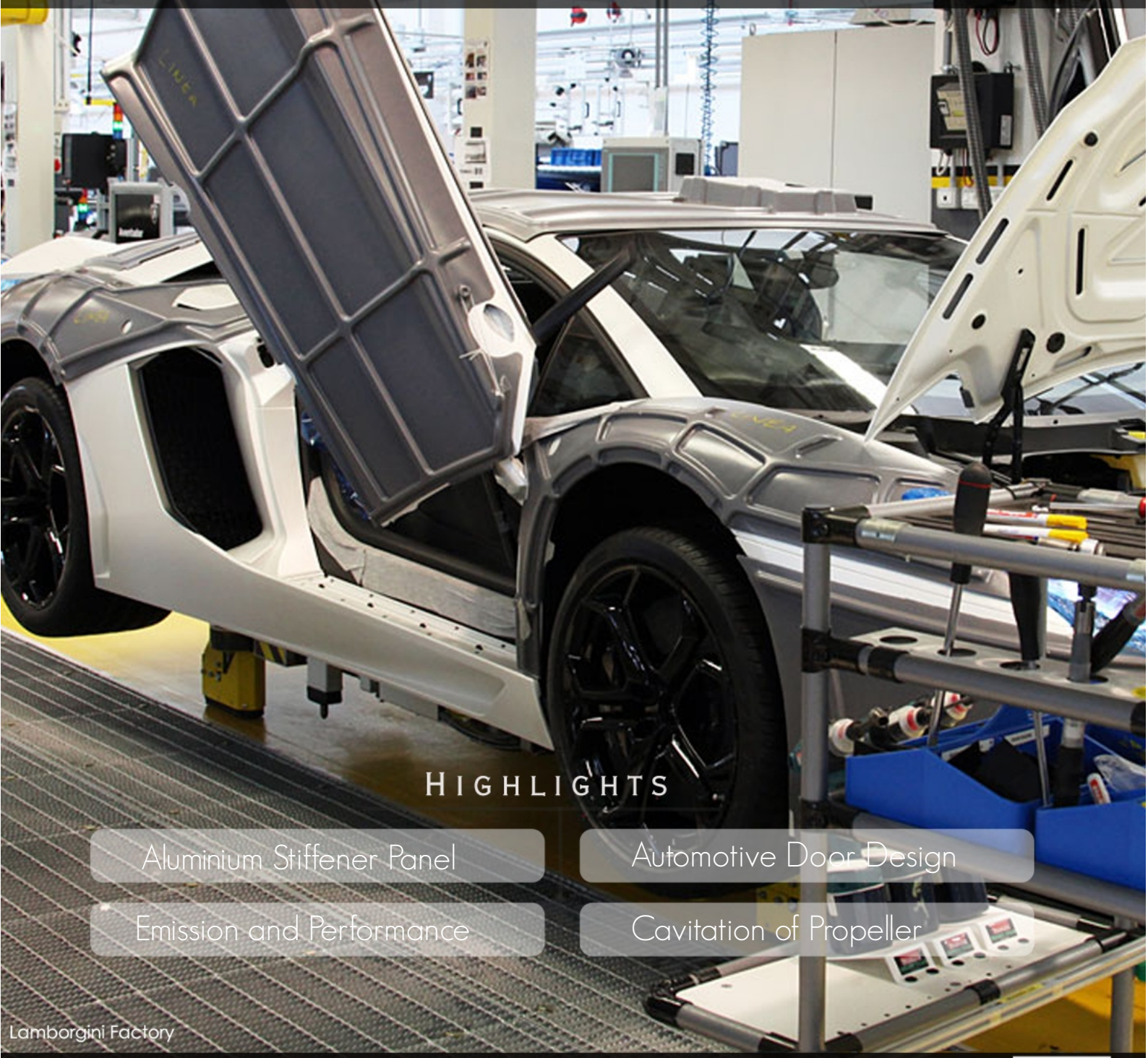
Online ISSN: 2249-4596
Print ISSN: 0975-5861

Global Journal

of Researches in Engineering : B

Automotive Engineering

DISCOVERING THOUGHTS AND INVENTING FUTURE



Highlights

- Aluminium Stiffener Panel
- Automotive Door Design
- Emission and Performance
- Cavitation of Propeller

Lamborgini Factory

Volume 12 | Issue 2 | Version 1.0 ENG

Global Journal of Researches in Engineering: B
Automotive Engineering

Global Journal of Researches in Engineering: B
Automotive Engineering
Volume 12 Issue 2 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals Inc., Headquarters Corporate Office, Cambridge Office Center, II Canal Park, Floor No. 5th, ***Cambridge (Massachusetts)***, Pin: MA 02141 United States
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Open Association of Research Society, Marsh Road, Rainham, Essex, London RM13 8EU
United Kingdom.

Packaging & Continental Dispatching

Global Journals, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investers@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Editorial Board Members (HON.)

Dr. Bart Lambrecht
Director of Research in Accounting and FinanceProfessor of Finance
Lancaster University Management School
BA (Antwerp); MPhil, MA, PhD (Cambridge)

Dr. Carlos García Pont
Associate Professor of Marketing
IESE Business School, University of Navarra
Doctor of Philosophy (Management), Massachusetts Institute of Technology (MIT)
Master in Business Administration, IESE, University of Navarra
Degree in Industrial Engineering, Universitat Politècnica de Catalunya

Dr. Fotini Labropulu
Mathematics - Luther College
University of ReginaPh.D., M.Sc. in Mathematics
B.A. (Honors) in Mathematics
University of Windso

Dr. Lynn Lim
Reader in Business and Marketing
Roehampton University, London
BCom, PGDip, MBA (Distinction), PhD, FHEA

Dr. Mihaly Mezei
ASSOCIATE PROFESSOR
Department of Structural and Chemical Biology, Mount Sinai School of Medical Center
Ph.D., Etvs Lornd University
Postdoctoral Training,
New York University

Dr. Söhnke M. Bartram
Department of Accounting and FinanceLancaster University Management SchoolPh.D. (WHU Koblenz)
MBA/BBA (University of Saarbrücken)

Dr. Miguel Angel Ariño
Professor of Decision Sciences
IESE Business School
Barcelona, Spain (Universidad de Navarra)
CEIBS (China Europe International Business School).
Beijing, Shanghai and Shenzhen
Ph.D. in Mathematics
University of Barcelona
BA in Mathematics (Licenciatura)
University of Barcelona

Philip G. Moscoso
Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich

Dr. Sanjay Dixit, M.D.
Director, EP Laboratories, Philadelphia VA Medical Center
Cardiovascular Medicine - Cardiac Arrhythmia
Univ of Penn School of Medicine

Dr. Han-Xiang Deng
MD., Ph.D
Associate Professor and Research
Department Division of Neuromuscular Medicine
Davee Department of Neurology and Clinical NeuroscienceNorthwestern University
Feinberg School of Medicine

Dr. Pina C. Sanelli
Associate Professor of Public Health
Weill Cornell Medical College
Associate Attending Radiologist
NewYork-Presbyterian Hospital
MRI, MRA, CT, and CTA
Neuroradiology and Diagnostic Radiology
M.D., State University of New York at Buffalo,School of Medicine and Biomedical Sciences

Dr. Roberto Sanchez
Associate Professor
Department of Structural and Chemical Biology
Mount Sinai School of Medicine
Ph.D., The Rockefeller University

Dr. Wen-Yih Sun
Professor of Earth and Atmospheric SciencesPurdue University Director
National Center for Typhoon and Flooding Research, Taiwan
University Chair Professor
Department of Atmospheric Sciences, National Central University, Chung-Li, TaiwanUniversity Chair Professor
Institute of Environmental Engineering, National Chiao Tung University, Hsin-chu, Taiwan.Ph.D., MS The University of Chicago, Geophysical Sciences
BS National Taiwan University, Atmospheric Sciences
Associate Professor of Radiology

Dr. Michael R. Rudnick
M.D., FACP
Associate Professor of Medicine
Chief, Renal Electrolyte and Hypertension Division (PMC)
Penn Medicine, University of Pennsylvania
Presbyterian Medical Center, Philadelphia
Nephrology and Internal Medicine
Certified by the American Board of Internal Medicine

Dr. Bassey Benjamin Esu
B.Sc. Marketing; MBA Marketing; Ph.D Marketing
Lecturer, Department of Marketing, University of Calabar
Tourism Consultant, Cross River State Tourism Development Department
Co-ordinator , Sustainable Tourism Initiative, Calabar, Nigeria

Dr. Aziz M. Barbar, Ph.D.
IEEE Senior Member
Chairperson, Department of Computer Science
AUST - American University of Science & Technology
Alfred Naccash Avenue – Ashrafieh

Contents of the Volume

Global Journal of Researches in Engineering
Automotive Engineering
Volume 12 Issue 2 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

CFD Simulation for Cavitation of Propeller Blade

By O. O. Sulaiman, A.S.A.Kader, W.B.Wan Nick & A.H. Saharuddin

Universiti Malaysia Terengganu

Abstract - Propeller cavitation is a major problem in ship operation and the costs of repair and maintenance is high for ship-owners. Proper design of propeller plays a very important role in life cycle and the performance of a vessel. The use of simulation to observe various parameters that affect cavitations can be helpful to optimize propeller performance. This project designs and simulates cavitations flow of a Kaplan series, Fixed Pitch Propeller (FPP) of a 48-metres Multipurpose Deck Ship at 11 knots. Simulation test was carried out for laminar and turbulent flow using Computational Fluid Dynamics (CFD) approach to observe cavitations occurrence at selected radius.

Keywords : *Simulation, cavitation, performance, propeller, CFD.*

GJRE-B Classification: *FOR Code: 090201*

Strictly as per the compliance and regulations of:

CFD Simulation for Cavitation of Propeller Blade

O. O. Sulaiman[α], A.S.A.Kader[σ], W.B.Wan Nick[ρ] & A.H. Saharuddin[ω]

Abstract - Propeller cavitation is a major problem in ship operation and the costs of repair and maintenance is high for ship-owners. Proper design of propeller plays a very important role in life cycle and the performance of a vessel. The use of simulation to observe various parameters that affect cavitations can be helpful to optimize propeller performance. This project designs and simulates cavitations flow of a Kaplan series, Fixed Pitch Propeller (FPP) of a 48-metres Multipurpose Deck Ship at 11 knots. Simulation test was carried out for laminar and turbulent flow using Computational Fluid Dynamics (CFD) approach to observe cavitations occurrence at selected radius. The parameters considered are pitch angle, angle of attack, viscosity of sea water, operating vapour pressure in the sea water, engine power, lift and drag vectors of each of the blade sections, and resultant velocity of the fluid flow. Comparison of performance is made and it compares well with the theory. Thrust coefficient (K_T), torque coefficient (K_Q), thrust (T), advance coefficient (J), and cavitations number (σ), were calculated to deduce efficiency and validate the model. The study can be used to build a prototype physical model that could be beneficial for future additional experimentation investigation.

Keywords : Simulation, cavitation, performance, propeller, CFD.

I. Introduction

A marine propeller is a propulsion system which turns the power delivered by the engine into thrust to drive the vessel through water. Propeller cavitation is a general problem encountered by the ship owner, whereby it causes vibrations, noises, degradation of propeller performance, deceases engine efficiencies, effects the life cycle of the ship and also results in high cost of maintenance. The basic physics of cavitation occurs when the pressure of liquid is lower or equal to the vapour pressure, which depends on the temperature, thus forming cavities or bubbles. The compression of pressure surrounding the cavities would break the cavities into smaller parts and this increases the temperature. Collapse of bubbles in contact with parts of the propeller blades will create high localised forces that subsequently erode the surface of the blades. Simulation on cavitating flow using CFD can be carried out to determine the performance of the propeller. A model is generated in Gambit and fluid-flow physics are applied to predict the fluid dynamics and other physical phenomena related to thepropeller. Ref. [1] stated that, CFD can provide potential flow analysis such as flow velocities and pressure at every point in the problem domain as well as the inclusion of viscous effects.

Author α σ ρ ω : Technology Department, University Malaysia Terengganu, Faculty Of Maritime Studies and Marine Science, Universiti Malaysia Terengganu.

a) Previous studies on propeller cavitation

Ref. [2] in their studies, generated hybrid grid of about 187 000 cells using Gambit and T Grid. The blade surface was firstly meshed with triangles including the root, tip and blade edges. The turbulent boundary layer was resolved with four layers of prismatic cells between blade and hub surfaces. In the cavitating propeller case, the boundary conditions were set to simulate the flow around a rotating propeller in open water. Inlet boundary, velocity components for uniform stream, blade and hub surfaces, and outer boundary were included. This ensured the rotational periodicity of the propeller on the exit boundary by setting the pressure corresponding to the given cavitation number and other variables was later extrapolated [3,11]. On the other hand, [3] applied a mixture of models with algebraic slip to simulate cavitating flow over a NACA 66 hydrofoil. This multiphase flow model which used incompressible fluids consisting of liquid and vapour was used as primary and secondary phase respectively. Structured quadrilateral grids of 19 490 cells were meshed. Inflow and outflow boundary were indicated as velocity magnitude and direction and zero gauge pressure respectively. Contour of vapour volume fraction shown in Figure 1 indicates that cavity can be observed at the mid-chord region [4,12].

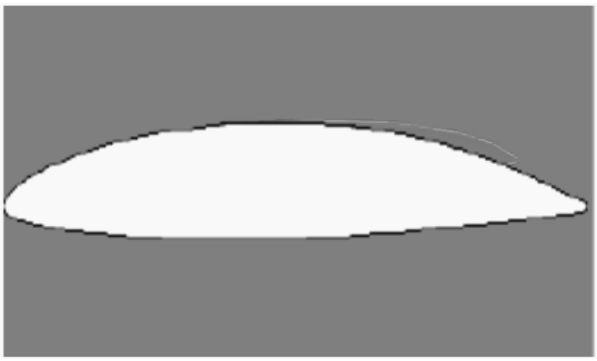


Figure 1 : Cavity at the mid-chord region

This study is focussed mainly on simulating a cavitating flow at the propeller blade section of Kaplan series in order to optimize the propeller blade to increase its performance. Two-dimensional simulations of different radii were carried out at different revolutions per minute (rpm) and the results were compared based on the pressure difference. The objective is to simulate and investigate the water flow at the propeller blade

section and to recommend measures to reduce cavitation in order to increase its efficiencies [4, 5].

II. Methodology

a) Model generation in Gambit

The Propeller Blade models of 0.2R and 0.6R were generated and computational domains were created to assume water is flowing from far towards the Propeller Blade. Figure 2 and Table 1 show far-field boundary conditions surrounding the Propeller Blade. Then, meshing was carried out between the boundaries and Propeller Blade to determine the accuracy of the model generation. Figure 3 and 4 show the meshing process [6, 13, 14].

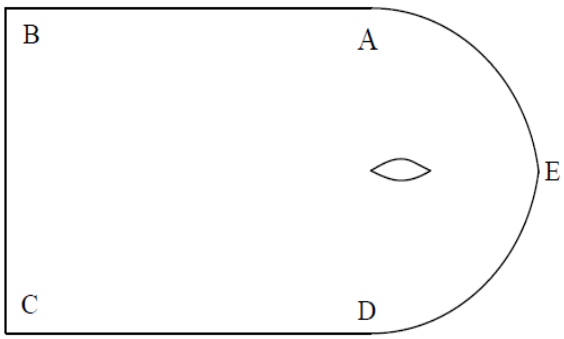


Figure 2 : Creation of far -field boundaries to simulate the fluid behaviour in Fluent.

Table 1 : Boundary conditions for simulating fluid behaviour

Curve	Boundary condition
AED	Far field 1
AB	Far field 2
CD	Far field 2
BC	Far field 3

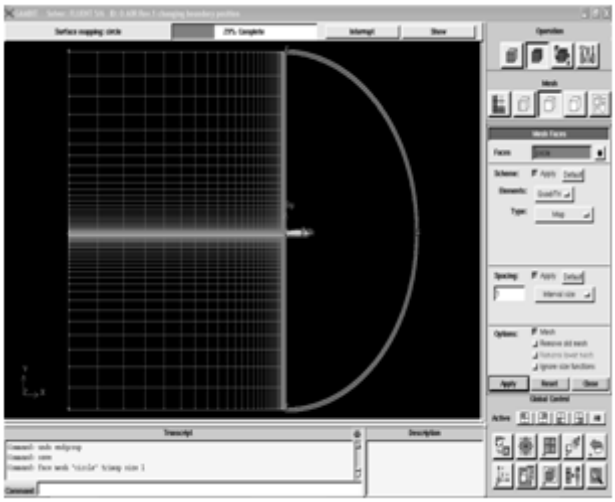


Figure 3 : Meshing process of 0.2R Propeller Blade section

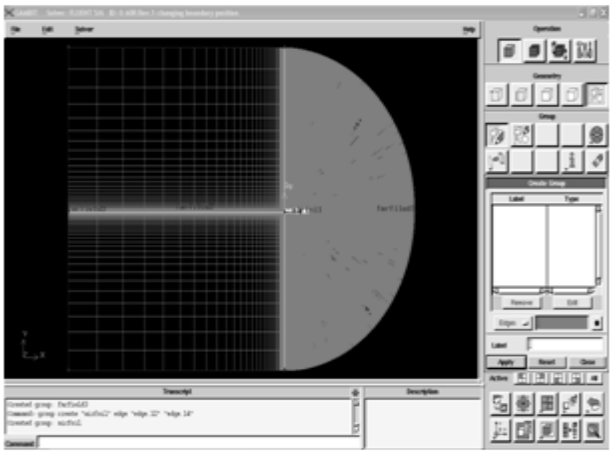


Figure 4 : Meshing result of 0.2R Propeller Blade section with boundaries creation

b) Numerical method

Propeller blades of 0.2R and 0.6R were simulated in Fluent 6.3.26. Pressure-based numerical solver, laminar and turbulent physical model were selected as the functioning base for 300rpm and 600rpm. Then, the material properties, for instance, the density of sea water and viscosity value were defined and calculated based on Table 2.. Consequently, the operating condition was set to be 2296 Pa, which is the condition for vapour pressure at sea water when the temperature is 20°C. On the other hand, the boundary conditions of far field 1 and far field 2 were specified as velocity inlet, whereby the velocity magnitude and direction were calculated[7,8].

As for far field 3, this boundary was specified as pressure outlet; the gauge pressure was set to be 0 Pa. The existence of inflow and outflow boundaries enables the characteristics of fluid to be observed by entering and leaving the flow domain. The turbulent viscosity ratio was set to correspond to the default value for 600rpm of both radii. Next, the solution procedure was set as simple algorithm, and under *discretisation,* the pressure and momentum were set as Standard and First Order Upwind respectively [9,10].

Table 2 : Water properties (Tupper, 2004)

Temperature (°C)	Density (kg/ m^3)		Kinematic viscosity ($m^2/s \times 10^6$)	
	Fresh water	Salt water	Fresh water	Salt water
0	999.8	1028.0	1.787	1.828
10	999.6	1026.9	1.306	1.354
20	998.1	1024.7	1.004	1.054
30	995.6	1021.7	0.801	0.849

At the temperature of 20°C, the density of sea water is 1025 kg/m^3, and the kinematic viscosity is 1.054 x 10^6 m^2/s. Thus, in order to insert the value of dynamic

viscosity in Fluent, the following formula was used to convert kinematic viscosity to dynamic viscosity.

$$\text{Dynamic viscosity} = \text{kinematic viscosity} \times \text{density} \quad (1)$$

Therefore, the calculated dynamic viscosity is 1.08035 x 10^9 kg/m.s.

Consequently, the operating condition was set to be 2296 Pa based on Table 3, which is the condition for vapour pressure at sea water when the temperature is 20°C.

