

**NUMERICAL EVALUATION OF ENERGY LABELLING
TEST SETUPS OF CEILING FANS**

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement of any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and believe it does not contain any previously published material or written by another person except where the acknowledgement is made in the text.

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ABSTRACT

Ceiling fans are widely used as a means of providing thermal comfort to occupants in an indoor environment all around the world and it contributes to a significant portion of annual energy consumption throughout the world. A number of standards for efficiency analysis of ceiling fans are employed by many countries, with the intention of making ceiling fans more efficient. In these test standards, different test setups have been utilised. Work performed on analysis of the effect of these setups on performance evaluation of ceiling fans is currently unavailable. Further, there is a scarcity of research work performed on analysis of flow characteristics around a rotating ceiling fan. Understanding the proper flow around a rotating ceiling fan can lead to designing more efficient fan blades, which can lead to significant energy savings. Therefore, this study is split into two sections. In section one, a systematic investigation of the different test standards available for performance analysis of ceiling fans is performed, namely standards considered are ANSI/AMCA 230 standard, IEC 60879: 1986 standard, SLS 1600:2011 standard and Energy Star v1.2 standard for performance testing of ceiling fans. In section two, a flow physics analysis around a ceiling fan is carried out. For these, a CFD model was developed and it was validated using experimental results. The analysis of test standards was carried out by using a RANS method whereas the analysis of flow physics was carried out by using LES method. The numerical results obtained shows that the test cylinder present in some of the standards mentioned above, does not have a significant impact on the measured performance of the tested ceiling fan (variation is less than 2%), therefore having a test cylinder at an extra cost have no benefit on the measured results of ceiling fan testing. On the other hand, maintaining test cylinders for every fan size would impart a significant cost on the testing process and having a cylinder which is not correctly aligned can lead to inaccurate readings. From the flow results of the LES simulations, creation of two major vortical structures is seen arising from the tip and the root of the blade. As these vortical structures move further downward, more vortices were formed due to the action of these and the number of vortices keep growing with flow time, resulting the flow to become turbulent with the flow time. Furthermore, it was seen that the flow transition from laminar to turbulent occurred at the mid chord section, starting from the deflected section of the blade.

TABLE OF CONTENTS

Declaration	i
Acknowledgement	ii
Abstract	iii
Table of Contents	iv
List of Figures	vi
List of Tables	viii
1. Introduction.....	1
1.1 Aims	5
1.2 Objectives.....	5
2. Literature Review.....	6
3. Methodology.....	19
3.1 Experimental Analysis	19
3.1.1 Experimental Facility.....	19
3.1.2 Experimental Setup.....	19
3.1.3 Instrumentation	21
3.1.4 Test Procedures.....	23
3.1.5 Experimental Procedure.....	23
3.1.6 Derived Data Definition.....	24
3.2 Computational Modeling.....	28
3.2.1 Model of the Fan.....	28
3.2.2 Mesh Generation.....	31
3.2.3 Turbulence Modeling.....	33
3.2.4 Solver Setup.....	34
3.2.5 Simulation of Motion of Blades.....	35

3.2.6	Boundary Conditions	37
3.2.7	Cell zone conditions.....	38
3.2.8	Initialization and Calculation.....	38
3.2.9	Analysis of the Effect of Ceiling Fan Test Chamber Geometry on the Performance Measurement of Ceiling Fans	39
4.	Results.....	41
4.1	Experimental Results.....	41
4.1.1	Assumptions.....	41
4.1.2	Results.....	41
4.2	CFD Simulations.....	43
4.2.1	Case 1: Analysis of The Effect of Ceiling Fan Test Chamber Geometry on The Performance Measurement of Ceiling Fans.....	43
4.2.2	Case 2: Analysis of The Flow Field Characteristics Around Rotating Ceiling Fan Blades	52
5.	Discussion.....	56
5.1	Experimental Data.....	56
5.2	Case 1: Analysis of the effect of ceiling fan test chamber geometry on the performance measurement of ceiling fans	59
5.3	Case 2: Analysis of the Flow Field Characteristics Around Ceiling Fan Blades.....	65
6.	Conclusion	75
7.	References.....	77

