Proceedings of the 1st international Symposium on AI and Fluid Mechanics
Paper No S6 P01_ABSTRACT

Mode Analysis of Unsteady Flow in Centrifugal Pumps

[1]Byungjin An*; [1]Szuyong Chen; [1]Motohiko Nohmi;

[1]Fundamental Technologies Research Department

Technologies & Intellectual Property Division

EBARA Corporation

Abstract

The irregular motion of eddies characterized by various spatiotemporal scales in turbulent flow is a primary cause of energy loss, vibrations, and noise. Therefore, the development of effective turbulence control technologies is a critical challenge that directly contributes to the emergence of new functionalities and added value in fluid machinery products. For pumps, which are representative fluid machinery, the importance of technologies that achieve both performance enhancement and the reduction of vibrations and noise has increased due to trends toward downsizing with higher rotation speed. The generation of vibrations and noise undermines equipment reliability and decreases customer satisfaction. Therefore, accurately identifying the sources of vibrations and noise, as well as developing suppression technologies, is essential for enhancing product value. For this challenge, traditional approaches such as theoretical analysis, experiments, and numerical simulations have been carried out. Recent efforts have increasingly focused on the application of data science techniques. This research introduces that utilizes fluid analysis and modal analysis of the Dynamic Mode Decomposition (DMD) to investigate the sound sources of abnormal noise generated under specific operating conditions of a centrifugal pump. By conducting DMD to the static pressure distribution of unsteady flow field, we successfully extracted modes that structures are highly correlated with the causes of abnormal noise. The results show that the dynamic characteristics of static pressure caused by unsteady flow interaction are key factors in the generation of abnormal noise. This study suggests that the integration of fluid dynamics and data science technologies can reveal unknown dynamic characteristics of turbulence, leading to further advancements in turbulence control technologies in fluid machinery.

Keywords: Modal analysis, DMD, Numerical analysis, Centrifugal pumps