Table 3 : Saturation vapour pressure, P_v for fresh and sea water (Carlton, 2007)

Temperature (°C)	0.01	5	10	15	20	25	30
Fresh water, P_v (Pa)	611	872	1228	1704	2377	3166	4241
Sea water, P_v (Pa)	590	842	1186	1646	2296	3058	4097

On the other hand, the boundary conditions of far field 1, far field 2 and far field 3 were specified to accommodate the fluid behaviour. Far field 1 and far field 2 were specified as velocity-inlet, whereby the velocity magnitude and direction were calculated as the following:

For 0.2R airfoil section profile,

$$\text{Pitch angle, } \theta = \tan^{-1}\left(\frac{P}{2\pi r}\right), \quad (2)$$

where, P is pitch and r is radius of the blade section

Thus, resultant velocity of the fluid flow at 0.2R is calculated as,

$$\text{Resultant velocity, } v = \left(\frac{2\pi rn}{\cos\theta}\right), \quad (3)$$

Where, n is equal to the rotational speed of the propeller

$$\text{Resultant velocity, } v = \left(\frac{2\pi rn}{\cos\theta}\right), \quad (4)$$

Velocity-inlets at both far fields were then indicated as 729 m/s for 0.2R airfoil section. As for far field 3, this boundary was specified as pressure-outlet, whereby the gauge pressure was set to be zero Pascal. The existence of inflow and outflow boundaries enables the characteristics of fluid to be observed by entering and leaving the flow domain. Parameters in the solution control were set up to select the suitable iterative solvers. Under *pressure-velocity coupling*, the solution procedure was set as SIMPLE algorithm, which equipped an accurate linkage between pressure and velocity. SIMPLE algorithm was used due to the assumption of steady flows. Besides, under *discretization,* the pressure and momentum were set as Standard and First Order Upwind respectively. The First Order Upwind was set due to convection terms in solution, thus the face value would be set to cell-centre value. This was done before any CFD calculation was performed. The solution was then initialised and computed from far field 1.

Monitoring of the convergence of the solution was performed. There were three differential equations to be solved in a two-dimensional incompressible laminar flow problem, which indicated the three residuals to be monitored for convergence, that is, *continuity, x-velocity* and *y-velocity.* The default convergence criteria were set as 0.001 for all three of these. As the code iterates, the *residuals* were calculated for each flow of equation. These residuals represented an average error in the solution. Moreover, monitoring lift and drag force was carried out and calculated as following:

For 0.2R airfoil section profile,

$$\text{Angle of attack, } \alpha = \left(\frac{2f_{max}}{C}\right) \quad (5)$$

Where, f_{max} is thickness of the airfoil section and C is chord length of the airfoil section

$$\text{Angle of attack, } \alpha = \left(\frac{2f_{max}}{C}\right) \quad (6)$$

Lift force is defined as a force perpendicular to the direction of the freestream. Therefore, *X* and *Y* are formulated as *sin θ* and *negative cos θ*, respectively, as shown in Figure 5.

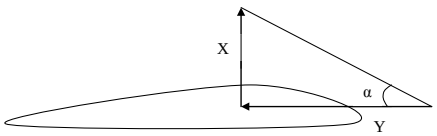


Figure 5 : A lift force vector of an airfoil section profile

To calculate the lift force vector of an airfoil,

$$X = \sin\alpha \text{ and } Y = -\cos\alpha \quad (7)$$

Where, α is the angle of attack

$$X = \sin 55°$$
$$= \underline{0.8192}$$

$$Y = -\cos 55°$$
$$= \underline{-0.5736}$$

Therefore, lift force vector at X and Y was 0.8192 and – 0.5736 respectively.

As for the drag force vector, it is defined as the force component in the direction of the freestream. Thus, *X* and *Y* are formulated as *negative cos θ* and *sin θ* respectively, as shown in Figure 6.

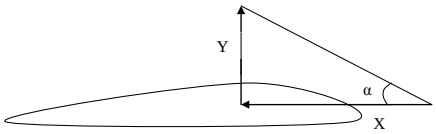


Figure 6 : A drag force vector of an airfoil section profile

To calculate the lift force vector of an airfoil,

$$X = -\cos\alpha \text{ and } Y = \sin\alpha \qquad (8)$$

Where, α is the angle of attack

$$X = -\cos 55°$$
$$= \underline{-0.5736}$$

$$Y = \sin 55°$$
$$= \underline{0.8192}$$

Therefore, lift force vectors at X and Y were –0.5736 and 0.819 respectively.

The solution was solved and iterated in order to remove the unwanted accumulations, so that the iterative process would converge rather than diverge. A converge solution is usually achieved when the residuals fall below some convergence criteria, that is 0.001. Besides examining residuals, variables such as lift and drag force were monitored to find out the convergence of the numerical computations.

Last but not least, the CFD results were visualised and analysed at the end of the computational simulation in different categories, such as vector plots and contour plots for a better relevant physical characteristics view within the fluid - flow problem.

The simulation process was repeated by inserting various operating pressure values below 2296 Pa in order to observe the pressure difference for cavitation to occur and also to examine the sensitivity for accuracy of the results and performance. Finally, document the findings of the analysis.

III. Results and Discussions

Three Propeller Blade section profiles at different radii, such as 0.2R, 0.6R and 1.0R were simulated. The CFD results were then visualised and analysed for comparison.

a) Result of 0.2R Propeller Blade section

The CFD results, for instance, three residuals of CFD calculation, lift and drag force, velocity vector plot, and contour plot were visualised and analysed

b) Iteration O.2R

Figure 7 shows 250 iteration results, whereby the continuity, x-velocity and y-velocity were calculated for flow equation.

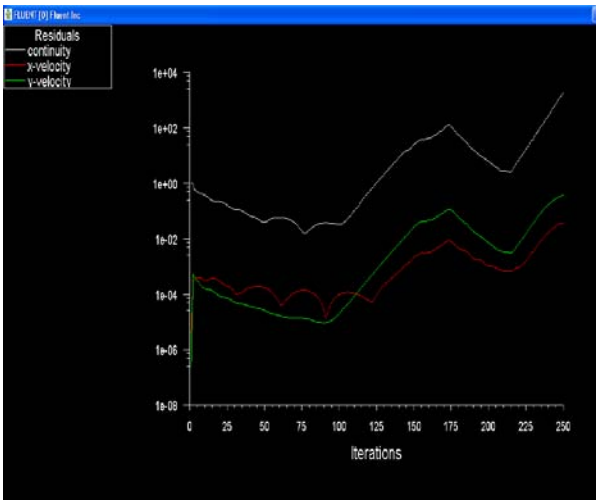


Figure 7 : Iteration results of three residuals

Based on Figure 6, it can be seen that the residuals were moving upwards and not fulfilling the converging criteria, that is to be below 0.001. This shows that the solution was diverging instead of converging. As for the lift and drag vector force, Figure 8 and 9 shows a divergence result which is not compatible with the convergence criteria.

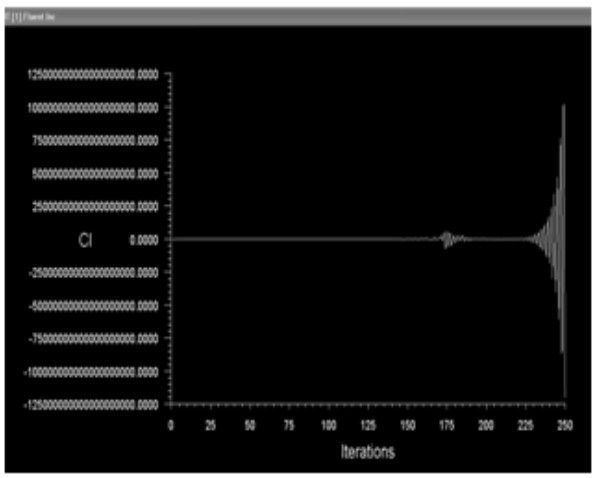


Figure 8 : Lift vector force iterated by CFD solver

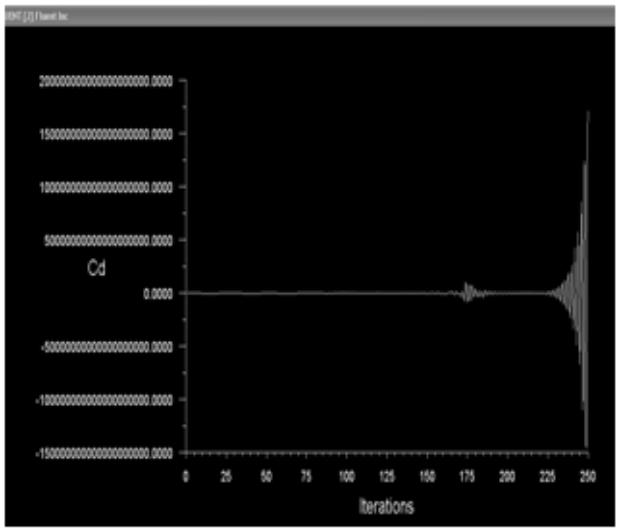


Figure 9 : Drag vector force iterated by CFD solver

c) Contours of Velocity Vectors

Laminar flow of 0.2R Propeller Blade section at 300rpm is observable in Figure 10. There is no pressure gradient observed surrounding the Propeller Blade section. This indicates that the possibility of cavitation to occur is very small.

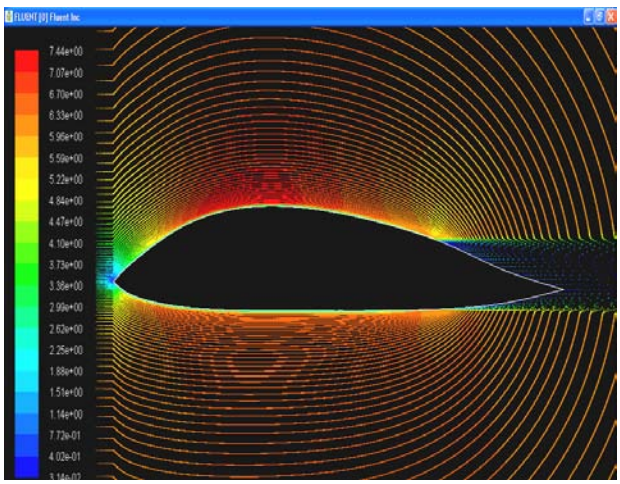


Figure 10 : Contour of velocity vector of 0.2R at 300rpm and 600rpm

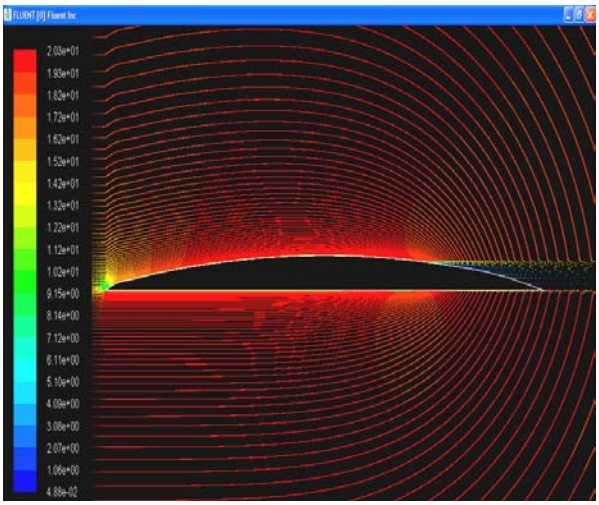


Figure 11 : Low velocity vector of 0.6R at leading and trailing edge at 300rpm and 600rpm

d) Contours of Absolute Pressure

Laminar flow of 0.2R Propeller Blade section at 300rpm is observable in Figure 12. There is no pressure gradient observed surrounding the Propeller Blade section. This indicates that the possibility of cavitation to occur is very small.

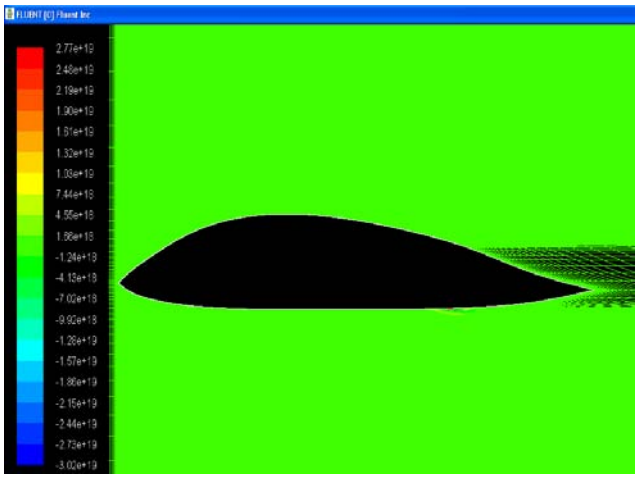


Figure 12 : No pressure gradient which indicated no cavitation occurrence at 300rpm

Turbulent flow at 600rpm shows pressure difference in Figure 13. Lowest pressure is observed below the Propeller Blade section. This indicates that possibility of cavitation to occur is high.

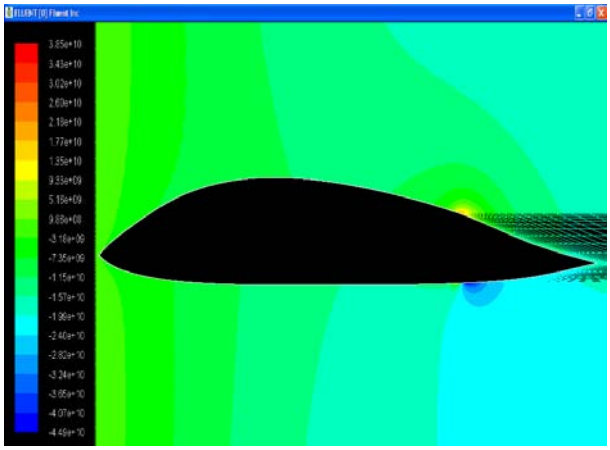


Figure 13 : Lowest pressure is observed below 0.2R Propeller Blade section

e) Result of 0.6R Propeller Blade Section

For 0.6R Propeller Blade section, the CFD results, for instance, three residuals of CFD calculation, lift and drag force, velocity vector plot, and contour plot were visualised and analysed (Figure 11).

f) Iteration of 0.6R

Figure 14 shows 250 iteration results, whereby the continuity, x-velocity and y-velocity were calculated for flow equation. It can be seen that the residuals were moving downwards equivalent to the convergence criteria, which is 0.001. This shows that the solution was converging.

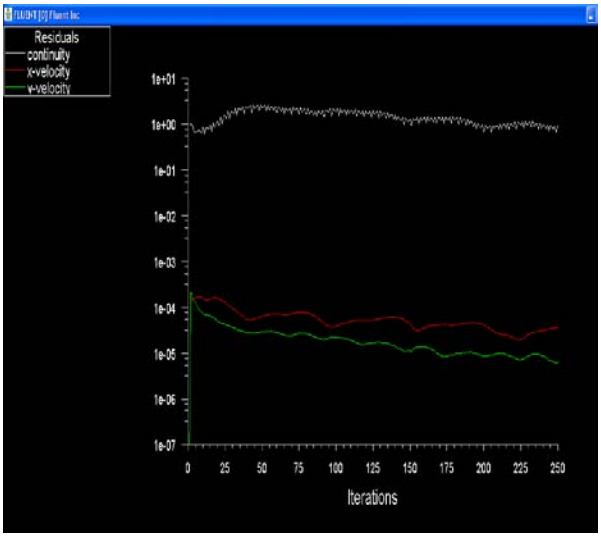


Figure 14 : Iteration results for continuity, x-velocity and y-velocity

Lift and drag vector force as shown in Figure 15 and 16 shows a convergence solution through the lift and drag convergence history.

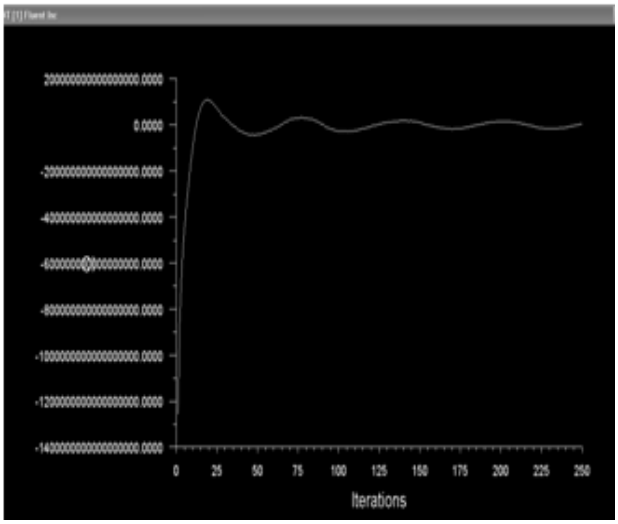


Figure 15 : Monitoring the solution convergence through lift convergence history

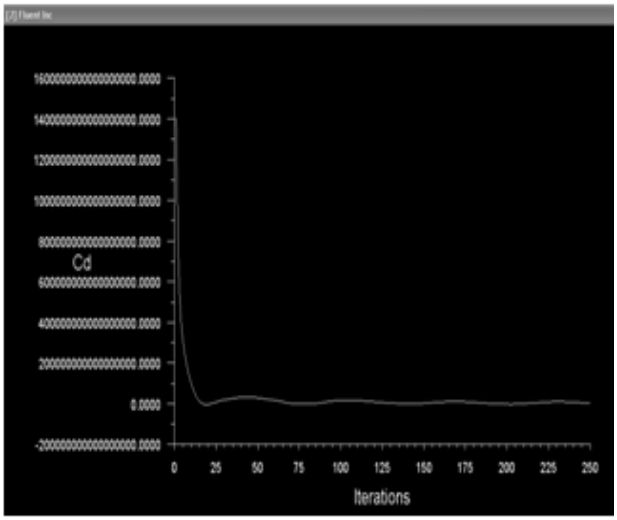


Figure 16 : Monitoring solution convergence through drag convergence history

On the other hand, laminar flow simulation of 0.6R at 300rpm resulted in lower pressure observable at the trailing edge as shown in Figure 15.

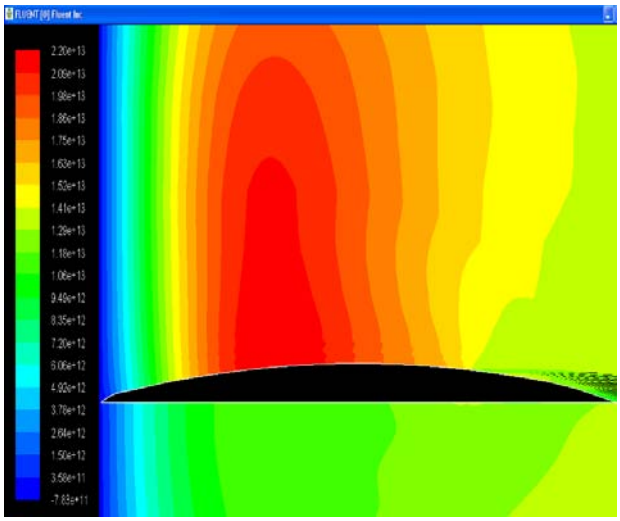


Figure 15 : Lower pressure at trailing edge of 0.6R

Besides, turbulent flow for 0.6R of 300rpm is seen that cavitation occurred at the upper surface of the Propeller Blade section as shown in Figure 17.

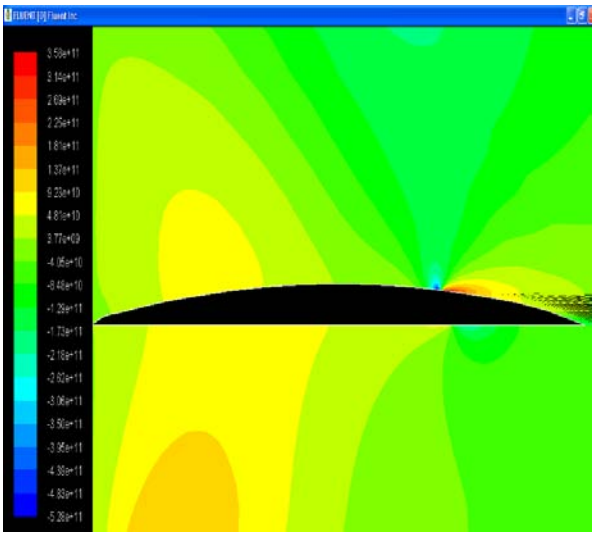


Figure 17 : Low pressure is spotted at the upper surface of the Propeller Blade section

For the 600rpm, huge area of lower pressure is observed at the upper surface of the 0.6R Propeller Blade section of the turbulent flow as shown in Figure 18.

