Air Flow Optimization of Discharge Duct based on Peregrine Falcon's Diving Wing Shape for Forward Curve Centrifugal Blower

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ABSTRACT

Centrifugal blowers are one of the largest electrical equipment in Heating, Ventilation and Air Conditioning (HVAC) because it is equipment which is regularly running and contributes to high electrical power consumption. The air flow optimization of a centrifugal blower operated inside a biosafety cabinet (BSC) is the main objective for this paper. Air movement can be accelerated when it passes through an aerodynamic duct inspired from an aerodynamic shape of Peregrine Falcon's diving flight. The impact of aerodynamic shape to air movement was determined by using computational fluid dynamics (CFD) analysis. Results showed that by introducing this methodology, air velocity discharge improves three times as the ones without any duct modifications. As a conclusion, a novel design of aerodynamic duct shape successfully developed and proved that air velocity can be increase naturally with the same impeller speed or energy consumption. It is a vital design approach in improving BSC designs while increasing its energy efficiency and containment.

***Keywords*—**Computational Fluid Dynamic, Energy Efficiency, Forward Curve Centrifugal Blower, Peregrine Falcon's

1. INTRODUCTION

Centrifugal blowers are widely used in industrial application such as air conditioning systems in buildings, blowers in automotive cooling units and also for lab equipment ventilation system. In this paper, a forward curved centrifugal blower type is normally use to circulate air inside biosafety cabinet (BSC) that has high efficiency, low noise level and relatively small air flow with a high increase of static pressure [1].

The World Health Organisation (WHO), U.S. Centers for Disease Control and Prevention (CDC) and other organisation classified BSC into 3 classes. Each classes are distinguished in two ways; level of personal and environmental protection and level of product protection provided. This research focuses on centrifugal blower operated inside a BSC Class II Type A2, a commonly used BSC worldwide due to their versatility and economic design [2].

Reduction of power requirement of equipment come to the highlight significantly when electrical power generation cost is showing an inceasing trend worldwide. The Malaysian Standard MS 1525 : 2007 Code of Practice on Energy Efficiency and use of Renewable Energy for Non – Residential Buildings has been introduced to encourage engineers, architects and building developers to better equip their equipment and design more efficiently to reduce energy consumption and electricity usage [3]. Energy saving can be increased by using energy efficient appliances. Energy efficiency is simply defined as using less energy to provide the same services [4,5]. Demand of reduction of power consumption by centrifugal blower is a critical design parameter for BSC. Natural acceleration of air flow without using excessive electrical power consumption to maintain its containment ability is one of the energy saving concept which can be implemented to BSC centrifugal blower.

A guideline from Air Movement and Control Association (AMCA) stated that each blower needs an extended length of ductwork specified as a 100 percent effective length for the velocity pressure to be fully converted be to static pressure [6]. It should be long enough so that the air velocity becomes uniform across the face of the duct that is called static to regain its velocity pressure. Therefore, the design of the duct at the outlet has great effect on the system performance. Unfortunately, current BSC design in the market does not follow the guideline highlighted by AMCA. Centrifugal blower is used without any duct connected at the end of blower outlet and does not effectively convert velocity pressure to static pressure to gain uniform air velocity. Thus, a non-uniformed velocity pressure can cause chaotic air flow and have potential to generate turbulence flow, which eventually might induces