

Accepted Manuscript

Research Paper

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PII: S1359-4311(17)32992-7

DOI: <https://doi.org/10.1016/j.applthermaleng.2018.01.071>

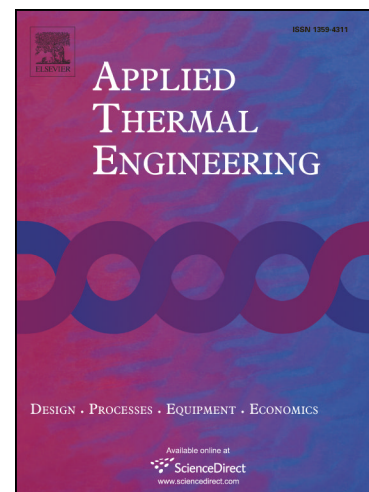
Reference: ATE 11725

To appear in: *Applied Thermal Engineering*

Received Date: 2 May 2017

Revised Date: 17 January 2018

Accepted Date: 19 January 2018



Please cite this article as: Z. Sun, X. Zheng, T. Kawakubo, Experimental investigation of instability inducement and mechanism of centrifugal compressors with vaned diffuser, *Applied Thermal Engineering* (2018), doi: <https://doi.org/10.1016/j.applthermaleng.2018.01.071>

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Experimental investigation of instability inducement and mechanism of centrifugal compressors with vaned diffuser

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ABSTRACT

The paper is proposed to experimentally investigate the flow instability of centrifugal compressors with vaned diffuser, and the instability inducement and mechanism at full operating range are presented and analyzed in detail. In this paper, the steady performance and transient evolution process of the compressor are measured by steady and dynamic sensors. Experimental results show that the compressor experiences diverse flow instability patterns at different operating conditions. At low rotating speeds, the compressor undergoes stable state, stall and deep surge successively with mass flow rate decreases and the inducement of the flow instability is the wave-like instability disturbance at the impeller inlet. At middle rotating speeds, the compressor experiences stable state, mild surge and deep surge successively with mass flow rate reduces, and the inducement of the flow instability is the spike type instability disturbance at the diffuser inlet. At high rotating speeds, the compressor still experiences stable state, mild surge and deep surge, whereas the flow instability is dominantly induced by the characteristic of the entire compression system. The research results of this paper promote understandings of the instability mechanism and improvements of the stability of centrifugal compressors.

KEY WORDS:

Turbocharger, compressor, vaned diffuser, flow instability, stall and surge

NOMENCLATURE

ρ	density
a	sound speed
c	slope of compressor characteristics in a compression system
f_H	Helmholtz frequency of a compression system
g	slop of throttle characteristics in a compression system
l	equivalent length of the duct
p_r	reference dynamic pressure
u	impeller velocity
A	equivalent cross-sectional area of the duct
B	a non-dimensional parameter on Greitzer's theory
DS	deep surge
SD	standard deviation
T	static temperature
V	compressed air volume

Subscripts

0	atmospheric conditions
2	impeller outlet (trailing edge of the impeller blade)
<i>ref</i>	reference condition

1. INTRODUCTION

Centrifugal compressor is widely applied in military, industry and agriculture because of its high efficiency, simplicity, compactness and easy maintenance [1-3]. A representative application of centrifugal compressor is the turbocharger. For the purpose

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