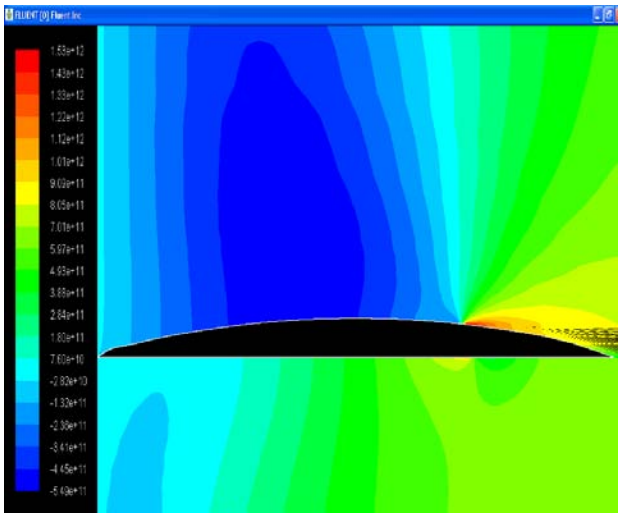


Figure 18 : Huge area of lower pressure is observed at the upper surface

Based on the above contours, cavitations can happen if the Propeller Blade radius section increases, especially for 0.6R compared to 0.2R. This is because the bigger the radius, themore pressure would be concentrated at that location. Besides this, in the turbulent flow, cavitation is more likely to be induce compared to laminar flow due to its fluid characteristics. Also, the higher the rpm, the lower the absolute pressure.

g) Graph of absolute pressure versus curve length

The graph in Figure 19 shows that, the pressure decreases when it passes by the Propeller Blade equivalent to the diagrams shown above and as it leaves the Propeller Blade, the pressure slowly increases back to its actual pressure.

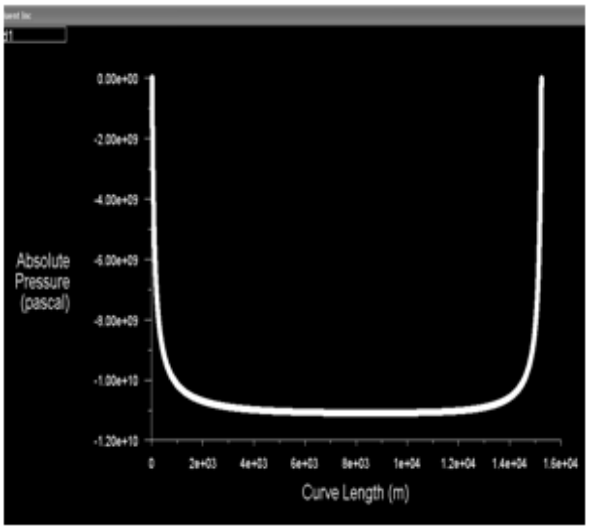


Figure 19 : Absolute pressure characteristic moving across a Propeller Blade

Figure 20 shows cavitation number, σ versus advance coefficient, based on the graph. When the propeller rotates at 300rpm, the operating condition falls in the region for a conventional propeller, which is suitable for most of the merchant vessels, whereas, at 600rpm, propeller operating condition falls in the poor region for high - speed propeller operation. This indicates low efficiency for propeller since low advance coefficient implies high propeller power coefficient. This is probably due to inaccurate application of propeller rotational speed with engine load and gear box used.

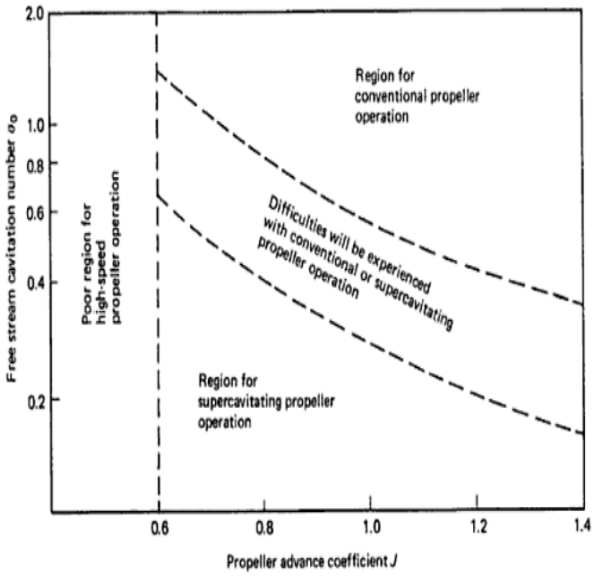


Figure 20 : Cavitation number, σ versus advance coefficient

When the propeller rotates at 300rpm, the advance coefficient and cavitation number reaches the region for conventional propeller operation. This means that, at 300rpm, the propeller rotates at a good condition suitable to the engine load and gear box required. On the other hand, when the propeller rotates at higher speed, it reaches a poor region for high - speed propeller operation which indicates damages, vibration and cavitation would occur. Based on the results of velocity and contour plots of 300rpm and 600rpm, the higher the rpm, the lower the absolute pressure, which is the condition for cavitation to occur. This is caused by high rotational rates of the propeller which creates high – pressure and low- pressure region on the blades. Besides, when the radius increases along the propeller, cavitation might happen too. Airfoil section profile at 0.2R does not have cavitation due to less pressure concentration in that region compared to 0.6R airfoil section profile. At 0.6R airfoil section profile, more works is required to be done in that region [14, 15].

IV. Conclusion

The paper presents the result of water flow at the blade section profile. Cavitation occurrence is observed to be at the upper surface of 0.6R compared to 0.2R of propeller blade section due to different pressure concentrations. Besides, cavitation is predicted at low absolute pressure when the rpm is high and this correlates with theory hypothesis. Optimisation of the propeller can be achieved by increasing the blade area ratio (BAR) and compare it with the standard Kaplan BAR value that is, 0.85. The result deduced from this study can be added to existing databased for validation purposes especially for ship navigating within Malaysian water. This could provide information on environmental differential impact on propeller. It is recommended that further multiphase, experimental simulation should carried out to test rotational speed of propeller at different powers produced by the engine load.

V. Acknowledgements

The author greatly acknowledges Kwa Ai Ai for direct contribution in the study.

References Références Referencias

1. J. Lundberg. 2009. Propelling a More Efficient Fleet [online]. Rolls-Royce Marine. http://www.ansys.com/magazine/vol3-iss2-2009/rolls-royce.pdf [Accessed on 12 Oct. 2009].
2. S.H., Rhee, G., Stuckert, Fluent, Inc. & Lebanon, N.H. 2009. Computational Fluid Dynamics [online]. CFD: A Powerful Marine Design Tool. http://memagazine.asme.org/web/Computational_Fluid_Dynamics.cfm. [Accessed on 10 Oct. 2009].
3. Fluent Incorporated. (1999). *Cavitating Flow Over a Hydrofoil.* Pg. 1-2.
4. Benson, T. (2009). 'Boundary Layer'. *National Aeronautics And Space Administrations*, http://www.grc.nasa.gov/WWW/K-12/airplane/boundlay.html (Feb. 16, 2010).
5. Chau, S. W., Hsu, K. L., Kouh, J. S., and Chen, Y. J. (2004). Investigation of cavitation inception characteristics of hydrofoil sections via a viscous approach. *Journal of Marine Science and Technology.* Vol. 8. 147-158.
6. Data Center Thermal Modeling Using CFD. (2009). Retrieved on October 5, 2009 from http://www.datacenterknowledge.com/archives/2009/04/08/data-center-thermal-modeling-using-cfd/ Experimental and Numerical Investigation of Marine Propeller Cavitation. (n.d.). Retrieved on October 5, 2009 from http://www.scientiairanica.com/PDF/Articles/00001054/Full%20Paper%20%5BEnglish%5D-Rev%206.pdf
7. Huang, D. G., & Zhuang, Y. Q. (2008). Temperature and cavitation. *Professional Engineering Publishing*. Volume 222, Number 2.
8. John Carlton. (2007). *Marine propellers and propulsion*. Second Edition. Burlington: Butterworth-

Heinemann.Ratcliffe, T. (1998). *Validation of the free surface Reynolds-averaged Navier Stokes and potential flow codes* – Proceedings, 22nd ONR Symposium on Naval Hydrodynamics.
9. Taylor, D. W. (1979). Naval Hydrodynamics. *Massachusetts Institute of Technology.*
10. Tupper, E. C. 2004. *Introduction to Naval Architecture*. Fourth edition. Amsterdam: Butterworth-Heinemann.
11. Tu, J., Yeoh, G. H., Liu, C. 2008. *Computational Fluid Dynamics*: *A Practical Approach*. Amsterdam: Butterworth-Heinemann Elsevier. Pg. 31 – 60.
12. Two Dimensional Airfoil Optimisation Using CFD in Grid Computing Environment. (2003). Retrieved on October 10, 2009 from http://www.geodise.org/files/Papers/europar-airfoil.pdf
13. Wu, Y. S., Cui, W. C., Zhou, G. J. (2001).*PracticalDesign of Ships and Other Floating Structures* – Proceedings of the Eight International Symposium on Practical Design of Ships and Other Floating Structures. Volume II. Shanghai: Elsevier.
14. Yongliang Chen, Heister.S.D.(1996). Modeling Hydrodynamic Nonequilibrium in Cavitating Flows. *Journal of Fluids Engineering*.Vol.118.172-178.

This page is intentionally left blank

Global Journal of Researches in Engineering
Automotive Engineering
Volume 12 Issue 2 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Ship Structural Integrity of Aluminium Stiffener Panel for Consequence Reduction

By O. O. Sulaiman, A.S.A.Kader, W.B.Wan Nick & A.H. Saharuddin

University Malaysia Terengganu

Abstract - The aluminium stiffener panels in ship structure are paramount to ensure safety and to guarantee the structural strength and integrity of the ship. The aluminium stiffener panel is very important to ship building, especially when the ship faces collision or unstabilized structure; the aluminium stiffener panel tends to increase bending moment, vertical shear force and stresses. This study investigate the strength of the aluminium stiffener panel at the amidship bulkhead with different shapes and typesin order to determine the strength of the aluminium stiffener from its features. AA 5083-H116 aluminium stiffener panel used has been approved by the recognized organization for shipbuilding. The aluminium stiffener panel has been tested using bending moment test and compressive load to obtain the highest endurance. Three types of aluminium stiffener panels, which are a flat shaped, L-shaped and T-shaped panel, are used in order to obtain the best panel ability for a better ship structural system. The aluminium stiffener panel is tested at the area where it is different to determine area where they are affected by extreme heat due to the welding results and fabrication. The result has showed that the aluminium stiffener panel in shipbuilding process effect in an area without extreme heat is more stable.

Keywords : *Ultimate strength, heat affected zone, collision damage, aluminium stiffener panel, bulkhead, amidships.*

GJRE-B Classification: *FOR Code: 091207*

Strictly as per the compliance and regulations of:

Ship Structural Integrity of Aluminium Stiffener Panel for Consequence Reduction

O. O. Sulaiman[α], A.S.A.Kader[σ], W.B.Wan Nick[ρ] & A.H. Saharuddin[ω]

Abstract - The aluminium stiffener panels in ship structure are paramount to ensure safety and to guarantee the structural strength and integrity of the ship. The aluminium stiffener panel is very important to ship building, especially when the ship faces collision or unstabilized structure; the aluminium stiffener panel tends to increase bending moment, vertical shear force and stresses. This study investigate the strength of the aluminium stiffener panel at the amidship bulkhead with different shapes and typesin order to determine the strength of the aluminium stiffener from its features. *AA 5083-H116* aluminium stiffener panel used has been approved by the recognized organization for shipbuilding. The aluminium stiffener panel has been tested using bending moment test and compressive load to obtain the highest endurance. Three types of aluminium stiffener panels, which are a flat shaped, L-shaped and T-shaped panel, are used in order to obtain the best panel ability for a better ship structural system. The aluminium stiffener panel is tested at the area where it is different to determine area where they are affected by extreme heat due to the welding results and fabrication. The result has showed that the aluminium stiffener panel in shipbuilding process effect in an area without extreme heat is more stable.

Keywords : Ultimate strength, heat affected zone, collision damage, aluminium stiffener panel, bulkhead, amidships.

I. Introduction

a) Background

The stiffener panel on ship structure is one of the support element from basic of building ship structure such as type flat bar, T bar and L bar used in shipbuilding construction, they are used commonly in the bulkhead and amidships. Study on ship strength and integrity determined from life cycle of ship and return of investment leads to ship own or spending more money on maintenance. Stiffened plates in ships revealed that other structures may be exposed to complex stress patterns due to simultaneously acting in-plane biaxial and shear stresses in design of such elements, buckling and ultimate strength are important issues researched by Brubak, L. and Hellesland J. (2008). Stiffened plates are required to resist extreme loading conditions, for example in term of axial compressive loads or lateral pressures studied by Khedmati M.R., and Ghavami K. (2009). The principal variables studied are the plate thickness, boundary conditions and the stiffener geometries beside the geometrical imperfection, the width of the welding heat-affected zone (HAZ) and welding residual stresses are also examined.

The study involved of ship structure construction and testing of different part of aluminium stiffener panel to investigate be more strength because they can cause support load weight on the ship such as machinery, fuel, oil and other equipment. Aluminium stiffener should be more strengthen for support the ship body, Therefore, it is important to find ship structure in respect to fatigue todetermine structural integrity.

b) Inherent Problem Associated with Ship Structure integrity

i. The variation in the buoyant forces increased the bending moment, vertical shear force, , stresses and amidships the buoyancy forces design in such situation will tend to 'hog' the vessel, if the trough is amidships the buoyancy forces will tend to 'sag' the ship.

ii. The stiffness against bending tend to increased by a hollow section with space between the stiffeners which is reduced by the twin-wall section shape compared to the single-wall stiffeners such as T-shaped or L-shaped stipulated by Ye N. and Moan T. (2007).

iii. Fatigue becomes the governing criteria in the design of the mid-ship stiffener/web frame connections at the top and bottom has studied by Ye N. (2007).

The study asses ship structurereliability strength of aluminium stiffener panel from outside pressure and consequential damages. The study investigated the aluminium stiffener strength by shape and type of stiffener at bulkheads and amidships and determined reliable effect of aluminium stiffener strength from their behavior.

II. Methodology

The study process involves the following stages:

a) Theoretical Modeling

The theory of stress and strain is compared with the value of lab test for validation purpose to deduce and recommendation as required. Compressive stress acts to reduce the length of the material (compression member) in the axis of the applied load is modelled.

Author α σ ρ ω : Maritime Technology Department, University Malaysia Terengganu. E-mails : O.Sulaiman@umt.edu.my, sdin@umt..edu.my

b) Field Work at Shipyard

The plate of aluminium alloys 5083-H116 was prepared at shipyard before the construction the aluminium stiffener panel. The plate is cut and preparedto get the dimension based on the ship requirement. Aluminium stiffener is resized to deduce the parameter smaller than panel dimension suitable for the tester machine. The methods for fabricating aluminium stiffener panel are presented by MIG welding technique.

c) Laboratory Test Panel

The aluminium stiffener panel work at shipyard as followed by determination of the type and dimension. A three panel with L-shaped, T-shaped and flat shaped stiffeners fabricated from extruded aluminium profiles in alloy AA5083-H116, joined by welding, was defined.

d) Compression Test

The method of research to determined behavior of materials under crushing loads. Compressive stress and strain is calculated and plotted as a stress-strain diagram test purposed to determine ultimate strength of aluminium stiffener panel under load. The result determined when the frequency of breakage or limit of aluminium stiffener panel test. The specimen was prepared to test at universal testing machine the best environmental condition. For aluminium stiffener, good condition and room temperature to avoid the other effect on the test specimen is providing for the test.

e) Bending Test

Three-point bending test involve involved simple two-dimensional analysis of a simply supported aluminium stiffener panel loaded. The formation of the process zone and failure of the specimen are simulated in aluminium stiffener dimension steps, controlled by the displacement under the applied load. The load-displacement diagram is deduced as final result for bending test.

f) Heat Affected Zone Test

The test specimen was conducted by hardness test to find the material properties in aluminium stiffener panel and material composition in the welding process.

The Vickers hardness test is conducted to measuring and assesses the extent of the structural weakness. The Hardness test required for welding process for construction of all type of aluminium stiffener panel. The Vickers Hardness test measurement was produced at allocated aluminium stiffener panel welding process for measurement on effected zone on panel extrusion.

g) Data Acquisation and analysis

The analysede for bending, compression test and Vickers hardness measurement has provided. The numerical analysis based on the result that was obtained from the compression test is provided. The theoretical modeling provided thetheoretical and formulation of aluminium stiffener panel compressive strength. The comparison data from the compression test deduced the different of imperfection and fatigue of material strength. The reliable effect on aluminium stiffener panel from their behaviour with the characteristic of each type of stiffener panel dimension has determined. The classification society validation requirement process approval the license and ship seaworthiness is used for necessary checking of the result.

III. Result and Discussion

a) Stiffener Panel Dimension

Stiffener panel dimension is calculated theoretically according to suggested requirement and comparison is made. The bending test require the dimension of aluminium stiffener panel the values of thickness and area of body applied load, A. The length of specimen, L is same and width of specimen, b. The range of dimension L/b is 6.9 of each specimen.

The total overall dimension for aluminium stiffener panel is likely to be the same with the bending test. The measurement weight of specimen, W slightly different and thickness of stiffener is also different. The flat bar (fb) is 3mm, T-bar (tb) is 4mm and angle bar (lb) is 5mm. The range of measurement is L/b that is 0.9 respectively. The aluminium stiffener panel has a cross sectional area with their body platting, have the area of dimension, sectional dimension of stiffener panel and type stiffener panel difference values and arrangement. The cross sectional area is analysed in Table 4.3 with specimen is considered.

Table 4.3 : Cross-Sectional Area Type Of Aluminium Stiffener Panel

Type specimen	Cross-section (nominal values)						
	a (mm)	b (mm)	t (mm)	t_w (mm)	h_w (mm)	t_f (mm)	b_f (mm)
Flar bar (fb)	345	50	4	3	51	-	-
T-bar (tb)	345	50	4	4	47	4	50
Angle bar (lb)	345	50	4	5	46	5	50

The requirement of body plate used is similar to other but structural strength of stiffener panel is slightly different compare to research by Khedmati M.R. et al. (2009). Table 4.4 shows the type of aluminium stiffened plate by type of stiffener panel. The used of average value of initial deflection in ship plating is investigated

and evaluated by Khedmati M. R. et al as $W_0^{max} = 0.05\beta^2 t$. The material properties were taken from the previous study. The Young modulus and the Poisson ratio of the material are 70 GPa and 0.33, respectively.

Table 4.4 : Type Of Aluminium Stiffened plate

Type Specimen	Stiffened plate				
	I (mm^4)	*r*	*β*	λ	W_0^{max}/L ($\times 10^{-3}$)
Flar bar (fb)	33162.7	5.6604	0.87966	0.001023	0.449
T-bar (tb)	34607.6	5.0077	0.65974	0.001157	0.252
Angle bar (lb)	40556.7	4.8488	0.52779	0.001195	0.161

b) Ultimate Strength And Maximum Load On Aluminium Stiffener Type

i. *Bending Test*

Graph 4.1 shows the result of angle bar type of stiffener panel in called L shaped. The initial angle bar specimen test has a disturbance of stresses between 0-1mm on deflection body because the material of plate has higher load better than load applied from the machine test. The result of the ultimate load of structural body is a 1083.69 kN.

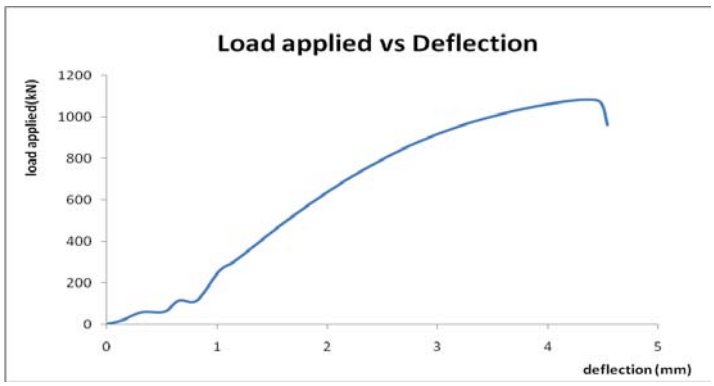


Figure 4.1 : Graph Load Applied Against Deflection Of Angle Bar

Figure 4.2 has shows the graph of flat bar (fb) type of stiffener panel, the load applied against deflection has proved the deflection of stiffener in the initial of bending test for flat bar specimen has a disturbance area of body plate between 0-0.7mm on deflection body.

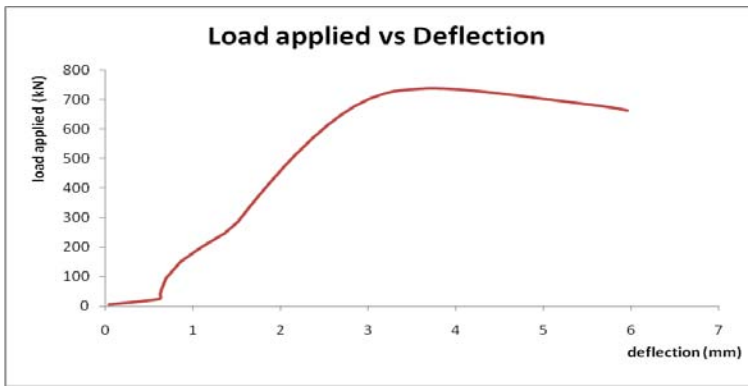


Figure 4.2 : Graph Load Applied Against Deflection Of Flat Bar

Figure 4.3 has shows the graph result of T-bar (tb) type of stiffener panel on the load applied against deflection has proved the deflection of stiffener. The T-bar result shows that the ultimate load of structural body is a 4089.146 kN. The percentage of successful of damage body required 5.12 % in area of deflection.

