SLOVENSKI STANDARD
SIST EN 62097:2010

01-januar-2010

Vodni stroji, radialni in aksialni - Metoda prenosa zmogljivosti z modela na prototip (IEC 62097:2009)

Hydraulic machines, radial and axial - Performance conversion method from model to prototype

Hydraulische Maschinen, radial und axial - Leistungsumrechnung vom Modell zum Prototyp

Machines hydrauliques, radiales et axiales - Méthodes de conversion des performances du modèle au prototype

Ta slovenski standard je istoveten z: **EN 62097:2009**

ICS:

27.140	Vodna energija	Hydraulic energy engineering

SIST EN 62097:2010 **en,fr**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 62097

May 2009

ICS 27.140

English version

Hydraulic machines, radial and axial - Performance conversion method from model to prototype
(IEC 62097:2009)

Machines hydrauliques, radiales et axiales - Méthode de conversion des performances du modèle au prototype (CEI 62097:2009)

Hydraulische Maschinen, radial und axial - Leistungsumrechnung vom Modell zum Prototyp (IEC 62097:2009)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 62097:2009 E

Foreword

The text of document 4/242A/FDIS, future edition 1 of IEC 62097, prepared by IEC TC 4, Hydraulic turbines, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62097 on 2009-03-01.

The International Standard contains attached files in the form of Excel file. These files are intended to be used as complement and do not form an integral part of this publication.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2009-12-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2012-03-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62097:2009 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60193	1999	Hydraulic turbines, storage pumps and pump-turbines - Model acceptance tests	EN 60193	1999

IEC 62097

Edition 1.0 2009-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Hydraulic machines, radial and axial – Performance conversion method from model to prototype

Machines hydrauliques, radiales et axiales – Méthode de conversion des performances du modèle au prototype

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE XC
CODE PRIX

ICS 27.140

ISBN 2-8318-1027-5

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HYDRAULIC MACHINES, RADIAL AND AXIAL – PERFORMANCE CONVERSION METHOD FROM MODEL TO PROTOTYPE

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereinafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62097 has been prepared by technical committee 4: Hydraulic turbines.

The text of this standard is based on the following documents:

FDIS	Report of voting
4/242A/FDIS	4/243/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This publication contains attached files in the form of Excel file. These files are intended to be used as a complement and do not form an integral part of this publication.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result data indicated on the IEC web site under “http://webstore.iec.ch” in the data related to the specific publication. At this date, the publication will be

- recommended;
- withdrawn;
- replaced by a revised edition;
- or amended.

INTRODUCTION

0.1 General remarks

This International Standard establishes the prototype hydraulic machine efficiency from model test results, with consideration of scale effect including the effect of surface roughness.

Advances in the technology of hydraulic turbo-machines used for hydroelectric power plants indicate the necessity of revising the scale effect formula given in 3.8 of IEC 60193. [1][1] The advance in knowledge of scale effects originates from work done by research institutes, manufacturers and relevant working groups within the organizations of IEC and IAHR. [1 - 7]

The method of calculating prototype efficiencies, as given in this standard, is supported by experimental work and theoretical research on flow analysis and has been simplified for practical reasons and agreed as a convention. [8 – 10] The method is representing the present state of knowledge of the scale-up of performance from model to a homologous prototype.

Homology is not limited to the geometric similarity of the machine components, it also calls for homologous velocity triangles at the inlet and outlet of the runner/impeller. [2] Therefore, compared to IEC 60193, a higher attention has to be paid to the geometry of guide vanes.

According to the present state of knowledge, it is certain that, in most cases, the formula for the efficiency step-up calculation given in the IEC 60193 and earlier standards, overstated the step-up increment of the efficiency for the prototype. Therefore, in the case where a user wants to restudy a project for which a calculation of efficiency step-up was done based on any previous method, the user shall re-calculate the efficiency step-up with the new method given in this standard, before restudying the project of concern.

This standard is intended to be used mainly for the assessment of the results of contractual model tests of hydraulic machines. If it is used for other purposes such as evaluation of refurbishment of machines having very rough surfaces, special care should be taken as described in Annex B.

Due to the lack of sufficient knowledge about the loss distribution in Deriaz turbines and storage pumps, this standard does not provide the scale effect formula for them.

An excel work sheet concerning the step-up procedures of hydraulic machine performance from model to prototype is indicated at the end of this Standard to facilitate the calculation of the step-up value.

0.2 Basic features

A fundamental difference compared to the IEC 60193 formula is the standardization of scalable losses. In a previous standard (see 3.8 of IEC 60193:1999 [1]), a loss distribution factor V has been defined and standardized, with the disadvantage that turbine designs which are not optimized benefit from their lower technological level.

This is certainly not correct, since a low efficiency design has high non-scalable losses, like incidence losses, whereby the amount of scalable losses is about constant for all manufacturers, for a given type and a given specific speed of a hydraulic machine.

This standard avoids all the inconsistencies connected with IEC 60193:1999. (see 3.8 of [1]) A new basic feature of this standard is the separate consideration of losses in specific hydraulic energy, disc friction losses and leakage losses. [5], [8 – 10]

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1 Numbers in square brackets refer to the bibliography.

Above all, in this standard, the scale-up of the hydraulic performance is not only driven by the dependence of friction losses on Reynolds number Re, but also the effect of surface roughness Ra has been implemented.

Since the roughness of the actual machine component differs from part to part, scale effect is evaluated for each individual part separately and then is finally summed up to obtain the overall step-up for a complete turbine. [10] For radial flow machines, the evaluation of scale effect is conducted on five separate parts; spiral case, stay vanes, guide vanes, runner and draft tube. For axial flow machines, the scalable losses in individual parts are not fully clarified yet and are dealt with in two parts; runner blades and all the other stationary parts inclusive.

The calculation procedures according to this standard are summarized in Clause 7 and Excel sheets are provided as an Attachment to this standard to facilitate the step-up calculation.

In case that the Excel sheets are used for evaluation of the results of a contractual model test, each concerned party shall execute the calculation individually for cross-check using common input data agreed on in advance.

HYDRAULIC MACHINES, RADIAL AND AXIAL – PERFORMANCE CONVERSION METHOD FROM MODEL TO PROTOTYPE

1 Scope

This International Standard is applicable to the assessment of the efficiency and performance of prototype hydraulic machine from model test results, with consideration of scale effect including the effect of surface roughness.

This standard is intended to be used for the assessment of the results of contractual model tests of hydraulic machines.

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.

IEC 60193:1999, *Hydraulic turbines, storage pumps and pump-turbines – Model acceptance tests*

3 Terms, definitions, symbols and units

3.1 System of units

The International System of Units (SI) is used throughout this standard. All terms are given in SI Base Units or derived coherent units. Any other system of units may be used after written agreement of the contracting parties.

3.2 List of terms

For the purposes of this document, the terms and definitions of IEC 60193 apply, as well as the following terms, definitions, symbols and units.

3.2.1 Subscripts' list

Term	Symbol	Term	Symbol	
model	M	component	CO	
prototype	P			
specific energy	E	spiral case	SP	in general term represented by CO
volumetric	Q	stay vane	SV	
torque or disc friction	T	guide vane	GV	
reference	ref	runner	RU	
hydraulic diameter	d	draft tube	DT	
velocity	u	stationary part	ST	
hydraulic	h			
optimum point	opt			
off design point	off			