LIST OF FIGURES

Figure 1.1 – Flow profile generated by a ceiling fan.....	2
Figure 2.1 - Variation of flow coefficient with ceiling height	9
Figure 2.2 - Standard test chamber setup as per SLS 1600:2011 standard.....	10
Figure 2.3 - Energy star v1.2 standard for ceiling fan testing.....	11
Figure 2.4– IEC 60879 standard	11
Figure 2.5 – Von Karman Vortices at the trailing edge of a propeller blade	16
Figure 2.6 – Tip vortices illustration using iso surfaces of Q-Criterion	17
Figure 2.7 – Vortex identification using Q criterion	18
Figure 3.1 - Standard test chamber setup.....	19
Figure 3.2 – Test chamber containing the cylinder and the placement of anemometer sensors...	20
Figure 3.3 - Anemometers probe and DAQ card.....	22
Figure 3.4 – Digital Power Meter	22
Figure 3.5 – Placement of the Anemometers.....	24
Figure 3.6 – 3D Model of the ceiling Fan.....	29
Figure 3.7 – Fan rotor dimensions	30
Figure 3.8 – CFD domain	30
Figure 3.9 – Close view of moving section	31
Figure 3.10 – Mesh in the moving region.....	32
Figure 3.11 - Cross Sectional view of the mesh	32
Figure 4.1 – Spatially and time averaged experimental data	42
Figure 4.2 – Measured parameters at different regulator settings	43
Figure 4.3 – Variation of output parameters with mesh size	44
Figure 4.4 – Effect of the turbulence model on the output velocity for turbulence models	45
Figure 4.5 – Comparision of axial velocity results of SA model with experimental results	46
Figure 4.6 – Simulated Results	47
Figure 4.7 – Generated velocity distributions.....	48
Figure 4.8 - Effect of the gap between the plane of rotation of the fan and the test cylinder.....	49
Figure 4.9- Effect of height of the test cylinder.....	50
Figure 4.10- Effect of diameter of the test cylinder.....	51
Figure 4.11 - Effect of the size of the test chamber	52

Figure 4.12 – Axial velocity variation	53
Figure 4.13 – Output value variation with mesh size	54
Figure 4.14 – Computational results for the selected RPM	55
Figure 4.15 – Area averaged results of 7 points at 0.1m intervals in radial direction just below the cylinder	55
Figure 5.1 – Measured parameters at different regulator settings	57
Figure 5.2 – Comparison of axial velocities 1m below the plane of rotation of fan	59
Figure 5.3 – Comparison of axial velocities at a height of 1m below the plane of rotation of the fan between a case with and without a test cylinder	60
Figure 5.4 – Comparison of calculated values between tested cases.....	62
Figure 5.5 – Comparison of calculated values between cases of different room sizes.....	64
Figure 5.6 – Spatially averaged axial velocity variation of 120^0 angle along radii of the ceiling fan with time	65
Figure 5.7 – Variation of axial velocity at 8 points at 100mm intervals along the radii of the ceiling fan with time in 5 lines along the radii of the fan at 30^0 intervals	66
Figure 5.8 – Instantaneous velocity vectors at 8 equally spaced points on one line at different flow times in comparison with experimental data.	67
Figure 5.9 – Formation of vorticial structures	68
Figure 5.10 – Vertical contour of velocity through centre of rotation of fan	69
Figure 5.11 – Iso surface of $Q=3000 \text{ s}^{-2}$ colored by velocity magnitude.....	70
Figure 5.12 – Iso surface of vortex core region at Vorticity = 250 s^{-1} colored by velocity.....	71
Figure 5.13 – Formation of vorticial structures	72
Figure 5.14 – Instantaneous contours of vorticity at vertical planes of $x=12\text{mm}$, 24mm and 36mm at a flow time of 3.299s	72
Figure 5.15 – Vorticity contour on the bottom surface of the blade.....	73
Figure 5.16 – Total pressure in the mid -chord section of the fan blade	74

LIST OF TABLES

Table 2.1 – Comparison of major dimensions of ceiling fan test standards	12
Table 3.1- Parameters evaluated during simulations	40
Table 4.1 – Measured RPM values	41
Table 4.2 – Flow parameters at different RPMs	42
Table 4.3- Variation of output with mesh size.....	44
Table 4.4 -Calculated RMSD between cases using different turbulence models	45
Table 4.5- Calculated NRMSD between simulated case using SA turbulence model and experimentally measured values for the five test cases	46
Table 4.6- Variation of output with mesh size.....	53
Table 5.1 – Flow parameters at different RPMs	56
Table 5.2 – Key for energy rating as per SLS 1600:2011	58
Table 5.3 – NRMSD w.r.t. a case without test cylinder	61
Table 5.4 – Summary of calculated service value and flow coefficient in cases with different cylinder geometries.....	63
Table 5.5 – Calculated energy rating of different cases.....	63