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Centrifugalne ļrpalke - Sile in momenti na prirobnicah - Centrifugalne, meġane in aksialne ļrpalke s horizontalnimi in vertikalnimi gredmi

Rotodynamic pumps - Forces and moments on flanges - Centrifugal, mixed flow and axial flow horizontal and vertical shafts pumps

Rotodynamische Pumpen - Zulässige Flanschenkräfte und Momente - Kreiselpumpen, Halbaxialaufpumpen und Axialpumpen mit horizontaler und verticaler Achse

Pompes rotodynamiques - Forces et moments applicables aux brides - Pompes centrifuges, hélico-centrifuges et hélices à axes horizontal et vertical

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Rotodynamische Pumpen - Zulässige Flanschenkräfte und Momente - Kreiselpumpen, Halbaxialaufpumpen und Axialpumpen mit horizontaler und verticaler Achse

This Technical Report was approved by CEN on 13 October 2008. It has been drawn up by the Technical Committee CEN/TC 197.

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Contents

Page

Foreword

This document (CEN/TR 13931:2009) has been prepared by Technical Committee CEN/TC 197 “Pumps”, the secretariat of which is held by AFNOR.

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

This document supersedes CR 13931:2000.

The pumps families are numbered sequentially, leaving room for the inclusion of additional types if required at a later date:

— horizontal shaft pumps: N° 1 to 8[1];

— vertical shaft pumps: N° 20 to 36[1].

The pump families are described and illustrated in Tables 2 and 5.

Annexes A and B are for information only.

1 Numbers 9 to 19 are reserved for potential new families of pumps.

1 Scope

This CEN Technical Report provides information for the calculation of maximum permissible forces and moments allowed on the flanges of various types of horizontal and vertical shaft rotodynamic pumps, caused by the reaction to pipework that is rigidly connected to the installation. This document does not take into account the effect of any elastic or deformable linkages, such as bellows, elastic joints, self butting sliding joints, etc.

This CEN Technical Report is not applicable to multistage monobloc pumps, whose outlets are remote from the installation plane, or to horizontal shaft pumps mounted vertically for installation reasons, such as, fixing to a vertical wall.

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.

EN 22858, *End-suction centrifugal pumps (rating 16 bar) - Designation, nominal duty point and dimensions (ISO 2858:1975)*

EN ISO 5199:2002, *Technical specifications for centrifugal pumps - Class II (ISO 5199:2002)*

API 610, *Centrifugal pumps for general refinery service*

3 Responsibilities of manufacturer and purchaser

3.1 General

The manufacturer should inform the purchaser of the family to which the equipment offered belongs.

The purchaser should calculate the loads applied to the pump at its flanges, considered for all possible relevant conditions (at ambient temperature, at operating temperature, at rest, under pressure).

The purchaser should ensure that the values of these loads do not exceed the corresponding calculated limits for the pump selected. If they do, the pipework should be modified to reduce the loads, or a different type of pump, capable of withstanding higher loads, shall be selected.

Both parties should agree on the type of baseplate to be provided (conventional, reinforced, concrete, etc.).

The basic values given in Tables 2 and 5 and Annex B correspond to the most common sizes of pumps; for larger sizes of pumps, the manufacturer shall indicate the limiting values.

3.2 Design considerations

Excessive loads transmitted to a pump by the piping can compromise smooth running and reduce the life of the pump, the coupling and perhaps the motor bearings, increase the demand for maintenance and, in the extreme, will cause failure. These adverse effects result from two distinct causes:

— displacement of the pump shaft end relative to that of the driver. The misalignment will overload the pump and driver bearings and, when a flexible coupling is used, increase its rate of wear.

— distortion of the pump casing, changing the internal clearances between the fixed and rotating parts, thus increasing wear and vibrations, sometimes leading to seizure. If mechanical seals are installed, parallelism of the faces will be upset, causing leakage and rapid breakdown.

It is for these reasons that limits must be set to the external forces and moments acting on the flanges. Manufacturers are responsible for verifying that the pump offered will operate satisfactorily when these limits are not exceeded.

4 Criteria adopted in setting limiting forces and moments

4.1 Shaft-end movement

The lateral displacement of the shaft-end, relative to a fixed point in space, is given in Table 1 for the various pump families, as a function of shaft size.

