SLOVENSKI STANDARD
oSIST prEN 17038-4:2021

01-oktober-2021

Črpalke - Metode za opredelitev indeksa energijske učinkovitosti centrifugalnih črpalk - 4. del: Preskušanje in računanje indeksa energijske učinkovitosti (IEE)

Pumps - Methods of qualification of the Energy Efficiency Index for rotodynamic pump units - Part 4: Testing and calculation of energy efficiency index (EEI) of submersible multistage pump units

Pumpen - Methoden zur Qualifikation des Energieeffizienzindexes für Kreiselpumpen - Teil 4: Prüfung und Berechnung des Energieeffizienzindexes (EEI) mehrstufiger Tauchmotorpumpenaggregate

Pompes - Méthodes de qualification de l'indice de rendement des groupes motopompes rotodynamiques - Partie 4 : Essais et calcul de l'indice de rendement énergétique (EEI) pour les unités de pompage submersibles des forages

Ta slovenski standard je istoveten z: **prEN 17038-4**

ICS:

23.080	Črpalke	Pumps
27.015	Energijska učinkovitost. Ohranjanje energije na splošno	Energy efficiency. Energy conservation in general

oSIST prEN 17038-4:2021 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 17038-4

August 2021

ICS 23.080

English Version

Pumps - Methods of qualification of the Energy Efficiency Index for rotodynamic pump units - Part 4: Testing and calculation of energy efficiency index (EEI) of submersible multistage pump units

Pompes - Méthodes de qualification de l'indice de rendement des groupes motopompes rotodynamiques - Partie 4 : Essais et calcul de l'indice de rendement énergétique (EEI) pour les unités de pompage submersibles des forages

Pumpen - Methoden zur Qualifikation des Energieeffizienzindexes für Kreiselpumpen - Teil 4: Prüfung und Berechnung des Energieeffizienzindexes (EEI) mehrstufiger Tauchmotorpumpenaggregate

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, 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: Rue de la Science 23, B-1040 Brussels

Ref. No. prEN 17038-4:2021 E

Contents

European foreword

This document (prEN 17038-4:2021) has been prepared by Technical Committee CEN/TC 197 “Pumps”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

Introduction

This document is the fourth part of a series of standards describing a methodology to evaluate energy efficiency performance of submersible multistage pump units (MS-S), comprising a rotodynamic pump part and a submersible motor which is either directly fed from the grid or combined with a frequency converter (CDM) to form a Power Drive System (PDS). For consistency purposes with other referred standards, CDM is used in this document. VSD, for variable speed drive, is the term used in Ecodesign regulations. Rotodynamic pump and motor are designed with outer diameters and special design features that enable to install them in boreholes and operate them completely surrounded by the pumped liquid. The methodology is based on a non-dimensional numerical value called Energy Efficiency Index (*EEI*). An EEI value allows the comparison of different configurations by one common indicator. Physical influences such as size and stage number of the incorporated rotodynamic pump, unit part-load operation, motor-efficiency characteristic and frequency converter influence are implemented into this metric.

Specific requirements for testing and a calculation method for *EEI*, the so called semi-analytical model (SAM) of submersible multistage pump units, specific flow-time profiles and reference pressure control curves are given in this document.

EEI is an index to rate submersible multistage pump units according to their energy efficiency but does not replace the need to do a life-time cost analysis regarding energy consumption over the lifetime of the submersible multistage pump unit.

1 Scope

This document specifies methods and procedures for testing, calculating, and determining the Energy Efficiency Index (*EEI*) of submersible multistage pump units.

