SLOVENSKI STANDARD
SIST CR 13930:2001

01-junij-2001

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

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

Ta slovenski standard je istoveten z: CR 13930:2000

ICS:

23.080 Ļrpalke Pumps

SIST CR 13930:2001 **en**

CEN REPORT

RAPPORT CEN

CEN BERICHT

CR 13930

August 2000

ICS

English version

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

This CEN Report was approved by CEN on 3 June 2000. It has been drawn up by the Technical Committee CEN/TC 197.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. CR 13930:2000 E

Contents

Foreword

This document has been prepared by CEN /TC 197, "Pumps".

Introduction

In addition to the risks of cavitation which 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 intake of the pump (see figures 1a) and 1b) below).

These phenomena which are generally unsteady, can have unwanted effects on 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.

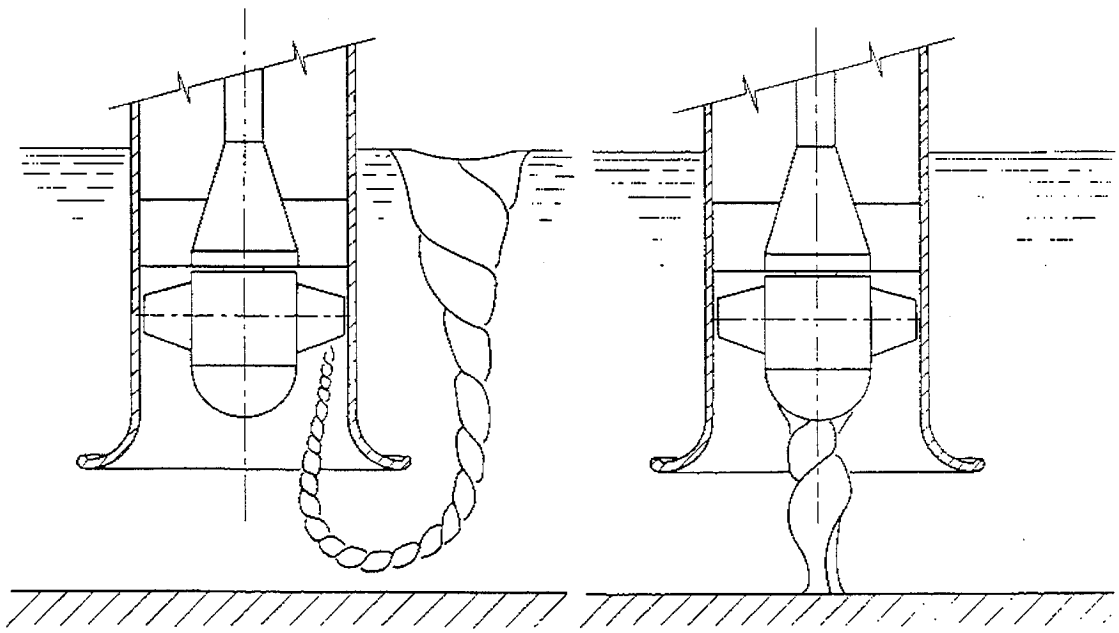


Figure 1a - Vortex causing entrainment of air in inlet piping

Figure 1b - Chimney or whirl between the floor and the inlet

Figure 1

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 uncloudy) 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 standard deals with various intake configurations :

— clause 3 contains recommendations which apply to vertical intakes with a bellmouth ;

— clause 4 contains recommendations applicable to top intakes ;

— clause 5 contains recommendations applicable to floor intakes ;

— clause 6 contains recommendations applicable to side-wall intakes.

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 inlet :

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

b) Inflow of liquid to the intake :

- inflow velocity of the liquid ;
- shapes and dimensions of inflow pipe ;
- position of inflow pipe.

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 intake.

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 impeller 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, and effort should be made to obtain a permanent, uniform and even flow in the inlet pipe. To achieve this, it is necessary to :

— supply the intake 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 pumps working, one or more intake sluices or filters 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 which are not dealt with in this document, the plant designer should adopt the following principles :

a) in inflows, 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 and 4 m/s in the inlet 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, 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 of the bellmouth) before the inlet pipe ;

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

g) at the entrance to the intake pipe, ensure an adequate submersion depth for the minimum working level and increase the submersion depths 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 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 intake and bellmouth or tapered suction

Installations with a vertical intake and tulip 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