Table 1 — Criteria for forces and moments limitations

Type of pump	Families	Shaft-end diameter (mm)	Displacement (mm)
Standard (N) Modular	1A, 1B 3A 4A, 4B	< 30 (N24) 31-40 (N32) > 40 (N42)	0,15 0,20 0,25
Other horizontal Pumps	2, 3B, 3C 5A, 5B 6, 7, 8A, 8B, 8C	≤ 50 > 50 > 50	0,125 0,175 0,175
Vertical pumps	All (20A-36B)	All	0,150

4.2 Distortion of the pump casing

It is the responsibility of the pump manufacturer to verify that the loads applied on the flanges, in any of the permitted combinations, do not cause greater changes in internal clearance or disturbances to the mechanical seals than are allowed by his own design rules or those of the specifications imposed by the user, whichever are the more stringent.

4.3 Validity of force and moment values – Effects of materials and temperature

Unless indicated otherwise, the values for forces and moments are given for the basic material for the pump family (see Tables 2 and 5) and for a maximum permissible temperature as shown. For other materials and higher temperatures, the values shall be corrected by applying the modulus of elasticity relation, namely:

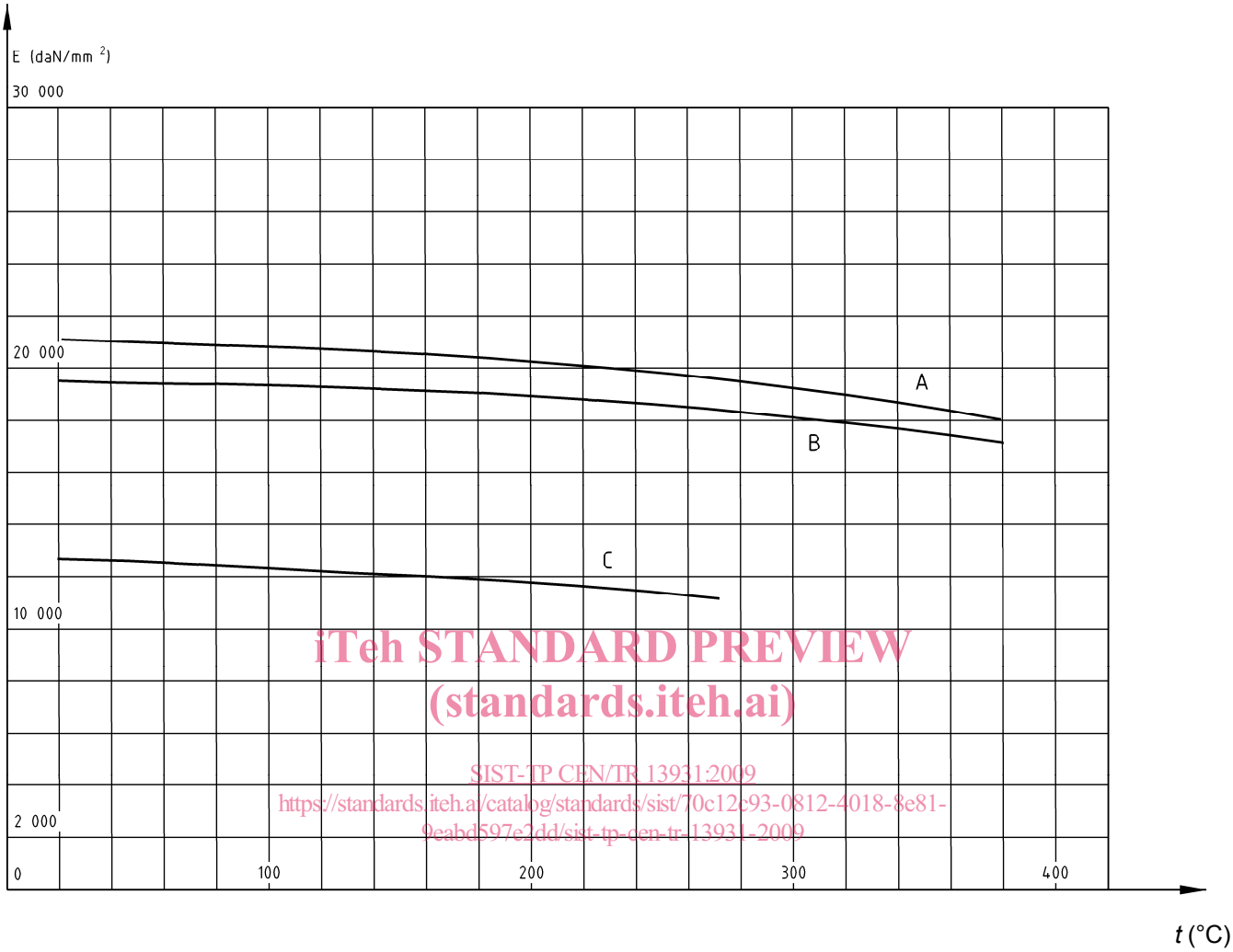
$$\frac{E_{tm}}{E_{20b}}$$

where

E_{20b} modulus of elasticity of the basic material at 20 °C

$E_{t.m}$ modulus of elasticity of the selected material at temperature t °C

For lamellar graphite cast iron, unalloyed steel and grade 18.8 stainless steel, refer to the graph in Figure 1.



Key

A Unalloyed steel

B Type 18.8 stainless steel

C Grey cast iron

Figure 1 — Variation of modulus of elasticity (*E*) as a function of temperature

5 Horizontal shaft pumps

5.1 Definition of pump families and summary of features