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 16480:2021, *Pumps — Rotodynamic pumps — Minimum required efficiency of rotodynamic water pumps and determination of Minimum Efficiency Index (MEI)*

EN 17038-1:2019, *Pumps — Methods of qualification and verification of the Energy Efficiency Index for rotodynamic pump units — Part 1: general requirements and procedures for testing and calculation of Energy Efficiency Index (EEI)*

EN 17038-2:2019,[1] *Pumps — Methods of qualification and verification of the energy efficiency index for rotodynamic pump units — Part 2: Testing and calculation of energy efficiency index (EEI) of single pump units*

EN ISO 9906:2012, *Rotodynamic pumps — Hydraulic performance acceptance tests — Grades 1, 2 and 3 (ISO 9906:2012)*

EN ISO 17769-1:2012, *Liquid pumps and installation — General terms, definitions, quantities, letter symbols and units — Part 1: Liquid pumps (ISO 17769-1:2012)*

EN 60034-1:2010, *Rotating electrical machines — Part 1: Rating and performance (IEC 60034-1:2010)*

EN 60034-2-1:2014, *Rotating electrical machines — Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles) (IEC 60034-2-1:2014)*

EN IEC 60034-2-3:2020, *Rotating electrical machines — Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors (IEC 60034-2020)*

EN IEC 60038:2011/prA1:2020, *{fragment 1}, Standard voltages for LVDC supply and LVDC equipment (Proposed horizontal standard)*

EN IEC 60038:2011/prA1:2020, *{fragment 2}, Standard voltages for AC supply and AC equipment (Proposed horizontal standard)*

EN IEC 60038:2011/prA1:2020, *{fragment 3}, Standard voltages for DC and AC traction systems (Proposed horizontal standard)*

EN 61800-9-2:2017, *Adjustable speed electrical power drive systems — Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications — Energy efficiency indicators for power drive systems and motor starters (IEC 61800-9-2:2017)*

[1] As impacted by EN 17038-2:2019/AC:2020.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 17769-1:2012 and the following apply.

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

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

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

3.1
submersible multistage water pump unit
MS-S
a submersible multistage water pump unit is composition of submersible multistage pump and submersible borehole motor with or without Variable Speed Drive (VSD)

3.2
submersible borehole motor
electric motor designed to be operated submersed at operating temperatures not below 0 °C and not above 40 °C

3.3
submersible multistage pump
MSS
multistage ($i > 1$) rotodynamic water pump with a nominal outer diameter from 2,5″ (63,5 mm) up to 6″ (152,4 mm) designed to be operated submersed, at operating temperatures within a range of 0 °C and 90 °C; with a nominal flow rate > 1,75 m^3/h

3.4
clean water
water with a maximum non-absorbent free solid content of 0,25 kg/m^3, and with a maximum dissolved solid content of 50 kg/m^3, provided that the total gas content of the water does not exceed the saturation volume

Note 1 to entry: Any additives that are needed to avoid water freezing down to – 10 °C shall not be considered.

3.5
clean cold water
clean water to be used for pump testing, with a maximum kinematic viscosity of 1,5 × 10^{-6} m^2/s, a maximum density of 1 050 kg/m^3 and a maximum temperature of 40 °C

3.6
fixed-speed pump unit
pump unit without a variable speed drive (VSD)

3.7
variable-speed pump unit
pump unit equipped with an VSD

3.8
complete drive module
CDM
variable speed drive
VSD
electronic power converter connected between the electric supply and a motor as well as extensions such as protection devices, transformers and auxiliaries (according to EN 61800-2)

Note 1 to entry: This term is defined in EN 61800-2.

3.9
power drive system
PDS
combination of CDM and motor

3.10
check-valve
non-return valve

Note 1 to entry: Such a valve is often integrated in submersible multistage pump units.

3.11
constant flow
slight variation of the flow rate around the nominal value

Note 1 to entry: Caused by secondary influences from the process as, for example, the (moderately) varying level of liquid in reservoirs, etc. The variation of flow rate occurs typically within the range which is covered by the definition and determination of the Minimum Efficiency Index (*MEI*) of the pump (see EN 16480), and which is from 0,75 $Q_{100\ \%}$ to 1,1 $Q_{100\ \%}$.