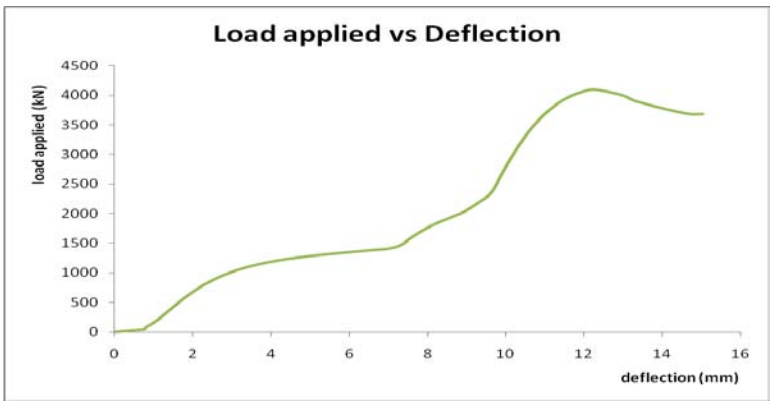


Figure 4.3 : Graph Load Applied Against Deflection Of T-Bar

The final value of test response by bending test is shown in Table 4.5. This is required to determine the ultimate capacity load with the sample of specimen. The comparison has achieved their properties and strength values, the ultimate strength break the applied load with the stiffener panel.

Table 4.5 : The Final Value Of Test Response By Bending Test

Type specimen	Test Response				
	Max. Load,k (N/mm^2)	Deflection (mm)	Break,k (N)	Elastic Modulus,E (N/mm^2)	Yield Strength (N/mm^2)
Flat bar	0.051	5.952	6513.113	0.091	0.16
Tbar	0.185	15.030	36077.32	0.332	0.184
Angle bar	0.042	4.537	9445.379	0.076	0.114

The aluminium stiffener is the most important in the local strength because the part is stable in that area and produced the higher strength and very reliable to use in the bulkhead amidships to prevent the consequential damage from outside.

ii. *Compression Test*

The result of angle bar process has show that is 8.671 kN was used to pressure the aluminium stiffener panel for testing the strength of aluminium stiffener panel. The higher load required for machine needs more applied load to damage their body until 4742.487 kN recorded. Finally the ultimate load applied with the body 5233.571 kN for the angle bar specimen has recorded. The graph of compressive load against strain is shown in figure 4.4.

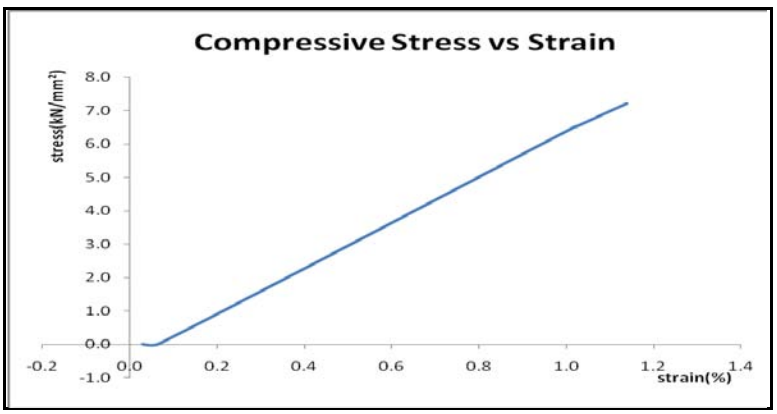


Figure 4.4 : The Graph Compression Test Of Angle Bar

The experiment of flat bar is shown, when the first value 5.017 kN was used to pressure the aluminium stiffener panel. The higher load required for machine because the strength of body needs more applied load to damage their body until 1946.741 kN recorded. Finally the values of flat bar totally reduce down because of the fatigue and failure mode on the structure. The graph compressive load against strain of flat bar is represented in Figure 4.5.

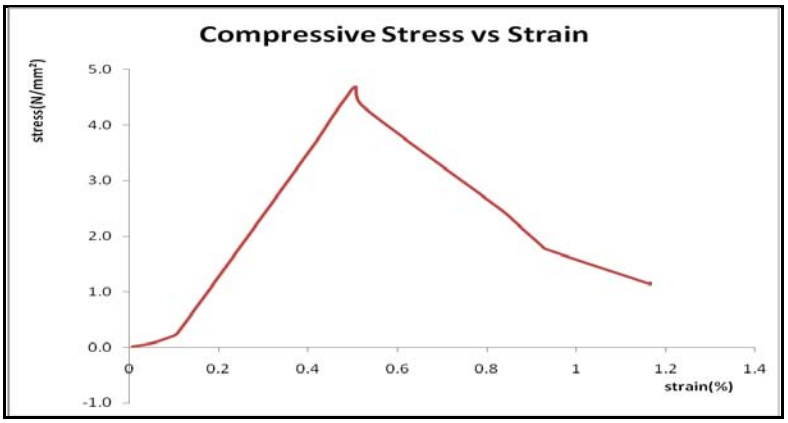


Figure 4.5 : The Graph Compression Test Of Flat Bar

The experiment has shows, that at first value of T-bar it only 2.733 kN used to pressure the aluminium stiffener panel. The higher load required for machine because the strength of body needs more applied load to damage their body until 5225.155 kN recorded. The T-bar has most structural stiffener panel in stay in the good condition because the stability of aluminium stiffener panel is covered all of body plate. The final load of aluminium stiffener panel of T-bar becomes 5189.425 kN. The graph compressive load against strain of T-bar has shown in Figure 4.6.

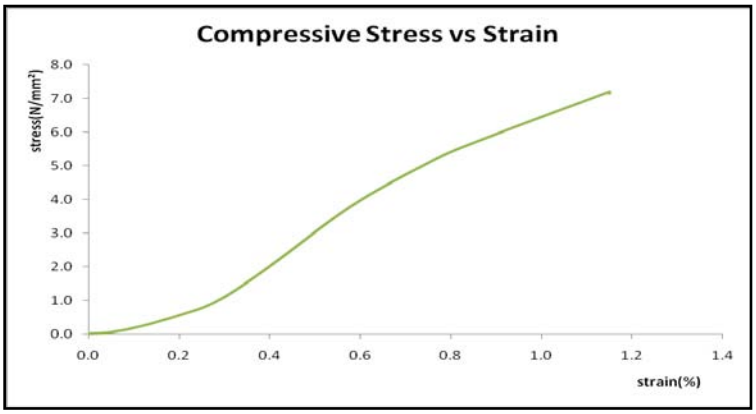


Figure 4.6 : The Graph Compression Test Of T-Bar

Table 4.9 showS the final result for compression test for requirement of test response determined a functional of each specimen in various side.

Table 4.9 : The Final Test Response of Compression Test

Type	Test Response							
	E (N/mm²)	Yield point (N)	Max.load Fu (N/mm²)	Break (N)	Extension Vu (mm)	Stress σ_u (kN/mm²)	Strain $\acute{\varepsilon}_u$ (%)	kb/EA
(fb)	20.701	19090	0.23	4696	4.661	4.690	1.165	27.33
(tb)	38.692	51449	0.43	50890	4.583	7.157	1.151	90.71
(lb)	38.138	46681	0.424	51323	4.553	7.218	1.138	92.81

The result has expected the difference in type of aluminium stiffener panel iss defined and determine the strength of aluminium stiffener panel in difference of ultimate strength.

c) The Effect on Reliable of HAZ at Aluminium Plates and Stiffener Panel

The measurement of HAZ modeling with type of specimen based on distance from weld centre was used

to find the reliable effect of HAZ on the characteristic of each specimen type. The Figure 4.7 showS the hardness of measurement by flat bar type of specimen.

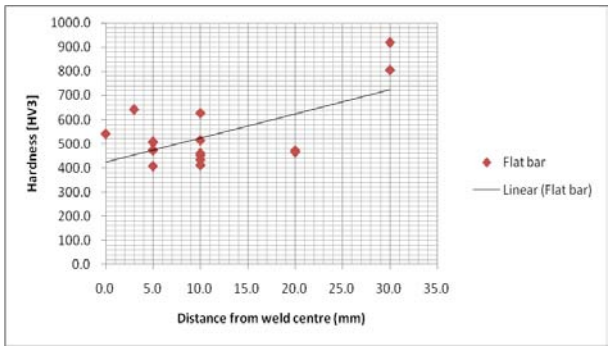


Figure 4.7 : The Hardness Measurement Of Flat Bar

Figure 4.8 has shown the hardness of measurement by T-bar type of specimen. The linearity graph shows that the value of HAZ is higher that very far distance over than nearest of distance weld centre with the influence of HAZ is very reliable because of effect of heat temperature of stiffener panel.

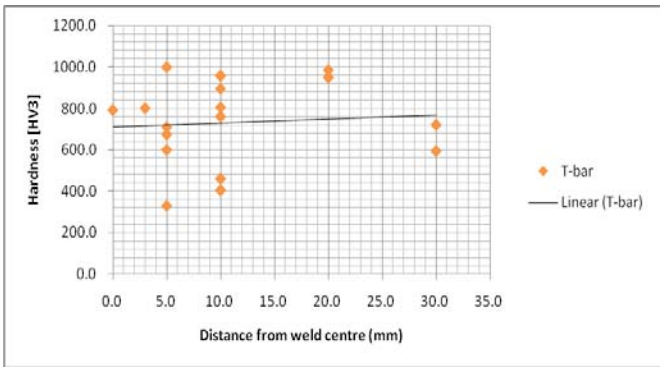


Figure 4.8 : The Hardness Measurement of T-Bar

Figure 4.9 shows the hardness of measurement by angle bar type of specimen with values of HAZ.

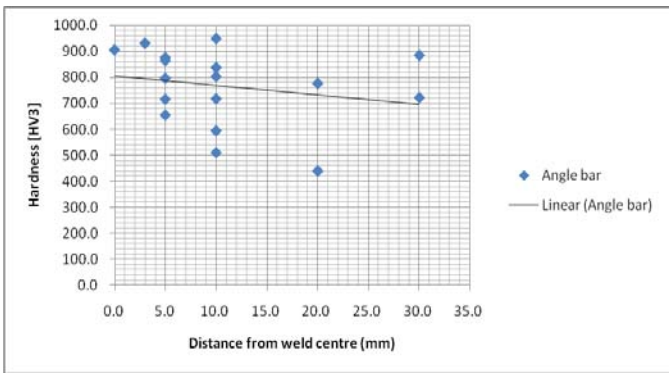


Figure 4.9 : The Hardness Measurement of Angle Bar

The hardness measurement in units HV3 use the 3kg load in Hardness test. The T bar graph show the concentration value from the distance weld centre, it is observed that the highest point in the hardness test produced 997.9 in 5mm from weld centre.

d) The Energy of Collision Stiffener Panel and Ship Structure

The variable of aluminium stiffener panel has required the energy of load collision in ship structure requirement of structural damage has reconsidered by

owner ship to determine a value and loss of damage in their body. In the element of load of collision, the theoretical modeling energy of ship tonnage and energy load of collision is provided by the equation:

$$E_T\ (mJ) = \tfrac{1}{2} \times (M_{stiff}\ V^2)\ k \quad -1$$

$$E_{load}\ (mJ) = E_T/2\ (M_{stiff}\ V^2) \quad -2$$

Table 4.11 : Calculation Of Energy Of Load Applied, Energy Of Collision

Specimen	E (kN/m²)	M_{stiff} (kg)	F_u (kN)	V_u	Tonnage of ship (ton)	E_T (mJ)	E_{load} (mJ)
Flat bar	2.07	0.38	19.09	0.16	1000	14.08	211.43
					2000	28.16	422.86
					3000	42.24	634.28
					4000	56.32	845.71
					5000	70.4	1057.14
T-bar	3.81	0.72	51.44		1000	14.08	1987.18
					2000	28.16	3974.36
					3000	42.24	5961.54
					4000	56.32	7948.72
					5000	70.4	9935.90
Angle bar	3.87	0.64	46.68		1000	14.08	1627.92
					2000	28.16	3255.85
					3000	42.24	4883.77
					4000	56.32	6511.69
					5000	70.4	8139.61

IV. Conclusion and Recommendation

a) Conclusion

The result showed that the aluminium stiffener panel area with lower heat is more stable and has reliability for approve in ship structural system. The stiffener panel strength isdetermined by the ultimate strength of the load collision applied. The effect of stiffener height on average tears length for the weld configuration shows increasing tearing threshold for a decreasing stiffener height. The deformation is slightly a symmetric with the centre in the plate and proceeds along the stiffener, when the tear reaches the weld it deviates around the weld and then proceeds along the weld and plate intersection. The importance of structural dimension of specimen prevents the outside pressure from structural damage and collapse.

b) Recommendations

i. *The following recommendation is proposed for future improvement of this study*

Firstly, the actual design study compared application to a ship structure design. Also, prediction of the possible impact on structural design, development arising from these conditions is that navies have increasingly turned to the application of classification society processes and resources to help them in establishing and applying technical criteria for naval ship design and construction including those related to the ship structure. Furthermore, the study of innovative designs for maximum the crashworthiness in an accidental impact is necessary. Lastly, probabilistic approach to consequent evaluation of damaged stability and vessel survivability can be researched from this study.

II. Acknowledge

I would like to thank Faculty of Maritime Studies and Marine Science (FMSM), Universiti Malaysia Terengganu for their assistance extended to facilitate the journey of this Final Year Academic Projects. The most appreciation is intended for Mr. Ir. Oladokun Sulaiman as supervisors who provide guidance and assistance throughout this project. At same, thanks for Mr Azlan b Musa as giving guidance towards this research. Also, a great thankful for the Mr Wan Mohd Shukri as project manager, Kay Marine Sdn Bhd in giving a lot information and prepared materials for my research. Thank you again.

References Références Referencias

1. Zha, Y., Moan, T. 2001. Ultimate strength of stiffened aluminium panels with predominantly torsional failure modes. *Thin-Walled Structures* 39: 631–648.
2. Rigoa, P., Sarghiutab, R., Estefenc, S., Lehmannd, E., Otelead, S.C., Pasqualinoc, I., Simonsene, B.C., Wanf, Z., Yaog. T. 2003. Sensitivity analysis on ultimate strength of aluminium stiffened panels. *Marine Structures* 16: 437–468.
3. Brubak, L., Hellesland, J. 2007. Semi-analytical post

buckling and strength analysis of arbitrarily stiffened plates in local and global bending. *Thin-Walled Structures* 45: 620–633.

4. Ye, N., Moan, T. 2007. Static and fatigue analysis of three types of aluminium box-stiffener/web frame connections. *International Journal of Fatigue* 29: 1426–1433.
5. Brubak, L., Hellesland, J. 2008. Strength criteria in semi-analytical, large deflection analysis of stiffened plates in local and global bending. *Thin-Walled Structures* 46 : 1382– 1390.
6. Khedmati, M.R., Ghavami, K. 2009. A numerical assessment of the buckling/ultimate strength characteristics of stiffened aluminium plates with fixed/floating transverse frames. *Thin-Walled Structures* 47: 1373–1386.
7. Paik, J.K., Seo, J.K. 2009. Non linear finite element method models for ultimate strength analysis of steel stiffened-plate structures under combined biaxial compression and lateral pressure actions — Partl : Plate elements. *Thin-Walled Structures* 47: 1008–1017.
8. Sekulski,. Z. 2009 . Least-weight topology and size optimization of high speed vehicle-passenger catamaran structure by genetic algorithm. *Marine Structures* 22 : 691–711.
9. Khedmati, M.R., Zareei, M.R., Rigo, P. 2009. Sensitivity analysis on the elastic buckling and ultimate strength of continuous stiffened aluminium plates under combined in-plane compression and lateral pressure. *Thin-Walled Structures* 47 : 1232–1245.
10. Wang, D., Ye, L., Lu Y., Su, Z. 2009. Probability of the presence of damage estimated from an active sensor network in a composite panel of multiple stiffeners. *Composites Science and Technology* 69 : 2054–2063.
11. Bonorchis, D., Nurick, G.N. 2010 .The analysis and simulation of welded stiffener plates subjected to localized blast loading. *International Journal of Impact Engineering* 37 : 260–273.
12. Rønning, L., Aalberg, A., Larsen, P. K. 2010. An experimental study of ultimate compressive strength of transversely stiffened aluminium panels. *Thin-Walled Structures* 48: 357–372.

Global Journal of Researches in Engineering
Automotive Engineering
Volume 12 Issue 2 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Effect of Exhaust Gas Recirculation on the Emission and Performance of Hydrogen Fueled Spark- Ignition Engine

By Zuhdi Salhab
Palestine Polytechnic University, Palestine

Abstract - Exhaust gas recirculation (EGR) is a designed widely used system to reduce the exhaust emissions, particularly nitrogen oxides (NOx). At high temperatures, the nitrogen and oxygen in the engine combustion chamber can chemically combine to form NOx, which, when combined with hydrocarbons and the presence of sunlight, produce an ugly haze known commonly as smog. The EGR system recirculates a fraction of exhaust gases into the intake manifold where it mixes with the fresh incoming charge. By diluting the air- fuel charge, peak combustion temperatures and pressures are reduced resulting in a reduction of NOx concentration. In this paper, an experimental study was conducted to observe the effect of different quantities of EGR on emission and performance of four- stroke single cylinder hydrogen fueled spark- ignition engine with different excess- air ratio. Experiments were carried out for mass flow measuring of EGR with simplifying adjustment (manual designed EGR system) on the engine.

Keywords : *Hydrogen fueled engine, EGR, NOx emissions, engine performance.*

GJRE-B Classification: *FOR Code: 090201*

Strictly as per the compliance and regulations of:

Effect of Exhaust Gas Recirculation on the Emission and Performance of Hydrogen Fueled Spark- Ignition Engine

Zuhdi Salhab

Abstract - Exhaust gas recirculation (EGR) is a designed widely used system to reduce the exhaust emissions, particularly nitrogen oxides (NOx). At high temperatures, the nitrogen and oxygen in the engine combustion chamber can chemically combine to form NOx, which, when combined with hydrocarbons and the presence of sunlight, produce an ugly haze known commonly as smog. The EGR system recirculates a fraction of exhaust gases into the intake manifold where it mixes with the fresh incoming charge. By diluting the air- fuel charge, peak combustion temperatures and pressures are reduced resulting in a reduction of NOx concentration. In this paper, an experimental study was conducted to observe the effect of different quantities of EGR on emission and performance of four- stroke single cylinder hydrogen fueled spark- ignition engine with different excess- air ratio. Experiments were carried out for mass flow measuring of EGR with simplifying adjustment (manual designed EGR system) on the engine. Measurement results with higher EGR rates indicate a drastically reduction of NOx, especially with richer mixtures (about 60% NOx reduction). It was also observed an increase in specific fuel consumption of about 8%, a reduction in an indicated mean effective pressure (about 15%) and a reduction in an engine cylinder maximum pressure of about 19%.

Keywords : Hydrogen fueled engine, EGR, NOx emissions, engine performance.

I. Introduction

The emission problem is one of the most interesting challenges in automotive technology and it is reached at alarming level. Because exhaust pollutants emitted to atmosphere by automobiles are the serious hygienic and environmental risk and the main source of air pollution, particularly in developing countries, the greatest interest and attention was devoted to use an effective technique to reduce the level of these pollutants. So research on improving the engine fuel economy and reducing exhaust emissions has become imperative in combustion and engine development [1].

In internal combustion engines, NOx formation is temperature dependent phenomenon and takes place when the temperature of the charge in the engine combustion chamber exceeds 2000 K [2]. So, to reduce the NOx emission levels in the exhaust, it is necessary to keep the combustion temperature under control. Exhaust gas recirculation is one of the most effective techniques for NOx reduction.

The literature survey shows many studies of the various effects of EGR on NOx emissions on internal combustion engines (petrol and diesel engines).

