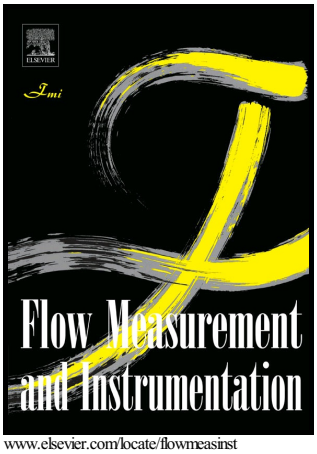
Theory and structure of a modified optical fiber turbine flowmeter

Ya-fei Gu, Yong Zhao, Ri-qing Lv, Yang Yang



www.elsevier.com/locate/flowmeasinst

PII: S0955-5986(16)30062-0
DOI: http://dx.doi.org/10.1016/j.flowmeasinst.2016.06.012
Reference: JFMI1209

To appear in: *Flow Measurement and Instrumentation*

Received date: 2 November 2015
Revised date: 9 May 2016
Accepted date: 7 June 2016

Cite this article as: Ya-fei Gu, Yong Zhao, Ri-qing Lv and Yang Yang, Theory and structure of a modified optical fiber turbine flowmeter, *Flow Measuremen and Instrumentation,* http://dx.doi.org/10.1016/j.flowmeasinst.2016.06.012

Theory and Structure of a modified Optical Fiber Turbine Flowmeter

Ya-fei Gu[1], Yong Zhao[1*], Ri-qing Lv[1], Yang Yang[2]

[1]Northeastern University, College of Information Science and Engineering, Shenyang 110819, China

[2]Hebei Instruments and Meters Engineering Technology Research Center, Chengde 067000, China

[*]Corresponding author. zhaoyong@ise.neu.eu.cn

Abstract

The measurement lower limit of traditional turbine flowmeter is too large to satisfy the measurement requirements of small flow rate. A modified optical fiber turbine flowmeter based on the traditional turbine flowmeter principle was purposed. The front guide vane was specially designed with a helix angle to reduce the measurement lower limit and improve the measurement sensitivity. The theoretical model for the modified flowmeter was established based on planar vector triangle of flow velocities. From theoretical analysis, the conclusion that if the helix angle of front guide vane plus the helix angle of turbine equals to 90°, the starting volume flow rate of turbine can get minimum value and the sensitivity of the flowmeter can get maximum value was found. The correctness of the conclusion was verified by the Computational Fluid Dynamics (CFD) simulation.

Index Terms: Turbine Flowmeter; Optical Fiber Technology; Front Guide Vane; Computational Fluid Dynamics

1. Introduction

Accurate flow rate measurement is the important precondition of many industry fields, such as medical, energy, petrochemical engineering, etc(1). Turbine flowmeter has become an important part of flow measurement instruments with high accuracy, good reproducibility and stability(2, 3). In addition, turbine flowmeter also can be used as a standard instrument to calibrate other flow measurement instruments.

The original helical turbine flowmeter was designed and primarily used in jet aircraft in the 1950s(4). After many years of research and exploration, its basic theory and the corresponding model has been nearly complete(5). However, the recent research of turbine flowmeter mainly focused on the response characteristics but not low flow rate. It was unable to satisfy the requirements of low flow rate measurement in actual production.