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Centrifugalne ļ rpalke - Naļ rtovanje dovodov - Priporoļ ila za vgradnjo ļ rpalk

Rotodynamic pumps - Design of pump intakes - Recommendations for installation of pumps

Kreiselpumpen - Gestaltung der Einlaufbauten - Empfehlungen zur Installation der Pumpen

Pompes rotodynamiques - Conception des ouvrages d'aspiration - Recommandations d'installation des pompes

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ICS:

23.080	Ļ rpalke	Pumps

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Rotodynamic pumps - Design of pump intakes - Recommendations for installation of pumps

Pompes rotodynamiques - Conception des ouvrages d'aspiration - Recommandations d'installation des pompes

Kreiselpumpen - Gestaltung der Einlaufbauten - Empfehlungen zur Installation der Pumpen

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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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (CEN/TR 13930:2009) has been prepared by Technical Committee CEN/TC 197 "Pumps", the secretariat of which is held by AFNOR.

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This document supersedes CR 13930:2000.

Introduction

In addition to the risks of cavitation that may exist at the intake of any pump depending on the NPSH available, pumping from a sump poses specific problems.

In fact, if the water passes from a flow state with an exposed surface to flow under pressure, significant swirling movements may occur and sometimes be amplified, thus creating a sort of funnel or vortex which opens out into the exposed surface of the sump with a risk of air being entrained or creating a swirling chimney, or whirl between the bottom and the intake producing degassing or vaporisation of the liquid in the entrance of the pump (see Figures 1a) and 1b) below).

These phenomena, which are generally unsteady, can have unwanted effects on the plant:

— undesirable vibration of various pump components;

— increased risk of cavitation;

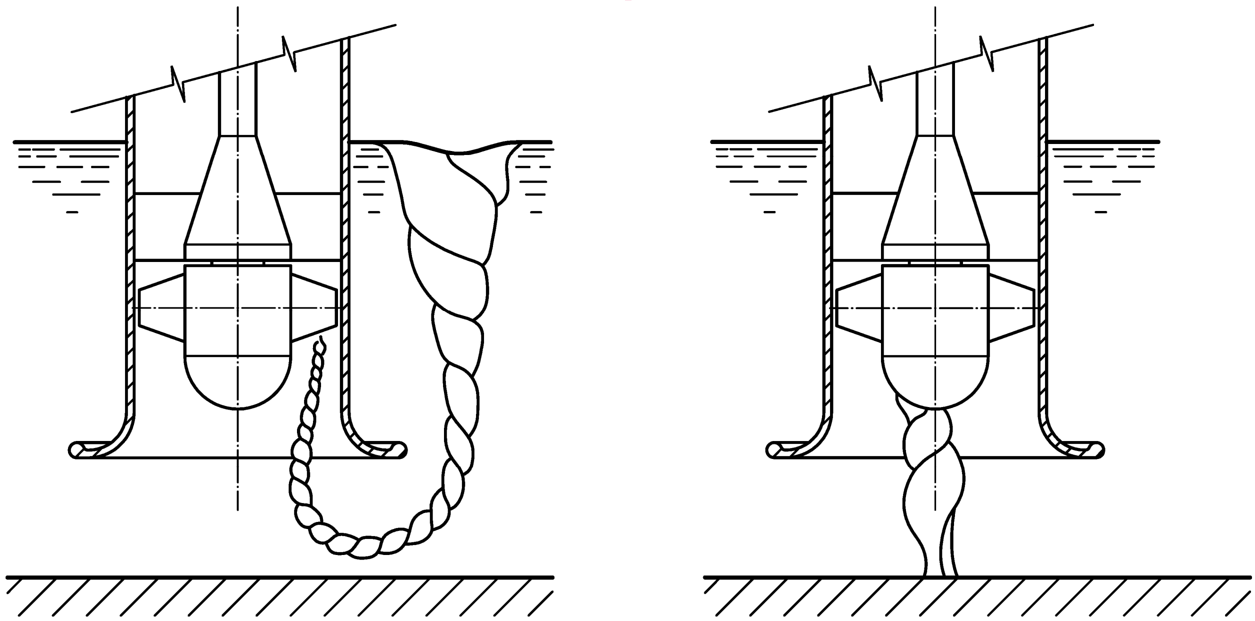
— drop in efficiency;

— reduction in flow rate and/or head;

— risk of floating bodies being sucked in;

— intense and irregular noise.

Compliance with the recommendations in this document makes it possible, in most commonly encountered industrial applications, to avoid or at least limit the phenomena mentioned above.



1a) Vortex causing entrainment of air in suction piping

1b) Chimney or whirl between the floor and the suction inlet

Figure 1 — Types of possible disturbances

1 Scope

1.1 This technical Report contains recommendations for the design of pump intakes and the installation of pumps.

As far as possible, these recommendations should be adhered to in order to obtain correct operation of the plant.