II. Basic Egr Operation

The NOx formation is controlled by reducing the temperature in the engine combustion chamber. This temperature is controlled by introducing a metered amount of inert gas into the engine cylinder to partially quench the flame, much like misting barbecue when it flares. It does not put out the fire, but it slows things down a bit. The result is that the fire in the combustion chamber is less intense. Recirculated exhaust gas occupies space that would otherwise contain air. With EGR, the fire is more like a smoldering pile of leaves than a blast furnace [3]. EGR system must precisely control the flow of recycled gases. Too much flow will retard engine performance and cause a hesitation on acceleration. Too little flow will increase NOx and cause engine ping. A well-designed systems will actually increase engine performance and economy [4]. Therefore, the EGR quantity must be controlled.

The EGR systems work with EGR valve which recycls exhaust gases into intake systems. Exhaust gases have already combusted, so they do not burn again when they are recycled. These gases displace some of the normal intake charge. This chemically slows and cools the combustion process by several hundred degrees, thus reducing NOx formation [4]. The decrease in NOx emissions with increasing EGR rate is the result of the following effects:

a) The thermal effect

Increase of inlet specific heats (heat capacities) due to higher specific capacity of recirculated carbon dioxide (CO_2) and water vapor (H_2O) compared with oxygen (O_2) and hydrogen (N_2) at constant pressure resulting in lower gas temperature during combustion process, and particularly in a lower flame temperature [5,6].

Author : Department of Mechanical Engineering, College of Engineering & Technology, Palestine Polytechnic University, Palestine.
E-mail : zuhdisalhab@ppu.edu.

b) The dilution effect

A decreasing in inlet oxygen concentration, whose principal consequence is the deceleration of the mixing between oxygen and fuel resulting in the extension of flame region. Also, the gas quantity that absorbs the heat release is also increasing which results in a lower flame temperature [5,6]. As a result, one consequence of the dilution effect is the reduction of local temperatures that can be also considered as a thermal effect (local thermal effect). Another consequence of the dilution effect is the reduction of the oxygen partial pressure and its effect on kinetics of the elementary NO formation reactions.

c) The chemical effect

The recirculated H_2O and CO_2 are dissociated during combustion, modifying the combustion process and the NOx formation. In particular, the endothermic dissociation of H_2O results in a decrease of the flame temperature [5,6].

d) An increase of the ignition delay

With EGR rate is generally observed [7], so that the premixed part of combustion is higher, without EGR, it may increase NOx emissions [8], but in the presence of EGR, the rate of heat release premixed peak is lower, so that it would reduce NOx emissions.

e) All the combustion process is delayed with diluted air. Consequently, the whole combustion process is shifted further into the expansion stroke, which leads to lower combustion temperature [6].

It is also necessary to mention that the amount of recirculated gases in the combustion chamber depends on the following operating condions [9]:

1. High EGR flow is necessary during cruising and mid-range acceleration, when combustion temperatures are very high.
2. Low EGR flow is needed during low speed and light load conditions.
3. No EGR flow should occur when it could adversely affect the engine operating efficiency or vehicle driveability (engine warm up, ideal open throttle, etc.). So the main aim of this paper is to investigate and observe some effects of EGR rates on NOx emissions and engine performance (indicated mean effective pressure, maximum pressure of cylinder charge, and specific fuel consumption).

III. Experimental Apparatus

All experiments have been performed and conducted on a computerized direct injection, single cylinder four- stroke hydrogen fueled spark- ignition engine (it is also modified to run on gasoline) at the laboratory of Mechanical Engineering Department at Palestine Polytechnic University. All experiments have been realized with various EGR rates at 1500 RPM/100 kPa/15^0 BTDC.

A fraction of the exhaust gases is to be recirculated back to the engine combustion chamber along with intake air. The quantity of EGR is to be measured and controlled. Because the possibilities available in the laboratory and political conditions did not allow programming the EGR system and engine control unit, a by-pass for the exhaust gases was provided along with the handle (manually) EGR valve to control the quantity of EGR mass flow.

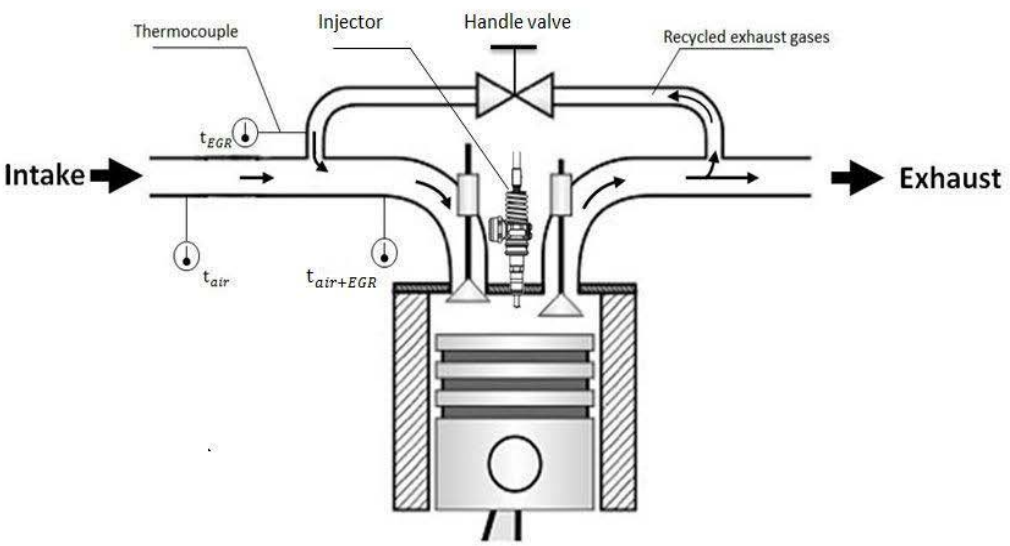


Fig. 1 : A schematic diagram of the proposed EGR system

The engine is coupled with three thermocouples to measure the temperatures of the intake air, EGR, and mixture of air and EGR. A schematic diagram of the components of the EGR proposed system is illustrated in figure 1.

Specifications of the engine are as given in table 1.

Table 1 : Specifications of the engine

Item	Unit	Value
Type of injection	-	Direct
Type of engine	-	OKC-OCTANE
No. of cylinders	-	1
Bore	mm	82.52
Stroke	mm	114.3
Connecting rod length	mm	254.5
Compression ratio	-	10
Engine speed	RPM	1500
Ignition timing	°	-15
Intake open	°	715
Intake closed	°	225
Exhaust open	°	480
Exhaust closed	°	35

The quantity of recycled exhaust gases was calculated by the use of the measured temperatures due to the energy balance equation (at constant pressure) expressed as [10]:

$$C_{P/a}.\dot{m}_a.t_a + C_{P/EGR}.\dot{m}_{EGR}.t_{EGR} = C_{P/m}.\dot{m}_m.t_m$$

Where:

- index m is equal to: m= a +EGR,
- $Cp_{/a}$: the specific heat of air at constant pressure,
- $Cp_{/EGR}$: the specific heat of recycled exhaust gases at constant pressure,
- $Cp_{/m}$: the specific heat of the mixture of air and recycled exhaust gases at constant pressure,
- t_a: the temperature of fresh air,
- t_m: the temperature of mixture,
- t_{EGR}: the temperature of recycled exhaust gases,
- $\dot{m}_a$: air mass flow,
- $\dot{m}_{EGR}$: recycled exhaust gases mass flow, and
- $\dot{m}_m$: mixture mass flow.

The values of specific heats were calculated and then the percentage of recycled exhaust gases was determined from the following equation [10]:

$$\%EGR = \frac{\dot{m}_{EGR}}{\dot{m}_{(m_a+m_{EG})}} * 100$$

During measurements the speed of engine was kept constant (1500 RPM) and ignition timing as well (15^0 BTDC before top dead center).

The following parameters were measured:

- Temperatures of EGR, air, and mixture with temperature thermocouples.
- Fuel flow and air flow by digital indicators.
- NOx and excess-air ratio by Sun Diagnostic Gas Analyzer.

The indicated mean effective pressure and cylinder maximum pressure were observed during measurements with different rates of EGR and different values of excess-air ratio. The performance parameters were compared with different EGR and without EGR for same engine operating conditions. The quantity of exhaust gases is recirculated into the engine combustion chamber with air and is achieved with manually controlled EGR valve.

IV. Results and Discussion

Substantial reduction in NOx concentrations are achieved with 5-15% EGR. 15% EGR was the maximum percentage achieved. The effect of EGR on NOx emissions and engine performance, is similar to addition of excess-air. Both EGR and excess air dilute the unburned mixture. Figure 2 shows the effect of increasing EGR on NOx emissions with excess air. The variation of NOx concentration is a result as the exhaust gases absorb some energy and hence lowers the peak combustion temperature.

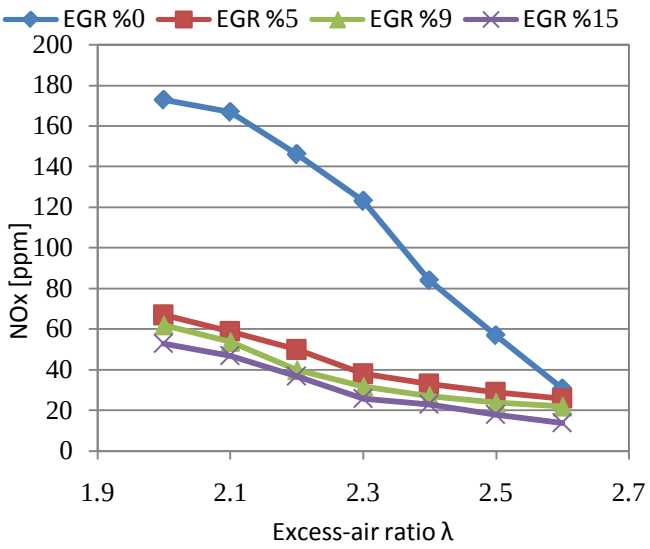


Fig. 2 : NOx vs. excess-air ratio λ with different EGR rates

At low load conditions, very low NOx can be obtained with higher EGR rates and excess air at constant pressure, because the combustion process is delayed due to higher dilution. This is accompanied with an increase of specific fuel combustion (about 8%). And this may be due to the oxygen deficiency which leads to incomplete combustion. Figure 3 shows the variation of indicated specific fuel consumption with excess air and without EGR and 15% EGR.

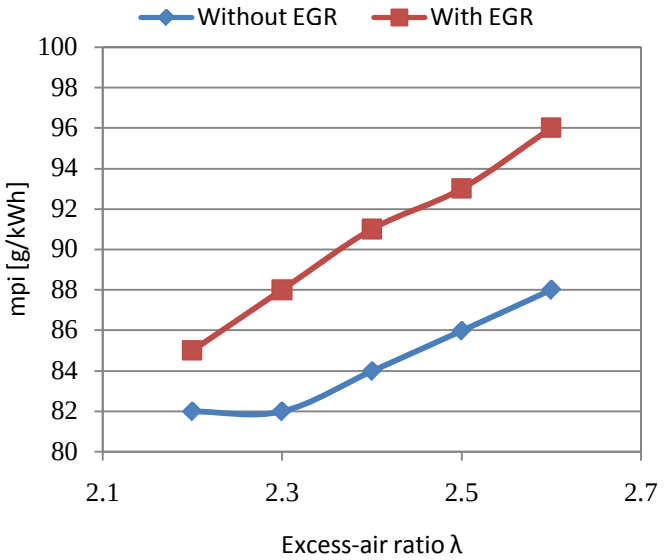


Fig. 3 : Specific fuel consumption as a function of excess-air ratio λ at 0% EGR and 15% EGR

When increasing EGR rate and with extreme lean mixture, the combustion occurs later in the cycle during expansion at a lower in-cylinder temperature, thus reducing combustion speed, the rate of heat release and the value of peak pressure.

Figures 4-5 illustrate the relation of indicated mean effective pressure and maximum pressure of cylinder charge with excess-air ratio λ at 0% EGR and 15% EGR.

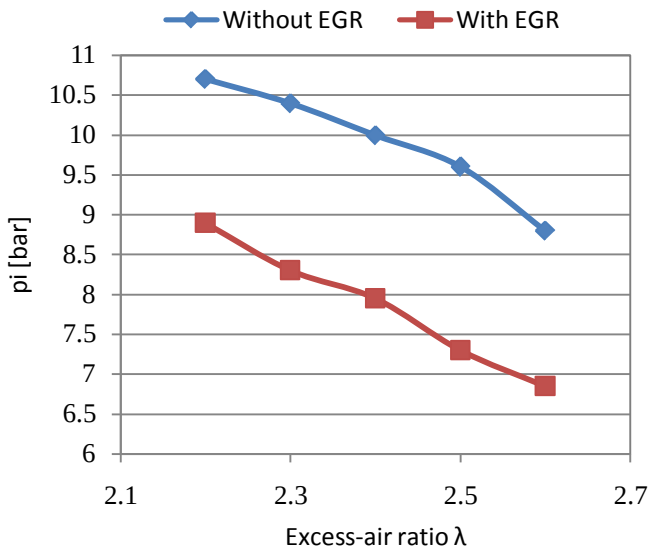


Fig. 4 : Indicated mean effective pressure vs. ēxcess air ratio λ at 0% EGR and 15% EGR

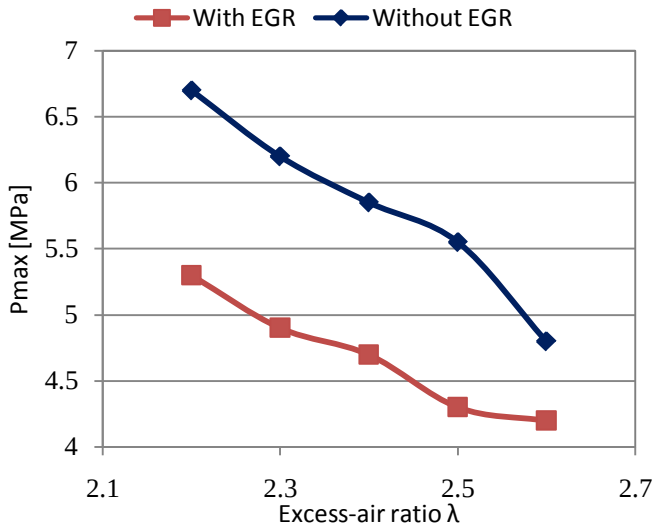


Fig. 5 : Maximum pressure vs. excess-air ratio λ at 0% EGR and 15% EGR

V. Conclusion

It can be concluded from the measured results that employing EGR is an efficient technique in internal combustion engines (petrol, diesel, and gas engines) for NOx reduction as it was seen from figure 2. Further it was also indicated that the engine performance of the engine are slightly independent on EGR. Peak cylinder pressure and indicated mean effective pressure are reduced and ignition delay period was prolonged with 15% EGR.

Further experimental investigations must be done taken into consideration using other engine operating conditions.

References Références Referencias

1. Mozafari A. Exhaust gas recirculation in spark-ignition engine. Adv Heat Trans ASME 1994; PD64(1):197-202.
2. Lapuerta M, Hernandes JJ, Gimenez F. Evaluation of exhaust gas recirculation as a technique for reducing diesel ebgine emissions Proc Instn Mech Engrs Part D, J Autom Engng 2000; 214:85-93.
3. Eran Sher. Hand Book of Air Pollution from Internal Combustion Engines- Pollutant Formation and Control. ISBN: 0-10-639855-08. Library of Congress Cataloging. McGraw-Hill Inc. 1998.
4. Ladommatos N. Abdelhalim SM. Zhao H. Hu Z. Effect of EGR on heat release in diesel combustion. SAE paper no. 980184, Society of Automotive Engineers Inc. Warrendale, PA, 1998.
5. Jacobs T, AssNIS d, Fillipi Z. The impact of exhaust gas recirculation on performance and emissions of a heavy-duty diesel engine. SAE paper no. 2003-01-1068. Society of Automotive Engineers Inc. Warrendale, PA, 2003.
6. Engell R. The influence of EGR on heat release rate and No formation in a DI diesl engine. SAE paper no. 2000-01-1807, Society of Automotive Engineers Inc. Warrendale, PA, 2000.
7. Nitu B, Singth I, Zhong L, Badreshany K, Henien NA, Bryzik WW. Effect of EGR on autoignition, combustion, regulated emissions, and aldehdes in DI diesel engines. SAE paper no. 2002-01-1153, Society of Automotive Engineers Inc. Warrendale, PA, 2002.
8. Musculus MPB. On the correlation between NOx and the diesel premixed burn. SAE paper no. 2004-01-1401, Society of Automotive Engineers Inc. Warrendale, PA, 2004.
9. Toyota Motor Sales. Emission Sub Systems, Exhaust Gas Recirculation, USA, 2006, pages 1-8.
10. Salhab Z. Termodynamic and emission parameters of spark-ignition engines powered by gaseous fuels. Doctroral work, 2001, CZ.

This page is intentionally left blank

Global Journal of Researches in Engineering
Automotive Engineering
Volume 12 Issue 2 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Automotive Door Design & Structural Optimization of Front Door for Commercial Vehicle with ULSAB Concept for Cost and Weight Reduction

By Mr. Sandeep Bundele & Dr.(Mrs.) Rupa S. Bindu
D.Y.Patil college of engineering Akurdi,Pune

Abstract - This research papers describes the drawbacks of existing automotive door structure and suggest design changes to overcome the present drawbacks. This research paper details out the analysis of the existing structure and identifies the drawbacks and explains the process of door system design. Changes required can be found out with correct method as explained in this paper. Validation of the design parameters is of vital importance so the way by which validation of newly designed or modified parts can be done is briefly explained in this paper. Designer from an automobile engineer faces so many different problems during their work. Some of the major problems in automobile door are taken as problem for this research paper and those problems like high weight, high cost, excessive reinforcements, and water leakage. At first theoretically study of the existing system is done. After that deciding the key areas of modification is the flow of this paper. After finding the modification areas we tried some parameters for calculation. On the basis of calculations the design of new parts are finalized.

Keywords : *ULSAB Concept, Problems in TWB technology, new inner panel for hardpad, water leakage issue.*

GJRE-B Classification: *FOR Code: 090299*

Strictly as per the compliance and regulations of:

Automotive Door Design & Structural Optimization of Front Door for Commercial Vehicle with ULSAB Concept for Cost and Weight Reduction

Mr. Sandeep Bundele[α] & Dr.(Mrs.) Rupa S. Bindu[σ]

Abstract - This research papers describes the drawbacks of existing automotive door structure and suggest design changes to overcome the present drawbacks. This research paper details out the analysis of the existing structure and identifies the drawbacks and explains the process of door system design. Changes required can be found out with correct method as explained in this paper. Validation of the design parameters is of vital importance so the way by which validation of newly designed or modified parts can be done is briefly explained in this paper. Designer from an automobile engineer faces so many different problems during their work. Some of the major problems in automobile door are taken as problem for this research paper and those problems like high weight, high cost, excessive reinforcements, and water leakage. At first theoretically study of the existing system is done. After that deciding the key areas of modification is the flow of this paper. After finding the modification areas we tried some parameters for calculation. On the basis of calculations the design of new parts are finalized. Then 3D models are prepared in CATIA V5, which are used for analysis purpose. Finally on the basis of analysis results actual metal parts are developed in the proto shop and fitment trials are taken on the vehicle. Once the fitment trial is completed actual testing is done on the vehicle. Comparing those results with the old results the improvement is suggested, during this study some specific parameters are chosen for observation and improvement. On the basis of these results final design is frizzed.

Keywords : ULSAB Concept, Problems in TWB technology, new inner panel for hardpad, water leakage issue.

I. Introduction

Recently, there have been two approaches in reducing automobile weight. One is by using material lighter than steel and the other is by redesigning the steel structure. Although the former seems very effective, it is very expensive so that it may only be used for an expensive automobile. Therefore, the automobile industry is trying to use steel, which is not costly and recyclable. Lightweight steel can be achieved by improving the performance of the structure or adopting new manufacturing techniques. One of the efforts is the ULSAB (ultra light steel autobody) concept. ULSAB suggests three main weight reduction techniques such as hydro-forming and the tailor welded blank (TWB). In this research, the TWB technique is utilized for lightweight door design, and a design process is proposed for optimizing the automobile TWB door. In the automotive door assembly, door inner panel is divided into different thickness without reinforcement components and different thickness sheets, plates are assembled by laser welding. The use of tailored steel solutions eliminates the need for additional reinforcements and overlapping joints in the body, saving material and further reducing total weight. In this way, tailored blanks are a significant enabler to meet specified CO2 targets. Reducing the weight of a car, reduces CO2 emissions. Objective of this paper is Low cost door design for developing countries India, Srilanka, South Africa without compromising any performance and regulatory requirements for example removing molded trim with hard pad, cost saving approximately 1400 Rs/set. Reducing the weight of door assembly by reducing number of components and by using advance technologies like tailor welded blank and high strength material. Existing design has a water leakage problem from the assembly of inner door panel and seal because of different thickness of inner panel. The parts which are newly designed or modified are designed on the basis of space constrained. The main constrained is that avoids as much as modification in the machined parts.

