

Cfd analysis of a wind turbine engineering essay

[Engineering](#)



**ASSIGN
BUSTER**

Wind mills were used for grinding grains and pumping water about three thousand years ago, today wind energy is one of the main sources of getting renewable energy. Wind turbine is a very important mechanical engineers discovery. Converting wind energy in to electrical energy includes several stages of engineering work and problem solving techniques. In order to get the maximum efficiency, it has to be make sure that the input wind in the wind turbine is fully consumed to drive the wind turbine blades so that maximum and controlled amount of power is generated. For an efficient wind turbine, the design is very important, so the design undertakes several types of test and experiments, CFD (computational fluid dynamics) analysis is one of the most essential tests or analysis which helps to analyse different parameters which are responsible for efficient flow of wind over the wind turbine.

Introduction:

This project titled as ' CFD analysis of a wind turbine' is a major individual project for a final year Aerospace Engineering student. This project was started on 11-October 2010. Main purpose of the CFD analysis of a wind turbine is to get the most important relations which allow us to optimize the efficiency and design of a wind turbine. Parameters like coefficient of lift, drag and moment if compared with angle of attack can produce results which can help us to analyse a wind turbine performance. In this project a wind turbine designed in 2009 will be optimized and some parameters mentioned above and all other related parameters and values will be analysed in a CFD package ANSYS CFX to get better and more efficient results.

Project aim:

The main aim of the project is to conduct to optimize a previously designed wind turbine and CFD analysis of a wind turbine.

Project objectives:

The main objectives of the project are following: To get the detailed study of wind turbines including designs, components, operations, characteristics and performance. To learn the aerodynamics of a wind turbine. To redesign and optimize the wind turbine. Stress and strain analysis of the redesigned wind turbine CFD Analysis of an optimized wind turbine in ANSYS CFX. To fabricate a scale model of the wind turbine. Testing the fabricated model of the wind turbine in wind tunnel. To compare the results and data obtained from wind tunnel and ANSYS CFX model. To study the flow of wind over the wind turbine blades.

Project Stages:

This project includes 9 possible stages to its completion, starting from literal research to the final report writing these stages are detailed below:

STAGE-1: Literal Study

Stage-1 of the project includes the deep study of the wind turbine which is further broken down into the following:

Wind turbines history:

History of wind turbines and the basic concepts.

Wind energy resources:

Study of how the wind is caused, the basic physical phenomenon that are related to the characteristics of the wind.

Wind turbine designs:

Different wind turbine designs, including the design of rotors and their assemblies.

HAWT AND VAWT:

This section includes the technical study of the difference between horizontal axis wind turbine and vertical axis wind turbine.

Wind turbine components:

Wind turbine components and their characteristics and the study of their importance in the wind turbine.

Operations:

This study includes the reading of the operation and function of the wind turbine, also about how a wind turbine generates power.

Aerodynamics:

Study of all aerodynamics forces on the wind turbine and the performance of the wind turbine at different aerodynamic conditions.

STAGE-2: Software learning

Second stage of the project include the necessary software understandings, in this project ANSYS and CATIA will be required, as there University of Hertfordshire has already provided a working knowledge in CATIA in first two

years of the engineering degree, so ANSYS need to be understood and also need some practiced. This will be done by practicing some tutorials described below:

Tutorial-1: Two Dimensional Truss

An introductory ANSYS tutorial, in which a truss will be modelled and theoretical results, will be compared with simulation results.

Tutorial-2: Space Free Example

In this tutorial a simple 3D sample frame (a bicycle chassis) problem will be solved.

Tutorial-3: Application of Distributed Loads

This tutorial will help to explain the method of applying distributed loads.

Tutorial-4: Plane stress Bracket

2D Plane Stress Bracket will be introduced and work on Boolean operations, plane stress, and uniform pressure.

Tutorial-5:

Information pending

Tutorial-6:

Information pending

STAGE-3: Wind turbine 2009

The third stage of the project is to study about the previous year's design and operations of the wind turbine which is broken into the following sections:

Design Study:

The design of the wind turbine will be studied in deep detail.

Functions and Operations:

The components and their functions will be studied and any modern techniques and processes will be focused.

Results Study:

CFD and wind tunnel test readings and data will be analysed.