These recommendations are applicable regardless of the flow rate of the plant:

— plant which works with clear water (or relatively unclouded) and relatively non-aerated water or any other liquid having physical and chemical properties which are similar to those of water;

NOTE This document nevertheless contains several general recommendations for operation with cloudy (or very cloudy) water.

— pumping plant which has its own floor.

1.2 This document deals with various intake configurations:

— Clause 3 contains recommendations which apply to intakes with vertical suction inlet;

— Clause 4 contains recommendations applicable to intakes with top suction inlet;

— Clause 5 contains recommendations applicable to intakes with floor suction inlet;

— Clause 6 contains recommendations applicable to intakes with side-wall suction inlet.

2 General

2.1 Factors which influence the operation of the plant

The following factors have an effect on the operation of the plant:

a) Characteristics and position of the suction inlet:

- arrangements of the suction inlet (vertical with bellmouth or tapered suction, top, floor or side-wall intake);
- presence or absence of a bellmouth or tapered suction;
- distance between suction inlet and floor;
- distance between suction inlet and side-walls;
- submergence (level of liquid relative to suction inlet);
- strainer.

b) Inflow of liquid to the intake:

- inflow velocity of the liquid;
- shapes and dimensions of inflow;

— position of inflow.

c) Environment of the pump in the plant:

— velocity of liquid close to the pump;

— shapes and dimensions of the plant;

— special devices (gratings), anti-vortex device;

— relative positions of pumps to each other and in the plant.

Clauses 3 to 6 below contain recommendations concerning the determining factors for each arrangement of the suction inlet.

NOTE If the liquid is charged with solid particles in suspension, the following recommendations may be amended. Prevent the velocity of the fluid falling below a value which allows the deposition of solid materials. A minimum value of 0,7 m/s close to the suction inlet is currently admitted.

2.2 General design principles for a pumping plant

In order for the pump to be fed under the best possible conditions, effort should be made to obtain a permanent, uniform and even flow in the suction pipe. To achieve this, it is necessary to:

— supply the suction pipe for each pump with a balanced flow which is free from swirl;

— ensure that the water accelerates gradually along the intake; any deceleration generates flow instabilities;

— avoid any entrainment of air by suction (vortex) or by churning (weir).

Ensure that these conditions are adhered to as closely as possible regardless of the operating conditions of the plant (one or more pump(s) working, one or more intake sluice(s) or filter(s) in service, high water level or low water level, etc.).

The stipulations in the following clauses are aimed at achieving this. In those, inevitably numerous, situations that are not dealt with in this document, the plant designer should adopt the following principles:

a) in water inflows intakes, stay within moderate velocities which allow gradual acceleration: examples of such velocities are those of the order of 0,3 m/s in the approach channel, 0,5 m/s in the strainer, 1,5 m/s in the bellmouth or tapered suction, and 4 m/s in the suction pipe;

b) avoid excessively large chambers and dead zones which generate overall swirl in the flow and vortices as well as the deposition of solids if the water contains substances in suspension;

c) prevent separation by avoiding sudden widening and excessively divergent angles by preferring shaped forms for pillars, low walls, bellmouth or tapered suction, etc;

d) avoid sudden changes in direction caused, for instance, by lateral feed and excessively sloping falls;

e) eliminate any obstacle which might interfere with flow over a sufficient distance (of the order of 10 times the diameter *D* at the entrance to the bellmouth or tapered suction) before the suction pipe;

f) avoid any asymmetry in the mode of operation as well as in the design of structures;

g) at the entrance to the suction pipe, ensure an adequate submergence for the minimum working level and increase the submergence recommended below in this standard significantly if flow conditions are mediocre;

h) if a chamber is fed with water by an overflow, ensure that the later does not entrain air and provide a baffle device.

It is far preferable to design a plant which is intrinsically problem-free from the outset rather than to rely on baffles or anti-vortex accessories which are often only a palliative offering efficiency which is difficult to predict.

In difficult cases and if the importance of the plant justifies it, it is recommended to use a reduced model to check whether there is any need to improve the arrangements made.

3 Plant with vertical suction inlet

3.1 General arrangements

In these configurations the presence of a bellmouth is necessary but alternatively, the bellmouth may be replaced by a tapered suction.

Installations with a vertical suction are shown diagrammatically in Figures 2 and 3.

a) The pump design may be:

- axial flow without exceeding the outside diameter of the bellmouth or tapered suction greatest diameter;
- centrifugal or mixed flow with bellmouth possibly wider than diameter of the bellmouth or tapered suction greatest diameter.

b) The position of the pump on the piping can be:

- horizontal or vertical;
- immersed or not immersed.