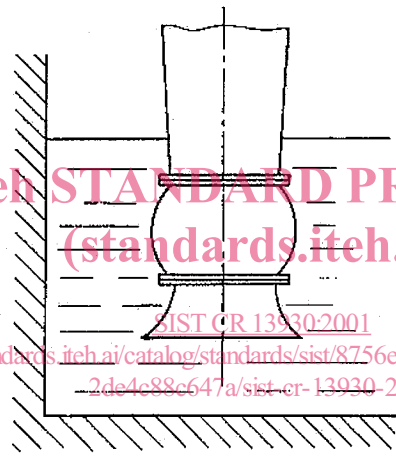
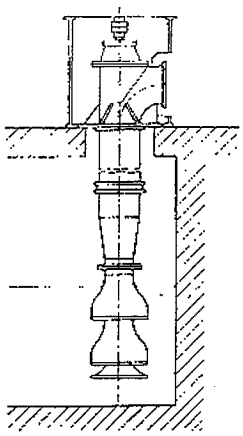
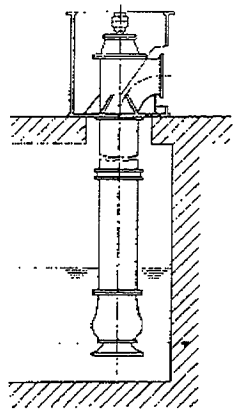


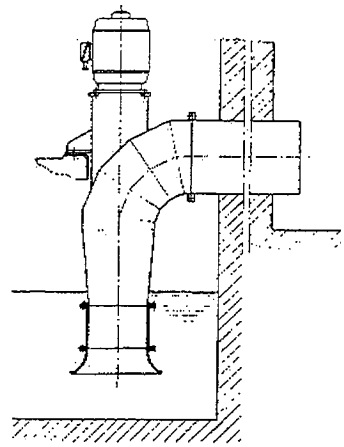
Figure 2 — Vertical inlet with bellmouth-Normal configuration



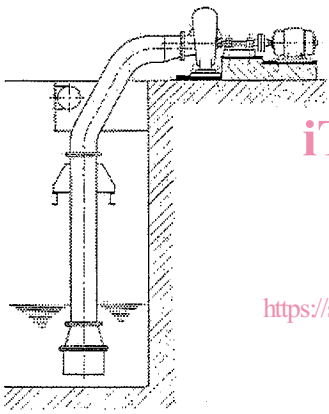
Centrifugal impeller 1)



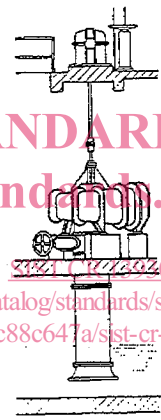
Mixed-flow impeller 1)



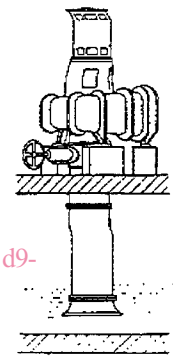
Axial flow impeller 1)



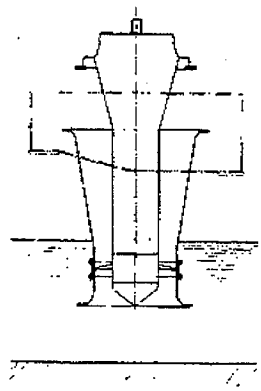
Non-immersed horizontal pump



Non immersed vertical pump



Non immersed vertical pump



Immersed vertical pump

1) The number of stages is stated for information only

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

3.1 Type of recommendations dealt with

The table below lists the types of recommendations dealt with in the remainder of this document.

Sub-clause 3.2
Bellmouth

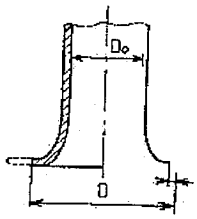


Figure 4a

Sub-clause 3.2
Tapered suction

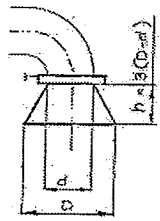


Figure 4b

Sub-clause 3.3
Distance (C) between the bellmouth and floor

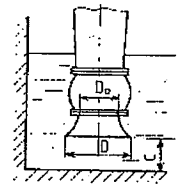


Figure 5

Sub-clause 3.4
Distances between inlet axis and walls (E and L)

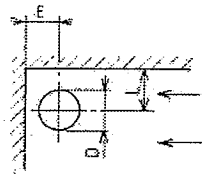


Figure 6

Sub-clause 3.5
Submergence(S)