STAGE-4: The wind turbine optimization

This stage of the project is the most important stage, after completion of the tutorials and the literal study of the wind turbine, now the wind turbine from 2009 will be ready to optimize. This process will include following steps

Optimizing the design:

In this step the possible modifications in the blade and other components will be made. Initially the designs will be made on paper by using pencils and scales.

Material research:

Materials like glass epoxy, PVC Foam, Styrofoam and Wood veneer will be studied in order to design and fabricate the body and blades of the optimized wind turbine.

Design calculations:

Stress, bending moments and shear forces will be calculated for the optimized wind turbine.

3-D Modelling in CATIA V-5:

After hand calculations of the scale and other parameters the wind turbine will be ready to model in CAD software CATIA V-5. Following are the steps to complete this task. CAD of rotor blade
CAD of rotor hub
CAD of rotor brake
CAD of tower
CAD of nacelle
Final Assembly
Technical drawings
http://ec.europa.eu/research/energy/nn/nn_rt/nn_rt_wind/images/wind_en_1370.gif
This image shows parts which will be modelled in the CAD software CATIA V-5

Mechanical calculations in ANSYS 12:

Once the wind turbine will be modelled, then it will be imported in the ANSYS to test its blades for stresses and to analyse the deformation by applying wind loading on it.

STAGE-5: CFD analysis

In stage-5 of the project wind turbine will be ready for the CFD modelling, in this stage the flow of wind and major parameters responsible for the efficient performance of the wind turbine will be analysed.

STAGE-6: Wind turbine fabrication

Required material will be arranged and necessary tools will be arranged in the University of Hertfordshire manufacturing laboratory to fabricate the components of the wind turbine and then the final assembly. The wind turbine will be fabricated to a scale which can be placed in the wind tunnel so that it can be tested on different wind speeds.

STAGE-7: Wind tunnel testing

This stage is totally depend on the completion of the stage-6, once the wind turbine will be fabricated then the flow of wind over the blades will be analysed by using the threads attached on the blades and parameters like angle of attack, coefficient of lift and drag will also be calculated.

STAGE-8: Results

In this stage all of the results from previous year and this year will be collected and necessary comparisons will take place between the data collected from wind tunnel and CFD analysis.

STAGE-9: Report Writing

Finally, all of the practical and theoretical work will be given a shape of a report, the final project report submission deadline is 20th April 2011 and it will be expected after this feasibility report that the report will be ready 5 days before the deadline.

Project Management:

Time plane:

Task name

Duration

Start date

Finish date

1

FEASIBILITY STUDY14dMon 11/10/10Thu 28/10/10

2

STAGE-1 Literal Study 30d Mon 11/10/10 Fri 19/11/10

3

STAGE-2 ANSYS 21d Mon 25/10/10 Mon 22/11/10

4

STAGE-3 Wind turbine 20095d Mon 25/10/10 Fri 29/10/10

5

STAGE-4 Optimization (CAD) 26d Mon 01/11/10 Sun 05/12/10

6

STAGE-5 CFD ANSYS CFX 13d Wed 15/12/10 Fri 31/12/10

7

STAGE-6 Wind turbine Fabrication 18d Wed 08/12/10 Fri 31/12/10

8

STAGE-7 Wind tunnel testing 9d Tue 25/01/11 Fri 04/02/11

9

STAGE-8 RESULTS 3d Thu 03/02/11 Mon 07/02/11

10

STAGE-9 Report Writing 5d Mon 31/01/11 Sat 16/04/11

STAGE-4 is dependent on STAGE -3
STAGE-5 can be started until STAGE-4 is finished
STAGE-6 is dependent on the completion of STAGE-4
STAGE-8 and STAGE-7 can only be start when all of the stages are finished

Project GANTT chart:

Conclusions:

This feasibility study of the project regarding the CFD analysis of a wind turbine shows that it is possible to optimize a wind turbine before the deadline of the final submission of the project. The project is composed of 9 stages and it is expected that all of the stages will be cover before 20th April 2011 (deadline of the final submission). According to the time plan this project starts from 11th October 2010 and finishes on 15th April 2011, in this time period project will cover all of its objectives. The time plan is design is such a way that the working days on the project are three and total hours per week for this project are 15hrs and the total hours to complete the whole project with efficient results and performance will be 375hrs. After the feasibility study of the project it will be expected that project will be completed with considerably good performance in the planned time period before the deadline.