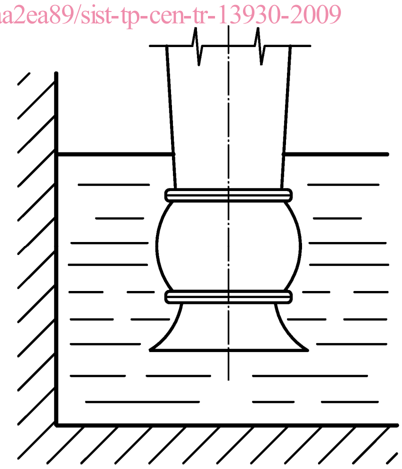
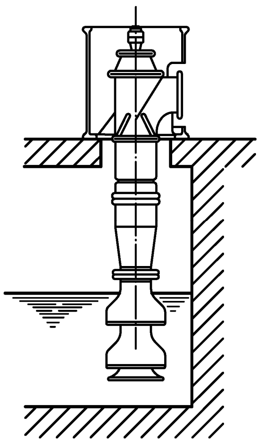
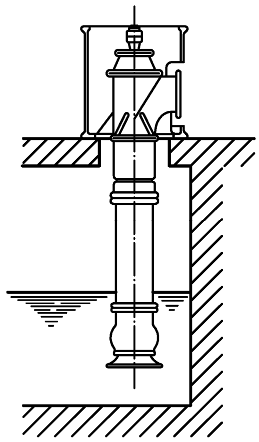


Figure 2 — Vertical suction inlet with bellmouth - Normal configuration



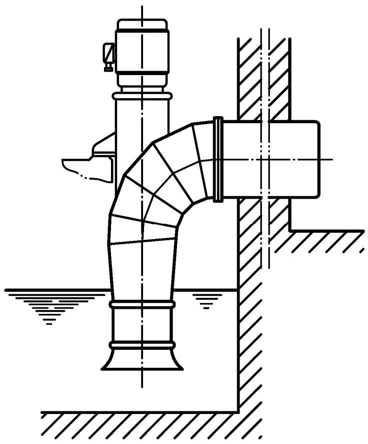
3a) Centrifugal impeller [a)]

a) The number of stages is stated for information only



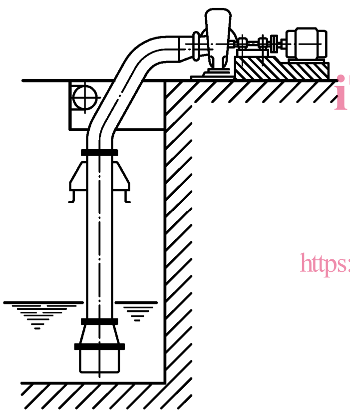
3b) Mixed-flow impeller [a)]

a) The number of stages is stated for information only

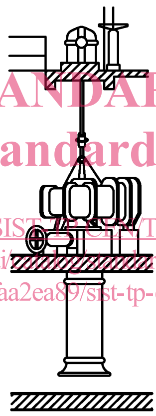


3c) Axial flow impeller [a)]

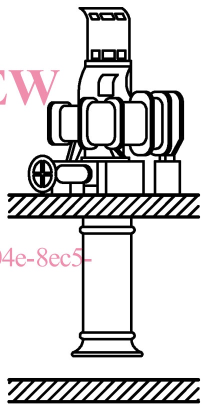
a) The number of stages is stated for information only



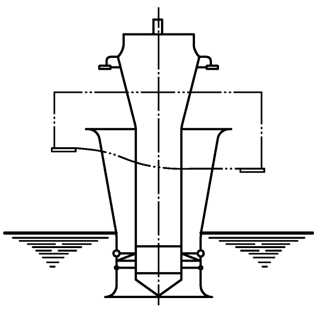
3d) Non-immersed horizontal pump



3e) Non immersed vertical pump



3f) Non immersed vertical pump



3g) Immersed vertical pump

Figure 3 — Vertical suction inlet with bellmouth (or with tapered suction) - Example of possible configurations

3.2 Diameter (*D*) at the entrance of the bellmouth or the tapered suction

Figure 4 shows typical profile of bellmouth.