Pump families are defined on the basis of the most commonly used geometric configurations and the most frequent operating conditions. They are numbered from 1 to 8, as listed and described in Table 2.

Pumps with characteristics different from those in Table 2 should be subject to agreement between the parties concerned.

Table 2 — Characteristics of horizontal pump families

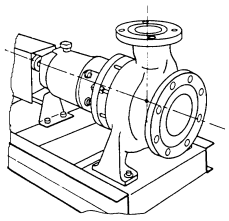
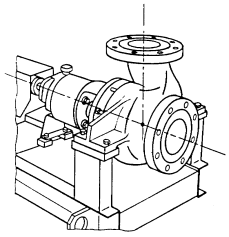
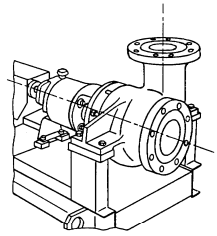
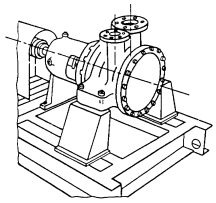
Family No. and Number of stages [1]	General Picture and description	Technical limits			Material	Remarks	Coefficients to apply to basic values		Additional possibilities [2]	
		Allowable Working		Flange DN_{max}			Forces (N)	Moment (N.m)	Reinforced mounting	Other
		pressure bar	Temperature °C							
1.A 1 stage	 Single stage, overhung bearing frame; feet on casing; mounted at base level. Axial inlet; outlet vertical on pump centreline.	10	110	200 (Outlet)	Cast iron	Dimensions in accordance with EN 22858.	x 0,50	X 0,50	yes	no
1.B 1 stage		16	250	200 (Outlet)	Cast steel		x 1	x 1	yes	no
2 1stage		10	110	500	Cast iron		x 0,40	x 0,40	yes	no
3.A 1 stage	 Single stage, overhung bearing frame; feet on casing; mounted at centreline level. Axial inlet; outlet vertical on pump centreline.	30	300	200 (Outlet)	Cast steel	Pump similar to EN 22858 but with casing mounted at centreline level.	x 1,2	x 1,2	yes	no
3.B 1 stage or 2 stages	  Single or two stage, overhung bearing frame; feet on casing; mounted at centreline level. Axial or overhead inlet; outlet vertical.	55	430	350	Cast steel	Equipment in accordance with API 610.	x 0,85	(- 500) on every axis x 1	yes	yes

