ANSI/HI 9.6.7-2021

American National Standard for

Rotodynamic Pumps

Guideline for Effects of Liquid Viscosity on Performance

HYDRAULIC INSTITUTE™

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Rotodynamic Pumps - Guideline for Effects of Liquid Viscosity on Performance

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www.Pumps.org

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Foreword (Not part of Standard)

Purpose and aims of the Hydraulic Institute

The purpose and aims of the Hydraulic Institute (HI) are to promote the advancement of the pump manufacturing industry and further the interests of the public and to this end, among other things:

a) Develop and publish standards.

b) Address pump systems.

c) Expand knowledge and resources.

d) Educate the marketplace.

e) Advocate for the industry.

Purpose of Standards and Guidelines

a) HI Standards and Guidelines are adopted in the public interest and are designed to help eliminate misunderstandings between the manufacturer, the purchaser, and/or the user and to assist the purchaser in selecting and obtaining the proper product for a particular need.

b) Use of HI Standards and Guidelines is completely voluntary. Existence of HI Standards does not in any respect preclude a member from manufacturing or selling products not conforming to the standards.

Definition of a Standard of the Hydraulic Institute

Quoting from Article XV, Standards, of the By-Laws of the Institute, Section B:

> "An Institute Standard defines the product, material, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing and service for which designed."

Definition of a Hydraulic Institute Guideline

A HI Guideline is not normative. The guideline is tutorial in nature, to help the reader better understand the subject matter.

Comments from users

Comments from users of this standard are appreciated, to help HI prepare even more useful future editions. Questions arising from the content of this standard may be directed to the HI Technical Director of the Hydraulic Institute. If appropriate, the inquiry will then be directed to the appropriate technical committee for provision of a suitable answer.

Revisions

American National Standards of HI are subject to constant review, and revisions are undertaken whenever it is found necessary because of new developments and progress in the art. If no revisions are made for five years, the standards are reaffirmed using the ANSI canvass procedure.

Disclaimer

This document was prepared by an HI committee and approved by following ANSI essential requirements. Neither the HI, HI committees, nor any person acting on behalf of the HI: 1) makes any warranty, expressed or implied, with respect to the use of any information, apparatus, method, or process disclosed in this document or guarantees that such may not infringe privately owned rights; 2) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this guideline. The HI is in no way responsible for any consequences to an owner, operator, user, or anyone else resulting from reference to the content of this document, its application, or use.

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This document does not contain a complete statement of all requirements, analyses, and procedures necessary to ensure safe or appropriate selection, installation, testing, inspection, and operation of any pump or associated products. Each application, service, and selection is unique with process requirements that shall be determined by the owner, operator, or its designated representative.

Units of measurement

Metric units of measurement are used, and corresponding US customary units appear in parentheses. Charts, graphs, and sample calculations appear in both metric and US customary units. Because values given in metric units are not exact equivalents to values given in US customary units, it is important that the selected units of measure to be applied be stated in reference to this standard. If no such statement is provided, metric units shall govern.

Consensus

Consensus for this American National Standard was achieved by use of the canvass method. The following organizations, recognized as having an interest in the standardization of pumps, were contacted prior to the approval of this revision of the standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

Trilliam Flow Technologies
Hidrostal
Doe Run Consulting
Patterson Pump Company
Moving Water Industries (MWI)
Summit Pump, Inc.
WC Livoti Consulting
LVVWD- Las Vegas Valley Water District
Irving Oil
Brown and Caldwell
TRWD - Tarrant Regional Water District
CB&I

Committee list

Although this standard was processed and approved for submittal to ANSI by the canvass method, a working committee met many times to facilitate its development. At the time it was developed, the committee had the following members:

Chair – Michael Coussens, Peerless Pump Company
Vice-chair – Trygve Dahl, Intelliquip, LLC

Committee members	**Company**
Ravindra Birajdar	Kirloskar Brothers Ltd.
Frank Ennenbach	Sulzer Pumps Ltd.
Eric Eylat	Flowserve Corporation
Jeff Olsen	Applied Flow Technology
Aleksander Roudnev	Weir Minerals North America

Alternates	**Company**
Scott Lang	Applied Flow Technology
Michael Mueller	Flowserve Corporation
Scott Race	Weir Minerals North America
Trey Walters	Applied Flow Technology

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9.6.7 Rotodynamic pumps – guideline for effects of liquid viscosity on performance

9.6.7.1 Introduction

This edition of ANSI/HI 9.6.7 includes editorial changes from prior publications related to standard deviation related for correction factors. While there have been various publications about viscosity corrections, the committee has reviewed the published data and found it is within the uncertainty range of data used to develop the current method. Additional clarification on the uncertainty of viscous power consumption is included. The Hydraulic Institute is seeking additional data to refine and expand its correction factors.

Viscosity is one of the properties that characterizes all fluids. The performance of a rotodynamic pump varies with the viscosity of the pumped fluid. If the viscosity of the pumped fluid differs significantly from that of water (which is the basis for most published performance curves), then the pump performance will differ from the published curve. For simplicity, the term *viscous fluid* is used within this document. In this context, viscous fluid is meant to describe a fluid with a viscosity greater than that of water, not to imply some fluids are not viscous. Head (H) and rate of flow (Q) will normally decrease as viscosity increases. Power (P) will increase, as will net positive suction head required (NPSH3) in most circumstances. Starting torque may also be affected.

The Hydraulic Institute (HI) has developed a generalized method for predicting performance of rotodynamic pumps on Newtonian liquids of viscosity greater than that of water. This is an empirical method based on the test data available from sources throughout the world. The HI method enables pump users and designers to estimate performance of a particular rotodynamic pump on liquids of known viscosity, given the performance on water. The procedure may also result in a suitable pump being selected for a required duty on viscous liquids.

Performance estimates using the HI method are only approximate. There are many factors for particular pump geometries and flow conditions that the method does not take into account. It is nevertheless a dependable approximation when only limited data on the pump are available and the estimate is needed.

Since the release of the previous version of this standard, use of computational fluid dynamics (CFD) by pump designers for simulation and optimization of the performance of rotodynamic pumps has dramatically increased. The code, expertise, and calculated outputs of this tool have greatly improved with maturity. Today's pump designers are finding CFD a valuable tool in the pursuit of high-performance hydraulics. However, little effort has been expended in the study of fluids other than water. The expectations are that this tool could add insight and increase the knowledge of the dynamics of pump flow with viscous fluids and lead to improved design in this application. It is the desire of the HI Effects of Liquid Viscosity on Rotodynamic Pump Performance Committee that CFD simulations of viscous fluids on pump performance would be an area of future research. Correlations of simulation results to the methodology offered in this standard and further test validation would be beneficial for the fluid handling industry.

Theoretical methods based on loss analysis may provide more accurate predictions of the effects of liquid viscosity on pump performance when the geometry of a particular pump is known in more detail. This document explains the basis of such theoretical methods. Pump users should consult pump manufacturers to determine whether or not more accurate predictions of performance for a particular pump and viscous liquid are available.

This document also includes technical considerations and recommendations for pump applications on viscous liquids.

9.6.7.1.1 Purpose

The purpose of this guideline is to offer a methodology to predict the performance of a rotodynamic centrifugal pump when the fluid viscosity differs from clean water.

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