Author α : Student M.E Design, D.Y.Patil college of engineering Akurdi, Pune. E-mail : Sandeep_bundele@yahoo.com

Author σ : Prof and Head, Department of Mechanical engineering, D.Y. Patil college of engineering Akurdi, Pune. E-mail : rsbindu31@rediffmail.com

II. Exsisting Inner Door Panel Design

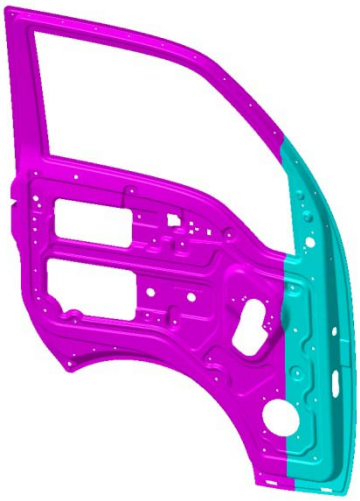


Fig 1 : Front Door Inner Panel, Weight: 6.3 kg

Inner door panel is a component which is use for strengthening the door assembly and it is one of the most important components on witch all accessories are mount like hinges, glass guide channel. Front door sill, window winding regulator, hard pad, molded trim, latch etc. Front door inner panel is use for sealing purpose when the primary sill is mounted on this. The weight of Door inner panel is near about 7to8kg depends upon its material and its thickness. The possible method is the integration method. In the integration method, the part is stamped out of a single blank. This reduces the number of tools needed; the assembly cost, and eliminates any fit ability problem. However, the design engineer is forced to work with same grade, thickness, and corrosion resistance throughout the entire part. Since the most demanding of all these conditions must be satisfied for the entire blank, this would increase the cost and weight of the part

Fig 2 : Assembly of molded trim and with inner panel

a) Material used for exsisting inner door panel

0.7mm thick, EDD 513,1.6mm thick, St40e

Table 1 : For material properties

	Grade St 35E	Grade St 40E
% Carbon	30 PPM max	30 PPM max
% Mangnese	0.35-0.45	0.35-0.45
%Sulphur	0.010 max	0.010 max
%Phosphorus	0.06 max	0.06 max
% Silicon	0.015 max	0.015 max
% Alumini	0.02 -0.04	0.02 -0.04
% Titanium	0.015-0.025	0.015-0.025
% Niobium	0.035-0.045	0.035-0.045
% Boron	5-10 PPM	5-10 PPM

	Grade St 35E	Grade St 40E
Yield Strength	180-220 MPa	230-270 MPa
Tensile Strength	345 -386 MPa	390 MPa min
% Elongation	35 min	34% min
R	1.6 -1.9	1.5 -1.9
N	0.21 -0.24	0.20 -0.24

III. Design Of New Door Inner Panel For Reducing Cost And Weight Of Front Door Assy

In this paper we are going to reduce weight of a front door assembly by using tailor welded blank concept for front door inner panel and using less thickness high strength material and reducing cost by replacing molded trim with hard pad in front door assembly and saving 1400 Rs/set.

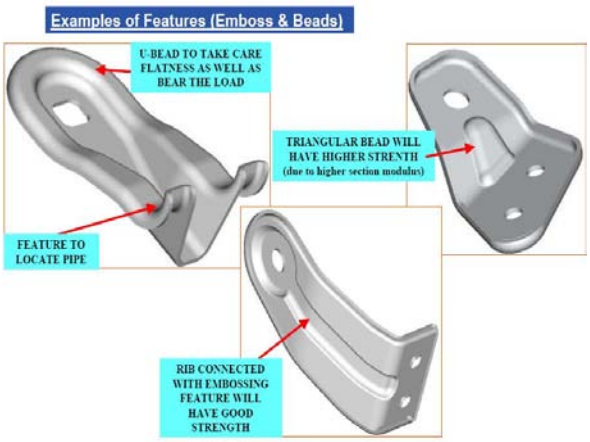
a) Methods of preparing inner door panel

1. In current automotive stamping technology, there are two basic paths that can be followed to arrive at the final inner door panel. The first method is part disintegration or part separation. In this technique, each different section of the blank is stamped separately and then spot welded together in the shape of the final part. This method has numerous advantages such as the ability to select the specific properties, i.e. the strength, thickness, corrosion resistance, etc. of each area of the blank. This method also gives a higher yield ratio of materialused.
2. The other possible method is the integration method. In the integration method, the part is stamped out of a single blank. This reduces the

number of tools needed; the assembly cost, and eliminates any fit ability problem. However, the design engineer is forced to work with same grade, thickness, and corrosion resistance throughout the entire part. Since the most demanding of all these conditions must be satisfied for the entire blank, this would increase the cost and weight of the part significantly.

3. A solution to the problems listed above is the utilization of tailor-welded blanks. A tailor-welded blank is a blank that is comprised of two separate pieces of sheet metal that has been welded together previous to stamping. Tailor welded blanks allow the welding of the different grades, different thickness or different corrosion coatings together in order give the properties needed in different areas, without increasing the number of tools needed to form the part and eliminating the fit ability concerns. They also allow a high degree of flexibility in designing parts and large blanks can be formed from much smaller sheets .The use of tailor-welded blanks would reduce the weight of the car. Having the ability to selectively place different thickness of material would result in weight reductions. An example of this used in production is the door inner panel. The only strength requirement on a door inner is in the region where the hinges attach to the panel.

b) Design guidelines for designing door inner panel



Beads and ribs increases the cross sectional area of component and load taking capacity increases. By adding beads we are able to reduce spring back effect of component.

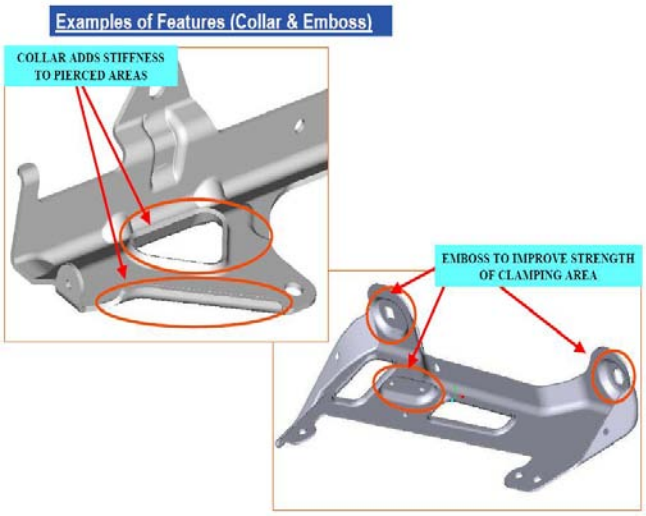


Fig 3 : Significance of ribs and beads

c) Material used for new door inner panel

0.7mm thick, EDD 513, 1.2mm thick, DP590

Table 2 : For material properties

Element	DP 590
% Carbon	0.08-0.12
% Manganese	1.1-1.6
%Sulphur	0.004 max
% P	0.02 max
Yield Strength	350min MPa
Tensile Strength	590min MPa
% Elongation	24 min

d) Design of new door inner panel for solving water leakage issue

Tailor Welded Blanks are made from individual steel sheets of different thickness, strength and coating which are joined together by laser welding. When we design inner door panel with tailor welded blank in witch some portion of a panel having different thickness and other is different. In our case some portion of door inner panel is 0.7mm thick shown below with pink color and another is 1.2mm thick shown below with sky color. There is a 0.5mm gap between these two thicknesses and this is the reason that water is leakage between door inner panel and secondary sill in shower test. Below figures gives the idea of existing and new coditions.

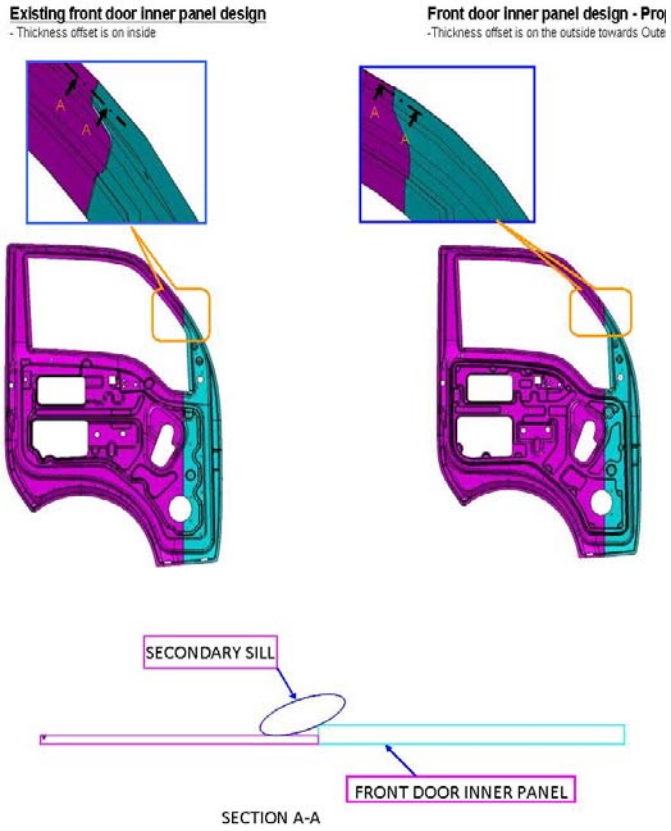


Fig 4 : Existing inner door panel condition with inside thickness

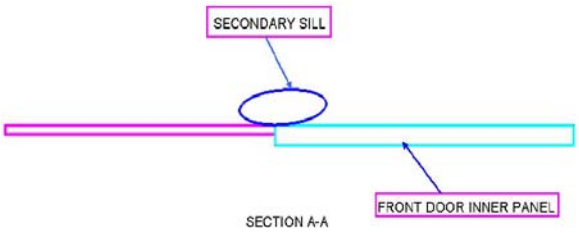


Fig 5 : New inner door panel condition with outside thickness

New front door inner panel for hardpad & no water leakage issue,weight-5.9kg

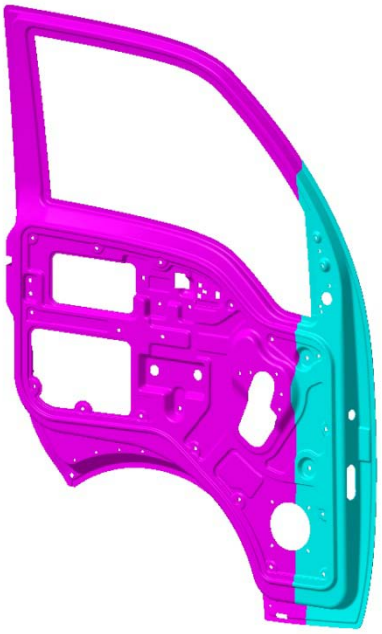


Fig 6 : New front door inner panel

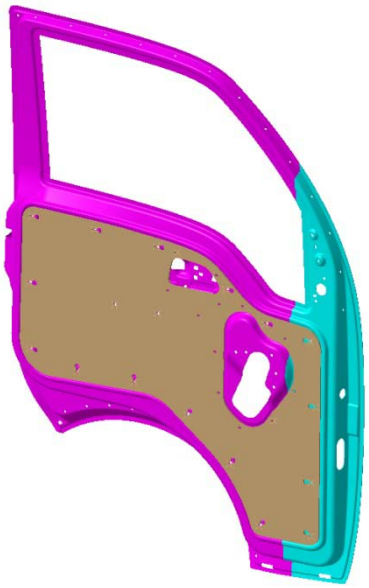
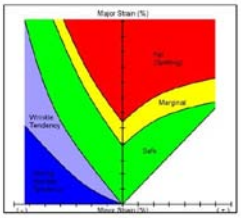


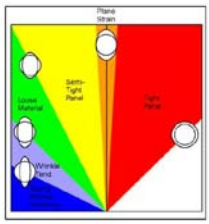
Fig 7 : Assembly of new door inner panel & hard pad

IV. Forming Analysis

The technique of sheet metal forming analysis requires non-contact optical 3D deformation measuring system. The system analyzes, calculates and documents deformations of sheet metal parts, for example. It provides the 3D coordinates of the component's surface as well as the distribution of major and minor strain on the surface and the material thickness reduction. In the Forming Limit Diagram, the measured deformations are compared to the material characteristics. The system supports optimization

processes in sheet metal forming by means of; Fast detection of critical deformation areas, Solving complex forming problems. The optical forming analysis with forming analysis system provides for precise and fast measurement of small and large components using a high scanning density. Forming analysis system operates independently of the material. It can analyze components made from flat blanks, tubes or other components manufactured by an internal high pressure forming process (Hydro forming). The Forming limit curve is used in sheet metal forming for predicting forming behavior of sheet metal. The diagram attempts to provide a graphical description of material failure tests, In order to determine whether a given region has failed, a mechanical test is performed. The mechanical test is performed by placing a circular mark on the work piece prior to deformation, and then measuring the post-deformation ellipse that is generated from the action on this circle.





Color	Zone	Description
	Low Strain	Minimal Major and Minor strain, located at the intersection of the two axes
	Strong Wrinkling Tendency	High compressive forces producing a strong tendency to wrinkle, most evident in thin materials
	Wrinkling Tendency	Compressive forces sufficient to cause thickening of the part and minor wrinkling
	Safe	Is the area between the shear margin on the left and the thinning limit on the right, and below the FLC safety offset. This area will not likely experience failure during forming
	Marginal	The area between the safe and fail zones. This area provides a buffer for process and material variability. The safety offset is usually 10% for steels and 6-8% for aluminums
	Fail	Any area to the left of the shear limit, above the FLC and to the right of the thinning limit. This area may experience localized thinning or necking, failure

Fig 8 : Color bands in forming limit dig

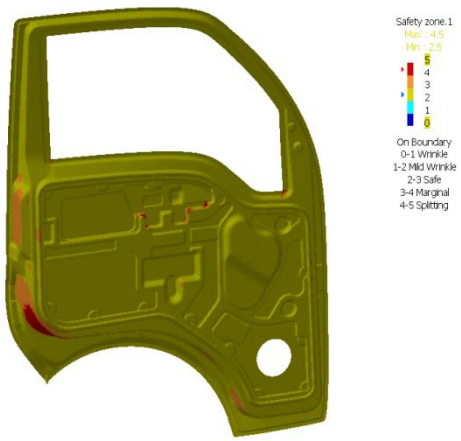


Fig 9 : Inner panel in safety zone

V. CAE Analysis

To evaluate the stiffness and sag performance of the front door for both existing and hard pad. Different stiffness's considered for front door assemblies are. The objective of this analysis is to predict the vertical sag behavior of the front door assembly of CUB (Goods Carrier). As per the procedure, there should not be a permanent set exceeding 1 mm and maximum latch point deflection (elastic) should not be more than 10 mm. At the latch point under two conditions

Table 3 : Boundary and Load conditions

Location No	Load Cases	Force
2	Torsional rigidity top	An inboard force 1000N is applied to the door inner corner(top)
3	Torsional rigidity bottom	An inboard force 1000N is applied to the door inner corner(bottom)
4	Beltline inner	A horizontal force of 600N is applied to the beltline reinforcement at the midpoint of the window opening (inner)
5	Beltline outer	A horizontal force of 600N is applied to the beltline reinforcement at the midpoint of the window opening (outer)

a) Results

Stiffness Analysis :

1) Predicted vertical stiffness of door with hard pad interiors is lower than existing front door design
2) Predicted beltline inner stiffness of door with hard pad interiors is lower than existing front door design
3) Predicted beltline outer stiffness of door with hard pad interiors (CAE Proposed design) is equivalent to existing front door design

Door Sag Analysis :

Predicted maximum elastic deflection and permanent set in door under worst door sag load case are as follows.

1) Existing design: Maximum elastic deflection is 7.75mm and permanent set is 0.23
2) Hard pad design: Maximum elastic deflection is 9.27mm and permanent set is 0.34

VI. Conclusion

In this paper we design new front door assembly components with tailor welded blank technology for reducing weight and cost of door assembly. Tailor-welded blanks allow combining different strengths of steel in one part without adding complications at the joints. Weight of a door assembly is

reducing by 0.4 kg, by reducing weight of a door inner panel by using less thickness high strength material, reduce cost by replacing molded trim with hard pad. We are successfully solved water leakage problem by modeling front door inner panel correctly.

References Références Referencias

1. New methods for forming Tailor welded blanks. Date published: 1999-03-01,Paper no: 1999-01-0681,DOI: 10.427/1999-01-0681, By Brad Kinsey, Jian Cao
2. Formability Issues in the Application of Tailor Welded Blank Sheets. Date Published: 1993-03-01, Paper Number: 930278 ,DOI: 10.4271/930278, by ,Ming F. Shi - National Steel Corp. Ken M. Pickett - National Steel Corp. Kumar K. Bhatt - General Motors Corp.
3. Describing the formability of tailor welded blanks. Date Published 2002-01- 2085 By Rich Davies and Mark Smith
4. The Stiffness of Automobile Inner Panels. Date Published: 1987-11-08,PaperNumber: 871294 DOI: 10.4271/871294 by Toshiaki Sakurai - Mitsubishi Motors Corp, Hiroyuki Ono - Mitsubishi Motors Corp.
5. E Balmuth, "Steel alloy for thick section applications," presented at TMS-AIME meeting at Denver, co, February 1993.
6. The development of vibration damping steel sheets for inner panels of Automotive Vehicles. Paper no: 911083,By Toshiaki Shiota, Hiroyuki Nagai.
7. Laser Welding of Advanced High Strength Steels for Tailor Welded Blank (TWB) Applications. Date Published: 2009-12-13, Paper Number: 2009-28-0012, DOI: 10.4271/2009-28-0012 by B.Shanmugarajan - ARCI, J.K.Sarin Sundar - ARCI , G. Padmanabham – ARCI
8. Integrated Inner Door Panel/Energy Absorber Designs for Side Impact Occupation Protection. Date Published: February 26-29, 1996, Paper Number: 960151 by Luis Lorenzo, Scott Burr, and Karen Fennessy-Ketola- Dow Chemical Co.
9. Door System Design for Improved Closure Sound Quality. Date Published: 1999-05-17,Paper Number: 1999-01-1681, DOI: 10.4271/1999-01-1681 by A. Petniunas - Ford Motor Co. N. C. Otto - Ford Motor Co., S.Amman-FordMotorCo.R.Simpson–Ford.
10. Development of Lightweight Door Intrusion Beams Utilizing an Ultra High Strength Steel, Date Published: 1975-02-01, Paper Number: 750222, DOI: 10.4271/750222, T. E. Fine - Inland Steel Co. S. Dinda - Chrysler Corp.

Global Journal of Researches in Engineering
Automotive Engineering
Volume 12 Issue 2 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Autonomous UAV (Unmanned Aerial Vehicle) For Navigation & Surveillance Purposes

By Chetan Khemraj, Jitendra Kumar, Ashish Srivastava & Gaurav Srivastava

ABES Institute of technology, Ghaziabad

Abstract - The use of autonomous vehicles, for a wide variety of applications, has been increasing during the latest years. Land-based vehicles can be used for many purposes, but are not as versatile as could be desired, because they are dependent on the terrain. Aerial vehicles, such as aero planes and helicopters, do not depend on the terrain in the area of operation, as the land based vehicle. An autonomous helicopter has an advantage in maneuverability compared to an autonomous aero plane, which is not able to hover (stand still in the air). This and the ability to take off and land in limited spaces are clear advantages of the autonomous helicopter. An autonomous helicopter is a versatile platform for a wide variety of applications. It can be used in situations as agricultural crop dusting, search and rescue missions, inspection of bridges or power lines, surveillance of larger areas etc. Helicopters are complex, high performance machines designed to ensure the safety of their occupants during their expected lifetimes. To accomplish their goals, helicopters require extensive maintenance during their lifetimes at set intervals, whether necessary or not. To help alleviate the need for unnecessary maintenance, condition based maintenance systems are under heavy development, with the military expressing much interest in such systems. As the name implies, condition-based maintenance systems rely on information about the condition of various mechanical components to determine when maintenance is necessary. This has the potential to greatly reduce cost and enhance safety.

