating points with higher flow than best efficiency point, at nominal speed of rotation

3.2 Symbols and abbreviations

Table 1 gives an alphabetical list of symbols used and Table 2 gives a list of subscripts. As far as possible, the quantities, definitions and symbols used in this standard comply with those used in EN ISO 9906. Quantities, definitions and symbols used in EN ISO 9906, but not needed in this standard are not contained 3.2 and Tables 1 and 2 while these tables contain some quantities, definitions and symbols which are not used in EN ISO 9906.

In this document all equations are given in coherent SI-units.

Table 1 — Alphabetical list of basic letters used as symbols

Symbol	Quantity	Unit
A	Area	m^2
C	Constant	pure number
D	Diameter	m
e	Measurement uncertainty, relative value	pure number
f	Frequency	s^{-1}, Hz
g	Acceleration due to gravity	m/s^2
H	Pump total head	m
k	number of instrument readings or sample pumps	pure number
m	Mass	kg
M	number of pumps of a sample	pure number
n	Speed of rotation	s^{-1}, min^{-1}
N	Number of instrument readings	pure number
n_s	Specific speed	min^{-1}
p	Pressure	Pa
p	Probability	pure number
P	Power	W
Q	(Volume) rate of flow	m^3/s

s	Standard deviation of a sample	according to special quantity
t	Tolerance factor, relative value	pure number
t	Time	s
t	Student's factor	pure number
T	Torque	Nm
u	Peripheral velocity	m/s
U	Mean velocity	m/s
U	Voltage	V
v	Local velocity	m/s
V	Volume	m^3
x	General quantity	according to special quantity
y	General quantity	according to special quantity
z	Height above reference plane	m
z	number of produced pumps	pure number
η	Efficiency	pure number
θ	Temperature	°C
ν	Kinematic viscosity	m^2/s
ρ	Density	kg/m^3
ω	Angular velocity	rad/s
σ	Standard deviation of normal distribution	according to special quantity

NOTE For a list of concise designations (short-term description) of pump types in scope see Annex B.

Table 2 — List of letters and figures used as subscripts

Subscript	Meaning
1	electrical
2	mechanical
abs	absolute
amb	ambient
annual	per year
curve	on fitting curve
BEP	at best efficiency point
dr	driver
D	datum
exp	experimentally determined
G	guaranteed
H	pump total head
I	numbering index
J	numbering index
imp	impeller
man	manufacturing
max	maximum permissible
mean	mean value of pump series
min,requ	minimum required
N	nominal
OL	overload
Pd	pre-defined
P	power
PL	part load
Q	(volume) flow rate
R	random
S	specific, systematic
sync	synchronous
tot	total, overall
true	true value
T	torque
T	translated
v	vapour