Table 2 *(continued)*

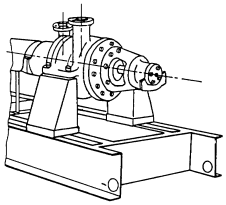
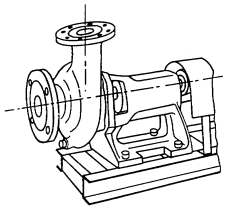
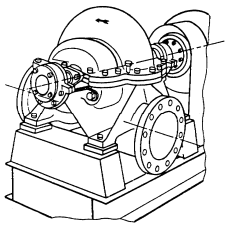
Family No. and Number of stages [1]	General Picture and description	Technical limits			Material	Remarks	Coefficients to apply to basic values		Additional possibilities [2]	
		Allowable Working pressure bar	Allowable Working Temperature °C	Flange DN_{max}			Forces (N)	Moment (N.m)	Reinforced mounting	Other
3.C 1 stage	 Single stage, impeller between bearings; feet on casing; mounted at centreline level. Inlet vertical; outlet vertical.	55	530	450	Cast steel	Equipment in accordance with API 610.	x 1	x 1	yes	yes
4.A	 Single stage, overhung bearing frame; feet on bearing frame; mounted at base level. Axial inlet; outlet vertical on pump centreline or tangential.	10	110	200	Cast iron		x 0,35	x 0,35	yes	no
4.B					Cast steel		x 0,60	x 0,60	yes	no
5.A 1 stage or 2 stages	 Single or two stage; impeller between bearings; horizontal joint plane; feet on casing; mounted at base level. Inlet and outlet perpendicular to shaft axis.	20	110	600	Cast iron		x 0,40	x 0,30	no	no

Table 2 *(continued)*

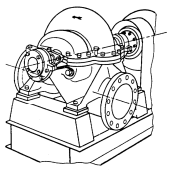
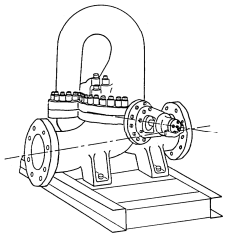
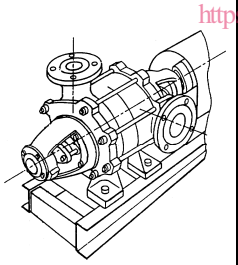
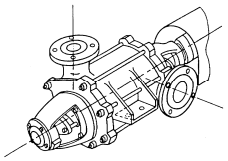
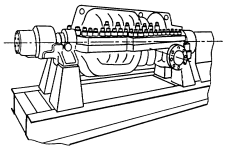
Family No. and Number of stages [1]	General Picture and description	Technical limits			Material	Remarks	Coefficients to apply to basic values		Additional possibilities [2]	
		Allowable Working		Flange DN_{max}						
		pressure bar	Temperature °C				Forces (N)	Moment (N.m)	Reinforced mounting	Other
5.B 1 stage or 2 stages	  Single or two stage; impeller between bearings; horizontal joint plane; feet on casing; mounted at base level. Inlet and outlet perpendicular to shaft axis.	120	175	450	Cast steel	Equipment in accordance with API 610.	x 1	x 1	yes	yes
6 Multi-stage	 Multi-stage; impellers between bearings; vertical joint plane; feet on casing mounted at base level. Inlet and outlet perpendicular to shaft axis.	15	110	150	Cast iron		x 0,30	(- 500) on resulting x 0,35	no	no

Table 2 *(end)*

Family No. and Number of stages [1]	General Picture and description	Technical limits			Material	Remarks	Coefficients to apply to basic values		Additional possibilities [2]	
		Allowable Working pressure bar	Allowable Working Temperature °C	Flange DN_{max}			Forces (N)	Moment (N.m)	Reinforced mounting	Other
7 Multistage	 Multi-stage; impellers between bearings; vertical joint plane; feet on casing; mounted at centreline level. Inlet and outlet perpendicular to shaft axis.	40	175	150	Cast steel		x 0,72	(- 500) on resulting x 0,84	no	no
8.A 3 to 5 stages	 Muti-stage; impellers between bearings; horizontal joint plane; feet on casing mounted at centreline or base level. Inlet and outlet perpendicular to shaft axis.	150	175	350	Cast steel	Equipment in accordance with API 610.	x 1	x 1	yes	yes
8.B 6 to 10 stages							x 1	x 0,75	yes	yes
8.C 11 to 15 stages							x 1	x 0,50	yes	yes

1) In family 7, with brackets on ground, divide index by 1,2 or:
- Forces: x 0,6;
- Moments: (- 500 N.m) on resulting x 0,7.

2) For additional possibilities, see Annex B.