GJRE-B Classification: *FOR Code: 090299*

Strictly as per the compliance and regulations of:

Autonomous UAV (Unmanned Aerial Vehicle) For Navigation & Surveillance Purposes

Chetan Khemraj[α], Jitendra Kumar[σ], Ashish Srivastava[ρ] & Gaurav Srivastava[ω]

Abstract - The use of autonomous vehicles, for a wide variety of applications, has been increasing during the latest years. Land-based vehicles can be used for many purposes, but are not as versatile as could be desired, because they are dependent on the terrain. Aerial vehicles, such as aero planes and helicopters, do not depend on the terrain in the area of operation, as the land based vehicle. An autonomous helicopter has an advantage in maneuverability compared to an autonomous aero plane, which is not able to hover (stand still in the air). This and the ability to take off and land in limited spaces are clear advantages of the autonomous helicopter. An autonomous helicopter is a versatile platform for a wide variety of applications. It can be used in situations as agricultural crop dusting, search and rescue missions, inspection of bridges or power lines, surveillance of larger areas etc. Helicopters are complex, high performance machines designed to ensure the safety of their occupants during their expected lifetimes. To accomplish their goals, helicopters require extensive maintenance during their lifetimes at set intervals, whether necessary or not. To help alleviate the need for unnecessary maintenance, condition based maintenance systems are under heavy development, with the military expressing much interest in such systems. As the name implies, condition-based maintenance systems rely on information about the condition of various mechanical components to determine when maintenance is necessary. This has the potential to greatly reduce cost and enhance safety. The system developed here uses data from three sensors to monitor the condition of a radio-controlled helicopter. Data from the sensors is transmitted to a microcontroller, where it is processed before being transferred to actuators and eventually to a computer for storage and visualization. The system must fulfill several requirements imposed by the constraints of the radio-controlled helicopter, mainly small size and low power usage, while still being powerful enough to perform processing on sensor data with on-board processing. The system is able to communicate with two different types of sensors, an inertial measurement unit and global positioning satellite receiver, perform calculations of statistics, and transmit the processed data reliably to a computer, where it is displayed in a custom graphical interface.

Author α : Department of Electrical Engineering, ABES Institute of technology, Ghaziabad.

Author σ ρ ω : Department of Electrical Engineering, ABES Institute of technology, Ghaziabad.

E-mail : Chetan_khemraj2002@rediffmail.com

I. Background and Motivation

An Unmanned Aerial Vehicle (UAV) as the name suggests is a remote-controlled or completely autonomous vehicle designed to carry out a pre-specified task in a particular way. The vehicle is either programmed or trained beforehand to accomplish such a task .Development of remotely controlled vehicles is as old as the 1950s. However, the history of Vertical Take-Off and Landing (VTOL) UAVs started in early 1960s when the US Navy studied the feasibility of such a vehicle for the first time. Some close and short range (50km and 200km respectively) vehicles were developed. Recent advances in controls, microelectronics, micro electromechanical systems (MEMS) and wireless communication have led to the development of long range UAVs. Currently long range i.e. endurance aircraft is being developed that is meant to be used for cinematography, search, surveillance and transportation.

Research is being carried out in different universities to develop a completely autonomous vehicle that is able to perform complex tasks on its own and different groups are exploring new techniques to make this concept practical. Towards this end engineers are exploring different configurations of VTOLs to exploit specific advantages associated with their particular design. For example Autonomous Helicopter' group at Carnegie Mellon University is working on vision based stability. A group at Stanford University is trying to achieve acrobatic maneuvers using apprenticeship and reinforcement learning. In simple words, reinforcement learning involves adaptive algorithms that a machine learns by observing actions taken by an intelligent teacher agent, which in most cases is human, in certain environmental situations.

II. Main Challenges

In designing a system like a UAV one need to take care of certain issues. The basic consideration in designing an autonomous or remote control aircraft is the choice of electronics. It should have minimum but sufficient electronics to carry out complex maneuvering tasks. The weight and placement of electrical components also play an important role and should be distributed carefully about the center of gravity. The system also needs to have a robust communication link

because in case of an autonomous vehicle it would be utilized in sending important information back to a base station.

The major challenge in this report was integration of different of-the-shelf components and modifying their firmware to meet the timing and rate synchronization requirements among them. Even in the design phase i.e. system identification, which is not needed for the vehicle once the model is established, the hard thing was to keep track of input/output time periods for analysis purposes.

Another issue was to mount a rigid platform on the helicopter that can carry all the electronics and sensors. Again this platform has a weight and care was taken to mount it so that the overall weight distribution remained unchanged.

Since the helicopter was built starting only from the mechanical structure a lot of things were adjusted manually and by performing experiments, which included but are not limited to adjustment of:

(1) servos/ swashplates linkages for collective pitch
(2) position given to each servo for varying collective and cyclic pitch
(3) calibration of collective and cyclic pitch using a pitch gauge
(4) throttle given to brushless DC motor
(5) gear ratio for enough RPM to take-off
(6) position of Inertial Measurement Unit (IMU) etc.

This project concerns the problem of modeling an autonomous helicopter (UAV) and thereafter stabilizing the model using optimal control for the purpose of surveillance and reconnaissance.

This system can be used for target & decoy, reconnaissance & civil purposes, which are very tedious and dangerous, if performed by humans .Thus this system can be proved much more efficient and helping for human beings.

III. Hardware Design & Methodology

The choice of hardware in any UAV is dependent upon a number of criteria, which include, but are not limited to, compatibility with other components, light weight, cost, and ease of integration in the system and the flexibility in firmware. Fortunately most of these criteria are design considerations of companies like Spark fun, a company based in Boulder Colorado, whose products have been used in this project.

Below is the list of all the hardware (mechanical and electronics) components that have been used and which is subsequently explain in detail:

(1) Single Rotor Trex-450 Frame
(2) Brushless DC Motor
(3) Electronic Speed Controller (ESC)
(4) Battery Eliminator Circuit (BEC)
(5) Nylon Gear Servos
(6) Arduino Duemilanove(CPU)
(7) Inertial Measurement Unit(IMU)
(8) Power Board
(9) Battery

IV. Methodology

Step 1 : Designing and testing of helicopter prototype for providing mechanical stabilization.
Step 2 : Calibration of servo motors and Rotor head motor for proper swash plate orientation and proper Rotor head speed.
Step 3 : Installing CPU and IMU units for testing stabilization of the platform.
Step 4 : Programming CPU with Arduino IDE.
Step 5 : Installing GPS with IMU unit for providing Autonomous Navigation to the UAV platform.
Step 6 : Installing Camera and mount with gesture capability.
Step 7 : Interfacing the system with computer for telemetry.
Step 8 : Installing distance sensor for providing ability, to this system to avoid any object in its path.

V. Control System

Our control system is made from the CPU, IMU, Telemetry system and sensors. We use the Arduino Duemilanove 328 for the CPU .It is act as brain of the system.IMU unit is made up from accelerometer & Gyro which is stabilizes our system. We use wireless camera for live video streaming and RF 434 module for the transmitting & receiving of data. We take supply from the battery of 11.1 V and 20C Li-Po(Lithium Polymer) and give to the system. Our CPU i.e. Arduino take all the data from sensors and give the processed data to the all motors i.e. servo and out runner brushless motors. There are four types of servo motors i.e. aileron servo, elevator servo, pitch and rudder servo which is used for cyclic, collective and tail rotor pitch control respectively.

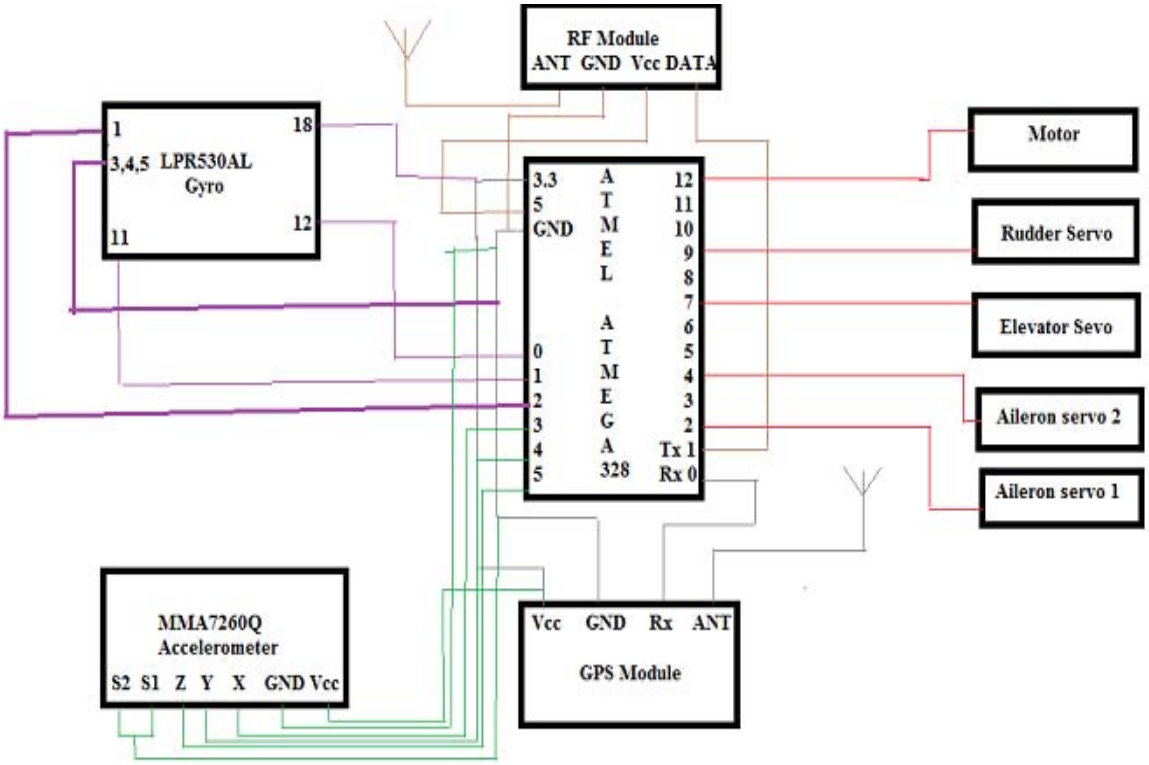


Fig 1 : Block diagram representation of UAV

VI. Applications

a) Present Applications

An autonomous helicopter is a versatile platform for a wide variety of applications such as:

- Search and rescue missions
- Surveillance of larger areas
- Inspection of bridges, or power lines
- Traffic control
- Detection of land mines
- Agricultural crop dusting
- High altitude photography
- Mapping of topology

b) Future Applications

- With decreased cost, the area of application can be widened
- These systems can be armed with less lethal weapons for combat purposes
- These can be used by homeland security

References Références Referencias

1. Kimono Valavanis, "Advances in unmanned Aerial Vehicles and control" Sept. 2003, pp. 523–528. (Invited paper)
2. Rogelio Lozano, *Unmanned Aerial Vehicle-embedded controls*, New York: Academic Press, 1977.
3. Christian M Capp, *Unmanned Aerial Vehicles Designs and Their Applications*, Ph.D.Dissertation, Texas Tech University, Lubbock, TX, Oct. 1997.
4. Nikolas, K.P.Valavanis" Evolutionary path planner for UAV" *IEEE Transactions on Systems, Man, and Cybernetics*, vol. SMC-17

This page is intentionally left blank

Global Journal of Researches in Engineering
Automotive Engineering
Volume 12 Issue 2 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Investigation on Effect of Variation in Compression Ratioon Performance and Combustion Characteristics of C.I Engine Fuelled With Palm Oil Methyl Ester (POME) and its Blends by Simulation

By Sanjay Patil & Dr. M.M.Akarte

Guru Nanak Dev Engineering College, Bidar-India

Abstract - The paper describes the development of zero dimensional single zone thermodynamic model for compression ignition engine cycle simulation. Rate of heat release due to combustion is modeled with double wiebe function, takes care of premixed as well as diffusive phase of combustion. Adjustable parameters of wiebe function are obtained by fitting it to experimental mass fraction burned profile by least square method. Empirical correlations are established between adjustable parameters of vibe function, relative air-fuel ratio and engine operating conditions. The simulation is used to analyze the engine performance fuelled with diesel, Palm Oil Methyl Ester (POME) and its blends. Effect of change in compression ratio on peak pressure, net heat release rate and brake thermal efficiency is analyzed and discussed. The model is validated by comparing predicted peak pressure and brake thermal efficiency with diesel and POME –diesel blends at 17.5:1 compression ratio with that of experimental results.

Keywords : *Biodiesel, compression ignition engine, double vibe function, simulation.*

GJRE-B Classification: *FOR Code: 090201*

Strictly as per the compliance and regulations of:

Investigation on Effect of Variation in Compression Ratioon Performance and Combustion Characteristics of C.I Engine Fuelled With Palm Oil Methyl Ester (POME) and its Blends by Simulation

Sanjay Patil[α] & Dr. M.M.Akarte[σ]

Abstract - The paper describes the development of zero dimensional single zone thermodynamic model for compression ignition engine cycle simulation. Rate of heat release due to combustion is modeled with double wiebe function, takes care of premixed as well as diffusive phase of combustion. Adjustable parameters of wiebe function are obtained by fitting it to experimental mass fraction burned profile by least square method. Empirical correlations are established between adjustable parameters of vibe function, relative air-fuel ratio and engine operating conditions. The simulation is used to analyze the engine performance fuelled with diesel, Palm Oil Methyl Ester (POME) and its blends. Effect of change in compression ratio on peak pressure, net heat release rate and brake thermal efficiency is analyzed and discussed. The model is validated by comparing predicted peak pressure and brake thermal efficiency with diesel and POME –diesel blends at 17.5:1 compression ratio with that of experimental results.

Keywords : Biodiesel, compression ignition engine, double vibe function, simulation.

I. Introduction

Energy is prominent requirement of present society. Internal combustion engines have been the prime movers for generating power for various applications for more than a century [1]. The increasing demand, depletion and price of the petroleum prompted extensive research worldwide on alternative energy sources for internal combustion engines. Use of straight vegetable oils in compression ignition engine for long term deteriorates the engine performance and is mainly because of higher viscosity [2-6]. The best way to use vegetable oils as fuel in compression ignition engines is to convert it into biodiesel [7] Biodiesels such as rape seed, soybean, sunflower and Jatropha, etc. are popular substitutes for diesel [8]. In the present energy scenario efforts are being focused on use of bio diesel in compression ignition engine, but there are many issues related to performance and emission [8]. The optimum operating parameters can be determined using experimental techniques but experimental procedure will be time consuming and expensive [9]. Computer simulation [10] serves as a tool for a better understanding of the variables involved and also helps in optimizing the engine design for a particular application thereby reducing cost and time. The simulation approach allows examining the effects of various parameters and reduces the need for complex experimental analysis of the engine [11]. A validated simulation model could be a very useful tool to study engines running with new type of fuels.

A zero-dimensional single-zone model as compared with multi-zone models is much simpler, quicker and easier to run. [12,13] and it is capable of predicting engine performance and fuel economy accurately with a high computational efficiency [14]. Hence a zero-dimensional single-zone model is developed similar to the one developed previously by the authors [15] where Single Wiebe function is used. In this paper double Wiebe function is used to model heat release rate.

II. Description Of Mathematical Modeling

a) List of symbols:

r = compression ratio.

L = length of connecting rod (mm).

B = bore diameter (mm).

V_{disp} = displacement volume (m3).

θ = angular displacement in degrees with respect to bottom dead center (BDC).

θ_s = crank angle at the start of combustion.

γ = specific heat ratio.

P = pressure (bar).

Author α : Department of Automobile Engineering, Guru Nanak Dev Engineering College, Bidar-India.
E-mail : sanjaypatil1021@yahoo.co.in
Author σ : National Institute of Industrial Engineering Mumbai- India.
E-mail : mmakarte@rediffmail.com

V = volume (m3).

m_c = number of moles of carbon in one mole of fuel.

m_h = number of moles of hydrogen in one mole of fuel.

m_o = number of moles of oxygen in one mole of fuel.

m = mass of the charge (kg).

h_c = coefficient of heat transfer due to convection (W/m2.K).

A = interior surface area of cylinder (m2).

T = instantaneous gas temperature (Kelvin).

T_w = cylinder wall temperature (Kelvin).

R = universal gas constant (kJ/kmole.kelvin).

C_m = piston mean speed (m/s).

U = internal energy.

H = enthalpy.

C_P = specific heat at constant pressure (kJ/kg.kelvin).

C_V = specific heat at constant volume (kJ/kg.kelvin).

$\Delta\theta$ = combustion duration in crank angle (degrees).

Q_r = heat released per cycle (kJ).

$\frac{dQ_r}{d\theta}$ = rate of heat released during combustion (kJ/degree CA).

$\frac{dQ_h}{d\theta}$ = rate of heat transfer (kJ/degree CA).

$\frac{dw}{d\theta}$ = rate of work done.

$\frac{du}{d\theta}$ = rate of change of internal energy.

$\frac{dV}{d\theta}$ = incremental change in cylinder volume (m3/degree CA).

$\frac{dT}{d\theta}$ = rate of temperature change (Kelvin / degree CA).

Q_p = heat released during premixed phase (kJ).

Q_d = heat released during diffusive phase (kJ).

m_p = shape factor of premixed phase.

m_d = shape factor of diffusive phase.

θ_p =burning duration of premixed phase.

θ_d =combustion duration.

b) Energy balance equation

According to the first law of thermodynamics, the energy balance equation for the closed cycle is

$$m\frac{du}{d\theta} = \frac{dQ_r}{d\theta} - \frac{dw}{d\theta} \quad (1)$$

The heat term (rate of heat release) can be split into the heat released due to combustion of the fuel and the heat transfer that occurs to the cylinder walls or from the cylinder walls to gases. The equation (1) can be written as

$$m\frac{du}{d\theta} = \frac{dQ_r}{d\theta} - \frac{dQ_h}{d\theta} - \frac{dw}{d\theta} \quad (2)$$

Replacing the work transfer by $p\frac{dV}{d\theta}$ or by the ideal gas law $PV = mRT\frac{dV}{d\theta}$, rate of heat transfer by $h_c = A(T - T_w)$ and the internal energy can be related to specific heat through the relationship $\frac{du}{d\theta} = C_V\frac{dT}{d\theta}$

Upon simplification we get equation (2) as

$$\frac{dT}{d\theta} = \frac{1}{mC_V}\frac{dQ_r}{d\theta} - \frac{h_c A(T - Tw)}{mC_V} - \frac{RT}{C_V V}\frac{dV}{d\theta} \quad (3)$$

Solving above equation by Range-kutta fourth order algorithm, the temperature at various crank angles during combustion can be calculated.

c) Cylinder volume at any crank angle

The slider crank angle formula is used to find the cylinder volume at any crank angle [10]

$$V(\theta) = V_{disp}\left[\frac{r}{r-1} - \frac{1-\cos\theta}{2} + \frac{1}{2}\sqrt{\left(2\frac{L}{S}\right)^2 - \sin^2\theta}\right] \quad (4)$$

d) Compression and Expansion strokes

The compression stroke starts from the moment the inlet valve closes (IVC) to the moment the fuel injection starts. The expansion stroke starts from the moment combustion ends to the moment the exhaust valve opens (EVO).During these processes the temperature and pressure at each step are calculated using ideal gas equation and an isentropic process [15].

e) Combustion Process

$$\frac{dQ_r}{d\theta} = 6.908\frac{Q_p}{\theta_p} m_p \left(\frac{\theta}{\theta_p}\right)^{m_p - 1} \exp\left[-6.908\left(\frac{\theta}{\theta_p}\right)^{m_p}\right] + 6.908\frac{Q_d}{\theta_d} m_d \left(\frac{\theta}{\theta_d}\right)^{m_d - 1} \exp\left[-6.908\left(\frac{\theta}{\theta_d}\right)^{m_d}\right] \quad (5)$$

The parameters θ_p and θ_d represent the duration of the premixed and diffusion combustion phases. Also, Q_p and Q_d represent the integrated energy release for premixed and diffusion phases respectively. Shape factors m_p and m_d for premixed and diffuse phase of combustionhave to be such that the simulated heat release profile matches closely with experimental data. These shape factors areobtained by fittingwiebe function to experimental mass fraction burned profile using least square method. Prior knowledge of actual overall equivalence ratio is necessary because the fuel/air equivalence ratio depends on the amount of fuel injected inside the cylinder, from which the mass of fuel admitted can be calculated [18]. The amount of heat released in premixed mode is 40% of the total heat released per cycle is assumed.

f) Heat transfer

The convective heat transfer between gases and cylinder wall is considerable and hence it directly affects the engine performance. The convection heat transfer in kJ/degree crank angle is given by

$$\frac{dQ_h}{d\theta} = h_c A(T - T_w) \quad (11)$$

Where Heat transfer coefficient due to convection (h_c) is given by Hohenberg equation [19].

$$h_c = \frac{130P^{0.8}(C_m + 1.48)^{0.8}}{V^{0.06}T^{0.4}} \quad (12)$$

g) Ignition delay

An empirical formula, developed by Hardenberg and Hase [20] is used for predicting Ignition delay in crank angle degrees.

$$ID = (0.36 + 0.22C_m)\exp\left[E_A\left(\frac{1}{RT} - \frac{1}{17{,}190}\right)\left(\frac{21.2}{P - 12.4}\right)^{0.63}\right] \quad (13)$$

Where ID = ignition delay period.

