Chapter 3

Methodology

3.1 Overview

Throughout the project, there are few stage needs to be done in order to complete the task. Firstly, Study on aerodynamics force and NACA airfoils in order to compute using CFD. Then, select 10 different geometry of NACA 4 digit airfoil. After that, choose one of ten NACA airfoils to validate simulation data on experimental data using ANSYS 14.0 software. Lastly the analyze simulation data according to its drag coefficient and drag force on airfoil. However, in this report, it will focus only on the simulation data on 10 different geometry of NACA airfoil.

3.2 Aerodynamic Forces

Force balance is an important instrument to measure aerodynamic force in a wind tunnel. First, we need to know about lift force, drag force and the formula that use to compute the forces that involved in a wind tunnel.

3.2.1 Lift force

The lift force is produced by a lower pressure occur on the upper surface of an object compared to the lower surface where the pressure is high and it is causing the object lifted upward. (Mehrdad, 2001). The formula that involved in this project is

$$F_L = \frac{\rho v^2 C_L A}{2}$$

Where,

F_L = Lift Force (in units Newtons, N)

ρ = Fluid density (kg/m^3)

C_L = Lift Coefficient

V = Fluid velocity (m/s)

A = Reference area (m^2) or airfoil area

3.2.2 Drag force

Drag is the aerodynamic force that opposes a model motion through the air. It is a mechanical force that is by the contact of a solid body with a fluid (liquid or gas). It is not force generated by gravitational effect or electromagnetic field effect where the object can affect another object without being in physical contact. If there is no fluid, the drag force does not occur because of the drag to be generated, the model must have physical contact with the fluid. Furthermore, drag generated by the difference velocity between two objects, which is it will make no difference if the moving object past static fluid or the moving fluid past the static object. If there is no motion, there is no drag because drag acts in the direction that opposes the motion. So, it must be a motion for both of the object and the fluid. (Mehrdad, 2001). The formula involved for drag force in a wind tunnel is:

$$F_D = \frac{\rho v^2 C_D A}{2}$$

Where,

F_D = Drag Force (in units Newtons, N)

ρ = Fluid density (kg/m^3)

C_D = Drag Coefficient

V = Fluid velocity (m/s)

A = Reference area (m^2) or airfoil area