3.12
variable flow
widely varying flow rate

Note 1 to entry: Typically, at considerable fractions of the total operating time, the actual demand for pump flow rate Q and pump head H is much lower than the values at the operating point of maximum flow rate which is demanded by the application.

3.13
suction pressure
pressure at the inlet of submersible multistage pump

Note 1 to entry: All pressures are gauge pressures (relative to the ambient pressure).

3.14
discharge pressure
pressure at the outlet of a submersible multistage pump

3.15
total differential head
the total differential head (or only head) of the submersible multistage pump is according to Formula (1):

$$H = z_2 - z_1 + \frac{p_d - p_s}{\rho \cdot g} \quad (1)$$

where

H is the total differential head [m];

z_2 is the geodetic height of reference level;

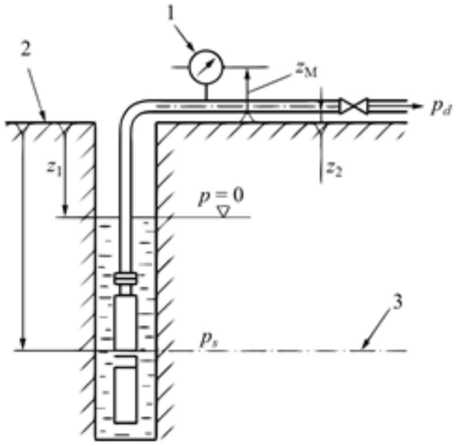
z_1 is the geodetic height of dynamic water level;

p_d is the discharge pressure [Pa];

p_s is the suction pressure [Pa];

ρ is the density of the test water at 20 °C (= 998,2 kg/m^3);

g is the gravitational constant (= 9,81 m/s^2).



Key

1 pressure reading

2 reference plane

3 NPSH datum plane

p_d is the discharge pressure [Pa]

p_s is the suction pressure [Pa]

p is the density of the test water at 20 °C (i.e. 998,2 kg/m^3)

z_2 geodetic height of reference level

z_1 geodetic height of dynamic water level

z_M geodetic height of pressure reading to reference plane

Figure 1 — Designations in submersible borehole pump unit set-up

Note 1 to entry: The differences of dynamic head $U^2/(2 \cdot g)$ (with c = flow velocity) and geodetic height z between inlet and outlet of the submersible multistage pump are typically very small compared to the pressure head and are, therefore, neglected in Formula (1).

3.16
hydraulic power
arithmetic product of the flow *Q* and the head *H*, and a constant a per Formula (2):

$$P_{hyd} = \rho \cdot Q \cdot g \cdot H \qquad (2)$$

where

P_{hyd} is the hydraulic power [W];

Q is the flow [m³/s];

H is the total head [m];

g gravitational constant 9,81 m/s²;

ρ is the density of fluid [kg/m³].

3.17
electric power input
electric power supplied:

— to the motor in the case of a (grid fed) fixed speed pump unit;

— to the CDM in the case of a variable speed pump unit

3.18
pump unit efficiency
ratio of hydraulic power *Phyd* and electric power input P_1

3.19
pump unit best efficiency point
$Q_{BEP,unit}$ **/** $H_{BEP,unit}$
flow-head-point where the pump unit runs at its best unit efficiency point and at maximum operation

3.20
reference flow rate, $Q_{100\%}$
flow per time unit [m³/s] or [m³/h] at the Best Efficiency Point (BEP) of the pump unit

3.21
reference head, $H_{100\%}$
total differential head [m] at the Best Efficiency Point (BEP) of the pump unit

3.22
control curve
functional dependency of the demanded head *H* vs. the delivered flow rate *Q* in the form of a non-dimensional correlation $H/H_{100\%}$ = f $(Q/Q_{100\%})$

3.23
reference control curve
pre-defined functional dependency $H/H_{100\%}$ = f $(Q/Q_{100\%})$ for standardised measurements and calculations of average power input $P_{1, avg}$