E_A is apparent activation energy

h) Gas properties calculation:

A hydrocarbon fuel can be represented by $C_x H_y O_z$ .The required amount of oxygen Y_{cc} for combustion per mole of fuel is given by:

$$Y_{cc} = m_c + 0.25m_h - 0.5m_o \quad (14)$$

The minimum amount of oxygen required $(Y_{\min})$ for combustion per mole of fuel is $Y_{\min} = Y_{cc} - 0.5m_c$

The gaseous mixture properties like internal energy (U), enthalpy (H) specific heats at constant pressure (C_P) and constant volume (c_v) depend on the chemical composition of the reactant mixture, pressure, temperature and combustion process and can be calculated using following equations.

$$U(T) = A + (B - R) * T + C * \ln(T) \quad (15)$$

$$H(T) = A + B * T + C * \ln(T) \quad (16)$$

$$C_p(T) = B + \frac{C}{T} \quad (17)$$

$$C_V(T) = (B - R) + \frac{C}{T} \quad (18)$$

Here A, B and C are the coefficients of the polynomial equation.

i) Friction losses

Total friction loss calculated by the equation [21].

$$FP = C + 1.44\frac{C_m * 1000}{B} + 0.4(C_m)^2 \quad (19)$$

Where *FP* is total friction power loss and *C* is a constant, which depends on the engine type, C = 75 kPa for direct injection engine.

III. Methodology

a) Simulation

A thermodynamic model based on the First law of thermodynamics has been developed. The molecular formula of diesel fuel is taken as $C_{10}H_{22}$ and biodiesel is

approximated as $C_{19}H_{34}O_2$. A computer program has been developed using MATLAB software for numerical solution of the equations used in the thermodynamic model described in Section 2. This computes pressure, temperature, brake thermal efficiency, brake specific fuel consumption and net heat release rate etc, for the fuels considered for analysis. Fuels considered for analysis are namely B20, B60, and B100, 20%, 60%, and 100% POME with petroleum diesel respectively.

b) Experimental

A stationary single cylinder, 4 stroke, water cooled diesel engine developing 5.2 KW at 1500 rpm is used for investigation. The technical specifications of the engine are given in Table 1. The fuel properties are determined using standard procedure and tabulated in table 2. The cylinder pressure data is recorded by using piezoelectric transducer for 80 cycles. The average of data for 80 cycles is computed to evaluate mass fraction burned profile and combustion duration within the framework of first law of thermodynamics.

Table1 : Specifications of Engine

Sl.No	Parameter	Specification
1	Type	Four stroke direct injection single cylinder diesel engine
2	Software used	Engine soft
3	Injector opening pressure	200 bar
4	Rated power	5.2KW @1500 rpm
5	Cylinder diameter	87.5 mm
6	Stroke	110 mm
7	Compression ratio	17.5:1
8	Injection timing	23 degree before TDC

Table 2 : Properties of Diesel and POME

Properties	Diesel(B0)	POME(B100)
Viscosity in cst(at 30°C)	4.25	4.7
Flash point(°C)	79	190
Fire point(°C)	85	210
Carbon residue (%)	0.1	0.64
Calorific value(kj/kg)	42700	36000
Specific gravity(at25°C)	0.830	0.880

IV. Results and Discussion

a) Effect of compression ratio on

i. *Peak pressure*

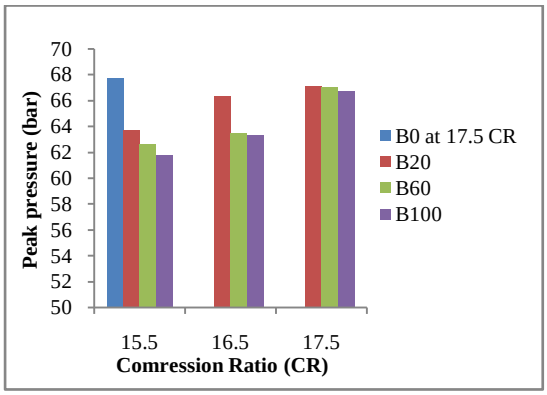


Figure 1 : Variation of Peak pressure with test fuels

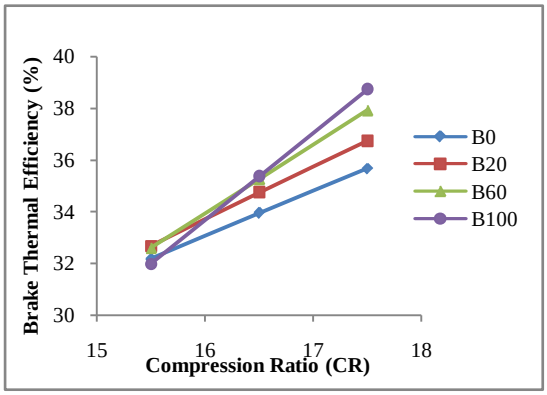


Figure 2 : Variation of Brake thermal efficiency at different Compression Ratio with test fuelsat different Compression Ratio

Figure 1. shows the variation of peak pressure with various test fuels at different compression ratios. With increase in compression ratio, the peak pressure is increased for all test fuels. At every compression ratio, the peak pressure decreases with increase in proportion of biodiesel in the blend and also found that the peak pressures of all test fuels are less in comparison with that of diesel.

Increase in compression ratio enhances the pressure and temperature of air–fuel mixture in compression stroke results in increased peak pressure. Increase in proportion of biodiesel in blend burns more fuel during diffusion phase of combustion and lower calorific value of blend causes in decrease of peak pressure.

ii. *Brake thermal efficiency*

Figure 2. Shows the variation of brake thermal efficiency for various test fuels at different compression ratios. It is observed that brake thermal efficiency for all the test fuel is increased with increase in compression ratio. From the results it is also observed that the brake thermal efficiency at every compression ratio is increased with increase in proportion of biodiesel in the blend. This is due to the presence of oxygen molecule in

the biodiesel which enhances combustion phenomenon. The brake thermal efficiency of test fuels is lower at compression ratio of 15.5:1and 16.5:1 and higher at compression ratio of 17.5:1 in comparison with diesel.

iii. *Net Heat Release Rate*

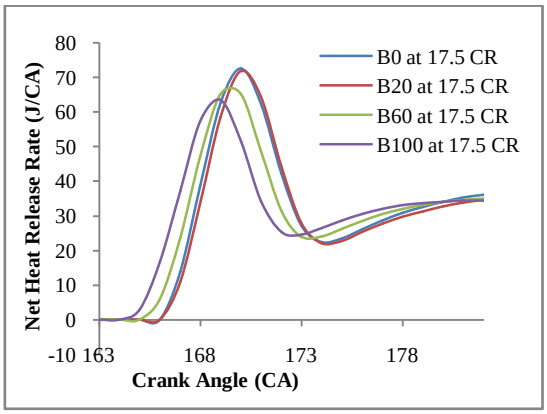


Figure 3(i) : Variation of Net heat release rate with

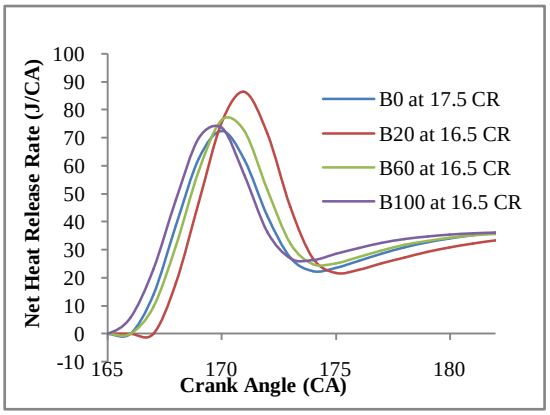


Figure 3(ii) : Variation of Net heat release rate with test fuels at 17.5 Compression Ratiotest fuelsat 16.5 Compression Ratio

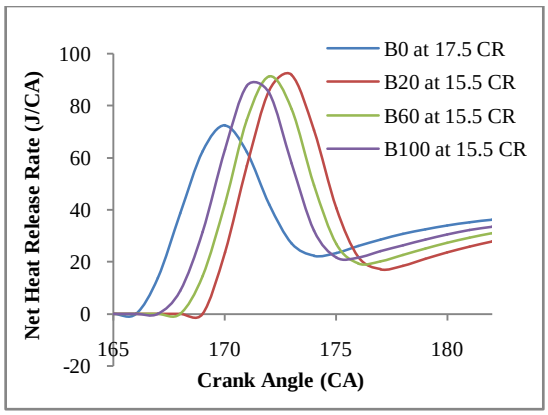


Figure 3(iii) : Variation of Net heat release rate with test fuelsat 15.5 Compression Ratio

Figures 3 (i, ii & iii). Shows the variation of net heat release rate for various test fuels at different compression ratios. From the results it is observed that decrease in compression ratio increases heat release in premixed phase; however occurrence of maximum heat release moved away from TDC. This is because decrease in compression ratio increases the ignition delay period, which causes more fuel to burn late in the expansion stroke. Same trend is observed for all the test fuels. Increase in proportion of biodiesel increases the cetane number of blend, decreasing the delay period. Decrease in delay period burns less amount of fuel in premixed phase, hence decrease in net heat release rate is observed at every compression ratio.

b) Effect of load on

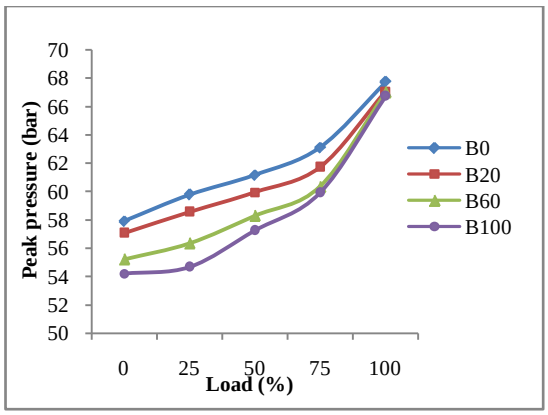


Figure 4 : Variation of Peak pressure with test fuels

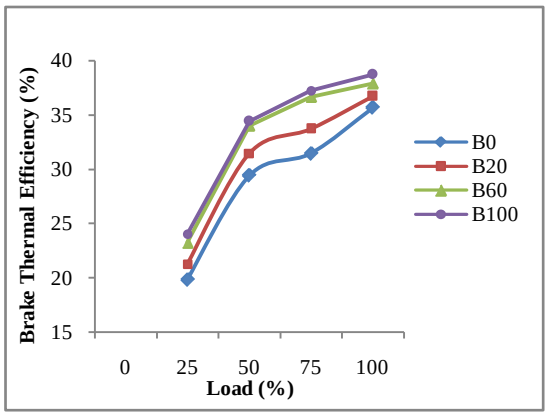


Figure 5 : Variation of Brake thermal efficiency at different load with test fuelsat different load

Figures 4 & 5. Shows the Variation of peak pressure and brake thermal efficiency with test fuels at different load. From the predicted results it is observed that increase in load increases the peak pressure and brake thermal efficiency. Same trend has been observed with all test fuels.

V. Model Validation

With the help of developed model theoretical results are predicted for brake thermal efficiency and peak pressure for all test fuels. The same are compared with that of experimental results. The figures below highlight the features. Predicted brake thermal efficiency and peak pressure at full load when engine is fuelled with B0, B20, B60 and B100 are compared with experimental results are found in closer approximation.

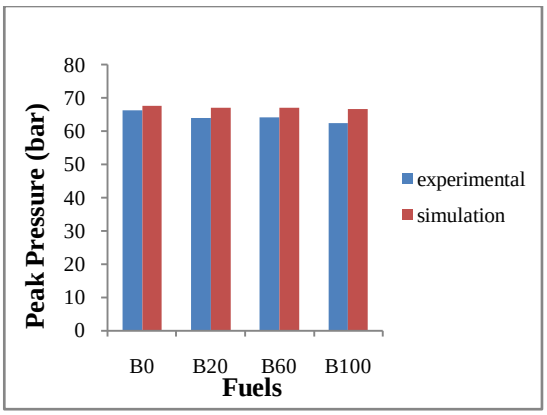


Figure 6 : Peak Pressure at full load

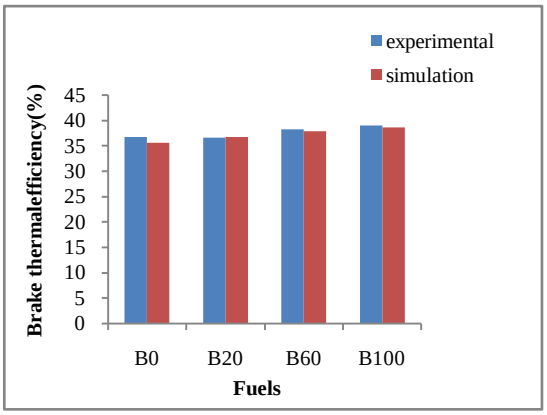


Figure 7 : Brake thermal efficiency at full load

VI. Conclusions

The thermodynamic model developed is used for analyzing the performance characteristics of the compression ignition engine. The modeling results showed that, with increase in compression ratio peak pressure and brake thermal efficiency are increased for all test fuels. At every compression ratio, increase in proportion of biodiesel in the blend decreased peak pressure and increased brake thermal efficiency. This model predicted the engine performance characteristics in closer approximation to that of experimental results. Hence, it is concluded that this model can be used for the prediction of the performance characteristics of the compression ignition engine fueled by any type of hydrocarbon fuel.

References Références Referencias

1. Jamil Ghojel, Damon Honnery. Heat release model for the combustion of diesel oilemulsions in DI diesel engines. Applied Thermal Engineering 25 (2005) 2072–2085.
2. O.M. I. Nwafor & G. Rice. Performance of Rapeseed Oil Blends in a Diesel Engine Applied Energy. Vol. 54, No. 4, pp. 345-354, 1996.
3. Vellguth G. Performance of vegetable oil and their monoesters as fuels for diesel engines. SAE 831358, 1983.
4. Tadashi, Young. Low carbon build up, low smoke and efficient diesel operation with vegetable oil by conversion to monoesters and blending of diesel or alcohols. SAE 841161, 1984.
5. Recep Altim, Selim C etinkaya, Huseyin Serdar, Yucesu, The potential of using vegetable oil fuels as fuel for diesel engines Energy Conversion and Management 42 (2001) 529-538 diesel engine, Applied Energy 86 (2009) 106–112.
6. Murugesan, C.Umarani, R.Subramanian, N.Nedunchezhian. Bio-diesel as an alternative fuel for diesel engine- A review. Renewable and Sustainable Energy Reviews 13(2009)653-662.
7. N.R. Banapurmath, P.G. Tewari, R.S.Hosmath. Performance and emission characteristics of a DI compression ignition engine operated on Honge, Jatropha and sesame oil methyl esters. Renewable Energy 33 (2008) 1982–1988.
8. T. Ganapathy, K. Murugesan, R.P. Gakkhar, "Performance optimization of Jatropha biodiesel engine model using Taguchi approach" Applied Energy (2009).
9. T. Ganapathy, K. Murugesan*, R.P. Gakkhar "Performance optimization of Jatropha biodiesel engine model using" Taguchi approach
10. Ganesan, V., Computer simulation of Compression-Ignition engine processes, University Press (India) Ltd., Hyderabad, India, 2000.
11. Udarapandian, "Performance and Emission Analysis of Bio Diesel Operated CI Engine" Journal of Engineering, Computing and Architecture Volume 1, Issue 2, 2007.
12. G.H. AbdAlla, A.A. Soliman, O.A. Badar, M.F. AdbRabbo, Combustion quasi-two zone predictive model for dual fuel engines, Energy Conversion and Management 42 (2001) 1477–1498.
13. P.A. Lakshminarayanan, Y.V. Aghav, A.D. Dani, P.S. Mehta, Accurate prediction of the heat release in a modern direct injection diesel engine, Proceedings of the Institute of Mechanical Engineers 216 (2002) 663–675.
14. (Krieger and Borman, 1966; Foster, 1985; Assanis and Heywood, 1986).
15. Sanjay Patil, Dr. M.M. Akarte, Performance Characteristics of CI Engine Fuelled with Biodiesel

and its Blends by Simulation, International Journal of Scientific & Engineering Research, Volume 3, Issue 4, April-2012 1 ISSN 2229-5518 .
16. Jamil Ghojel, Damon Honnery. Heat release model for the combustion of diesel oil emulsions in DI diesel engines. Applied Thermal Engineering 25 (2005) 2072–2085.
17. P. Arque`s, La combustion: Inflammation, combustion, pollution, applications, Ellipses, Paris, 2004, ISBN 2-7298-2037-X, p. 304.
18. Hohenberg GF. Advanced approaches for heat transfer calculations. SAE 790825, 1979.
19. J.B. Heywood, Internal Combustion Engines Fundamentals, McGraw Hill, 1988, ISBN 0-07-100499-8.
20. Shroff, H. D., Hodgetts, D., Simulation and Optimization of Thermodynamic Processes of DieselEngine, SAE 740194, 1974.

Global Journals Inc. (US) Guidelines Handbook 2012

www.GlobalJournals.org

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (FARSE)

- 'FARSE' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'FARSE" can be added to name in the following manner. eg. Dr. John E. Hall, Ph.D., FARSE or William Walldroff Ph. D., M.S., FARSE
- Being FARSE is a respectful honor. It authenticates your research activities. After becoming FARSE, you can use 'FARSE' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 60% Discount will be provided to FARSE members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- FARSE will be given a renowned, secure, free professional email address with 100 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- FARSE member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 15% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- Eg. If we had taken 420 USD from author, we can send 63 USD to your account.
- FARSE member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research, Society U.S.A.
- After you are FARSE. You can send us scanned copy of all of your documents. We will verify, grade and certify them within a month. It will be based on your academic records, quality of research papers published by you, and 50 more criteria. This is beneficial for your job interviews as recruiting organization need not just rely on you for authenticity and your unknown qualities, you would have authentic ranks of all of your documents. Our scale is unique worldwide.
- FARSE member can proceed to get benefits of free research podcasting in Global Research Radio with their research documents, slides and online movies.
- After your publication anywhere in the world, you can upload you research paper with your recorded voice or you can use our professional RJs to record your paper their voice. We can also stream your conference videos and display your slides online.
- FARSE will be eligible for free application of Standardization of their Researches by Open Scientific Standards. Standardization is next step and level after publishing in a journal. A team of research and professional will work with you to take your research to its next level, which is worldwide open standardization.

- FARSE is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), FARSE can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 80% of its earning by Global Journals Inc. (US) will be transferred to FARSE member's bank account after certain threshold balance. There is no time limit for collection. FARSE member can decide its price and we can help in decision.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (MARSE)

- 'MARSE' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'MARSE" can be added to name in the following manner. eg. Dr. John E. Hall, Ph.D., MARSE or William Walldroff Ph. D., M.S., MARSE
- Being MARSE is a respectful honor. It authenticates your research activities. After becoming MARSE, you can use 'MARSE' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 40% Discount will be provided to MARSE members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- MARSE will be given a renowned, secure, free professional email address with 30 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, SpamAssassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- MARSE member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 10% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- MARSE member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research,Society U.S.A.
- MARSE is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), MARSE can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 40% of its earning by Global Journals Inc. (US) will be transferred to MARSE member's bank account after certain threshold balance. There is no time limit for collection. MARSE member can decide its price and we can help in decision.

AUXILIARY MEMBERSHIPS

ANNUAL MEMBER

- Annual Member will be authorized to receive e-Journal GJRE for one year (subscription for one year).
- The member will be allotted free 1 GB Web-space along with subDomain to contribute and participate in our activities.
- A professional email address will be allotted free 500 MB email space.

PAPER PUBLICATION

- The members can publish paper once. The paper will be sent to two-peer reviewer. The paper will be published after the acceptance of peer reviewers and Editorial Board.

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

Preferred Author Guidelines

MANUSCRIPT STYLE INSTRUCTION (Must be strictly followed)

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. **Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be

sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page

- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to

shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic

principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.

- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation)
by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

save our planet

Global Journal of Researches in Engineering

Visit us on the Web at www.GlobalJournals.org | www.EngineeringResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9755861