

Design and Stress Analysis of a Mixed Flow Pump Impeller

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Abstract: In order to avoid resonance of a mixed-flow pump impeller and to avoid blade failure due to excessive stress development, it is required to know the natural frequencies at different modes and one should have an idea about the Von Mises stress distribution in the impeller blades. In this present work design and FEM analysis has been carried out on mixed flow pump impeller having different blade positions on the meridional annulus. The natural frequencies at its different modes of the pump impeller were obtained. The maximum Von Mises stress distribution was compared among the impellers having different blade positions. The mixed flow impeller having inlet inclined blade positions on the meridional annulus experiences less amount of Von Mises stress as compared to impeller having trapezoidal blade positions on the meridional annulus. The natural frequencies of the impeller having inlet inclined blade positions on the meridional annulus shows a higher value as compared to compared to impeller having trapezoidal blade positions on the meridional annulus.

Index Terms— Mixed flow pump, Von Mises stress, FEM analysis, natural frequency

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Nomenclature

$C_{\theta 2}$	: tangential component of absolute velocity, m/sec.
C	: actual chord, mm.
C'	: meridional chord, mm.
C_L	: coefficient of lift, dimensionless.
C_m	: meridional velocity, m/sec.
C_{in}	: meridional velocity at inlet, m/sec.
C_{out}	: meridional velocity at outlet, m/sec.
D_1	: blade diameter at inlet, mm.
D_2	: blade diameter at outlet, mm.
D_{in}	: blade diameter at inlet at hub section, mm.
D_{ti}	: blade diameter at inlet at tip section, mm.
D_{ou}	: blade diameter at outlet at hub section, mm.
D_{to}	: blade diameter at outlet at tip section, mm.
D_L	: Leibniz blade diffusion factor, dimensionless.
D_m	: mean diameter, mm.

d	: diameter ratio, dimensionless.
g	: acceleration due to gravity, m/sec ² .
H	: pressure head, m.
K_u	: velocity coefficient, dimensionless.
l	: blade span, mm.
N	: rotational speed, rev./min.
P	: power, kW.
Q	: volumetric discharge, m ³ /sec.
r	: radius, mm.
s	: blade spacing, mm.
u_i	: tangential velocity of blade at inlet, m/sec.
u_o	: tangential velocity of blade at outlet, m/sec.
V_s	: slip velocity, mm.
α_1	: blade inlet angle, degrees.
α_2	: blade outlet angle, degrees.
α_m	: mean blade angle, degrees.
λ	: blade stagger angle, degrees.
ρ	: mass density of the fluid (water), kg/m ³ .
ω	: angular velocity, rad/sec.
Ω	: dimensionless specific speed, dimensionless.
ϕ	: semi-cone angle of the impeller, degrees.

1. INTRODUCTION

The mixed flow pumps are extensively used in thermal power plants for cooling water duties. The performance of a mixed flow pump can be considerably improved by applying recent advances in understanding the flow behaviour of the pump and the blades. Thus, optimal blade position in the meridional annulus has an important effect on loss and flow deflection. The objective of the blade design is to realize a given velocity triangle with minimum losses as well as minimum stress development in the blade sections.

The industrial design methods are largely based on the application of empirical and semi-empirical rules along with the use of available information in the form of different types of charts and graphs from the existing literature. Impellers are mainly designed using profile

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Marcel A. Müller



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Dual-phase Materials in the Medium and High Entropy Alloy Systems Al-Cr-Fe-Ni and Al-Co-Cr-Fe-Ni Ulrike Hecht,Mark L. Weaver,Sheng Guo,2021-08-25

Optimal Design and Efficiency Improvement of Fluid Machinery and Systems, volume II Leilei Ji,Ramesh K. Agarwal,Kan Kan,Yongfei Yang,Ran Tao,Yang Yang,Alexandre Presas,2025-09-12 Fluid machinery is a machine that converts energy with fluid as a working medium including pumps compressors gas turbines fans etc Due to global warming and other factors people have begun to pay attention to carbon emission levels in the atmosphere As a significant energy consumer the operating efficiency of fluid machinery is directly related to carbon emissions Therefore the optimization design and efficiency of fluid machinery are increasingly valued With the continuous development of computational fluid dynamics CFD and interdisciplinary research methods scholars have proposed many new methods and ideas for the optimization of fluid machinery and its systems This Research Topic in Optimal Design and Efficiency Improvement of Fluid Machinery and Systems aims to bring together the latest research results in the field of fluid machinery focusing on the internal flow structural optimization and efficiency improvement of fluid machinery and systems Summarizing these results can provide new ideas for research and application in the field of fluid machinery This Research Topic encourages the submission of original research and review articles The scope of this Research Topic includes the following themes but is not limited to optimization design of fluid machinery and system efficiency optimization of fluid mechanical systems effectiveness evaluation method of fluid machinery and systems unsteady flow of fluid machinery and systems multiphase flow in fluid machinery

Mechanical Circulatory Support: A Companion to Braunwald's Heart Disease Ebook James K. Kirklin,Joseph G

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Scientific and Technical Aerospace Reports, 1995 *Methods for Solving Complex Problems in Fluids Engineering* Can Kang,Haixia Liu,Yongchao Zhang,Ning Mao,2019-01-12 This book describes recently developed research methods used to study complex problems in fluid engineering especially optical flow measurement flow visualization and numerical methods It includes a wealth of diagrams and images and the content is presented in a step by step manner from beginning to end helping readers grasp the central points of the book The book also presents a number of practical cases illustrating how the research methods covered can be concretely implemented Lastly the book offers a valuable point of departure for pursuing further research

Slurry Handling N.P. Brown,N.I. Heywood,1991-12-31

Israel Journal of Technology, 1981 Includes proceedings of various meetings and conferences **Selected Water Resources Abstracts**, 1988

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