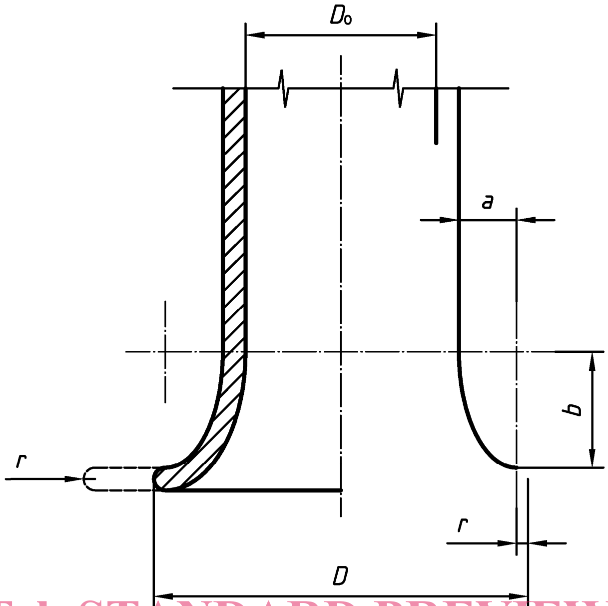


Figure 4 — Bellmouth

The diameter *D* at the entrance to the bellmouth is a result of the bellmouth profile, which is generally a quarter ellipse of which the short and long axes have the values 2a and 2b respectively.

If D_O is the diameter of the piping at the entrance to the impeller of the pump, the value of *D* is generally between 1,4 D_O and 1,8 D_O inclusive, the most common values are between 1,5 D_O and 1,6 D_O inclusive.

It is this value which is used as a reference for the recommendations given in sub-clause 3.3 and so on.

As an alternative of a suction by bellmouth, Figure 5 illustrates typical profile of tapered suction.

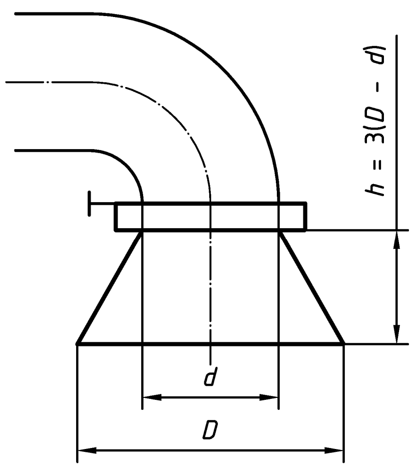


Figure 5 — Alternative with tapered suction

3.3 Distance (*C*) between the bellmouth or the tapered suction inlet and floor

Figure 6 indicates the recommended dimensions between suction inlet and the floor, in the case of a bellmouth.

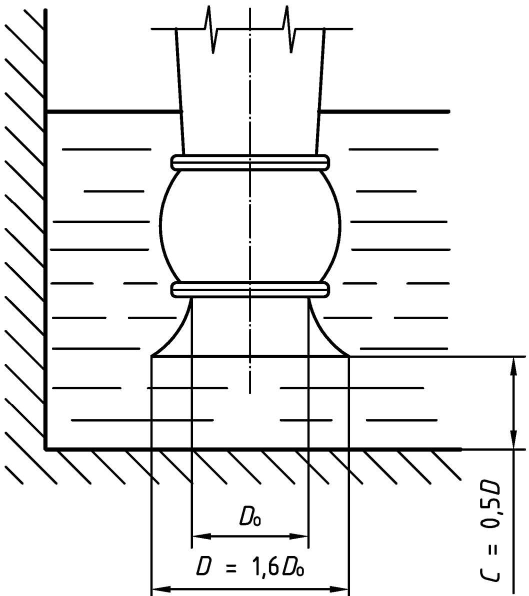


Figure 6 — Distance between the bellmouth and the floor

The distance (C) between the suction inlet and the floor should be between 0,25 and 0,5 times the diameter (*D*) at the entrance to the bellmouth; the most common values are between 0,4 and 0,5 *D* inclusive.

NOTE In the case of an intake on a natural floor (river, pond, sea, etc.) where there is always a risk of filling with sand, silting up or changing water levels, the distance (*C*) should be increased. Its value should be specified jointly with the pump manufacturer.

As an alternative of bellmouth suction, the case of tapered suction inlet is illustrated by Figure 7.

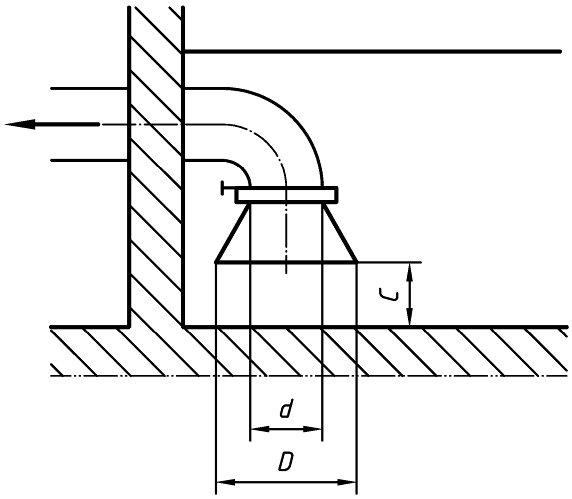


Figure 7 — Distance between the tapered suction inlet and the floor