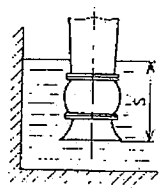


Figure 7

Sub-clause 3.6
Strainer

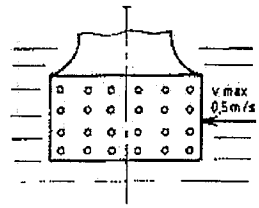


Figure 8

Sub-clause 3.7.1
Feed-types of supply

Sub-clause 3.7.1.3
Inflow facing, centred, wide

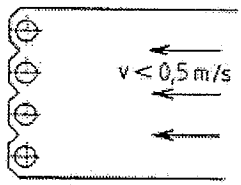


Figure 9

Sub-clause 3.7.1.4
Inflow facing, centred, narrow-single

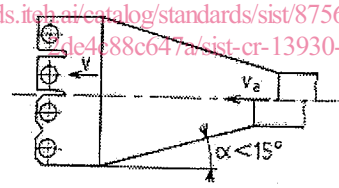


Figure 11

Sub-clause 3.7.1.5
Inflow facing, centred, narrow, multiple

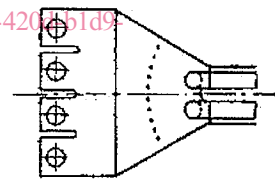


Figure 14

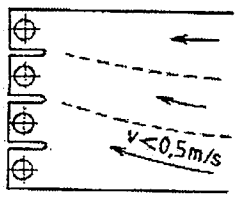


Figure 10

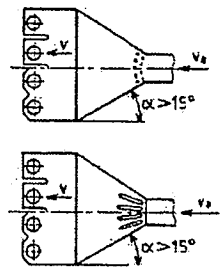


Figure 12

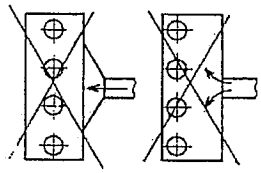


Figure 13

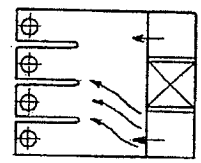


Figure 15

Sub-clause 3.7.1
Feed-types of supply (continued)

Sub-clause 3.7.1.6
Inflow facing, off-centre, narrow, single

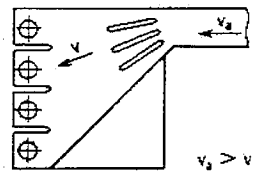


Figure 16

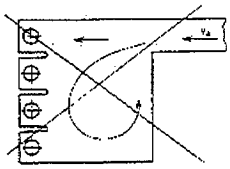


Figure 17

Sub-clause 3.7.1.7
Lateral inflow, centred

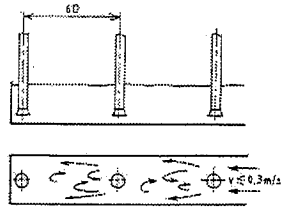


Figure 18

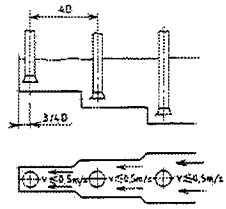


Figure 19

Sub-clause 3.7.1.8
Lateral inflow, off-centre

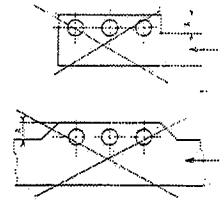
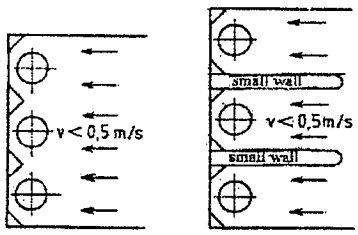


Figure 20

Sub-clause 3.7.2
Immediate environment of pump

Sub-clause 3.7.2.1
Inflow of water at the intake



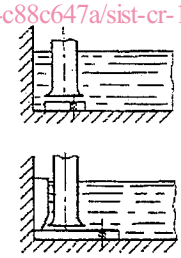
Common sump

Individually separated sump

Figure 21

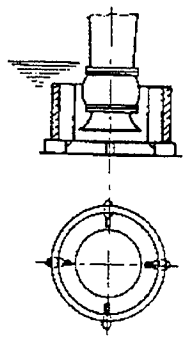
Sub-clause 3.7.2.2
Special devices

Sub-clause 3.7.2.2.1
Swirl and Vortex inhibitors



Low walls

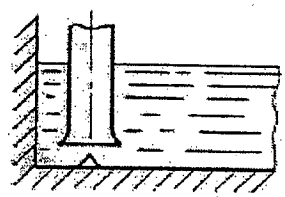
Figure 22



Jacket around bellmouth

Figure 23

Sub-clause 3.7.2.2.2
Other special devices



Cone

Figure 24