

Investigational Study of Nozzle Design by CAD Method and Performance Analysis in Motorcycle Engine

Sundarapriyaa.N
Department of Mechanical Engineering,
Angel college of Engineering and Technology,
Tiruppur, India

Shofiya Shalini.D
Department of Mechanical Engineering,
Angel college of Engineering and Technology,
Tiruppur, India

Saravanakumar. S
Department of Mechanical Engineering,
Angel college of Engineering and Technology,
Tiruppur, India

Abstract— Nozzle may be a unit won't to transfer the K.E. from the thermo chemical energy created within the combustion chamber. It converts hot temperature and air mass gas into temperature and depression gas. Nozzle converges the pressure gas to supply high speed, that emerges the aircraft to fly higher. CD Nozzles are utilized in dominant the flow and also the rate of flow and momentum that happens from them. By this investigation, the generator meter check was applied to the image model of the nozzle to research the performance of the bike engine.

Keywords- Nozzle expansion Ratio, Ansys, Air fuel Ratio, Dynamo meter, Back pressure

INTRODUCTION

Nozzle is a device used to convert the heat energy produced into high velocity energy. It converts the gas of low velocity into gas of high velocity. These mach regimes constitute to be subsonic, sonic, supersonic and hyper sonic regimes. The nozzle type mainly depends on the outlet velocity of the flow through nozzle and its design. The main applications of the nozzle covers majority of the engineering, chemical and medical fields. However. The design and optimization of the duct is considered prior, to attain high efficiency and low work stream.

Dynamo meter is a unit used to calculate the force, torque and power. For instant, the power produced by an engine, can be deliberated by concurrently torque and rotational speed measurement. The power absorption unit of the device absorbs the power developed by the machine. This power absorbed is then converted into thermal energy, which generally vanishes into the atmosphere. The dynamo meter should be able to operate at any rotational speed and should withstand the load to either level of torque that requires to test..

I. MODELLING

The design and modeling of Convergent-Divergent Nozzle is done using CATIA software. The ANSYS fluent Software is used to carry out the Analysis section of the nozzle. Ansys Fluent is widely used to carry out the fluid flow used simulation works. The modeling and analyzing of the nozzle was referred [3].

Draw the half portion of the CD nozzle with the specified dimensions given in Table 1. Make sure that the sketch drawn is closed completely and dimensions are precise while modeling. The closed part is now revolved with respect to the central axis to complete the nozzle surface.

Table 1: Dimensions of the Convergent - Divergent Nozzle

S.no	Specifications	Dimensions (cm)
1	Total length	65.81902
2	Divergent angle	11 degrees
3	Convergent length	18.92808
4	Throat radius	7.75716
5	Inlet radius	16.51
6	Exit radius	12.5476

This paper focuses on the simulation work which is carrying out by employing a suitable turbulence modeling method.



Fig-1: Sectional view of the nozzle at 11° angle of divergence

The experiment is then repeated by varying the divergent angle and exit radius and keeping the length of the nozzle as constant. The following table prescribes the Expansion Raton of the nozzle with the respective divergent angle and exit radius.

Table 2: Exit Radii & Expansion ratios for different Divergence angles

Divergence Angle (deg)	Exit Radius (mm)	Expansion Ratio
5	9.73074	1.5342
9	11.38174	2.0262
11	12.5476	2.4026
15	13.8303	2.84
20	15.9512	3.6172

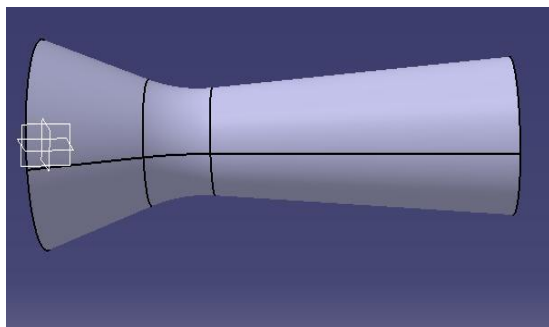


Fig-2: Generated Nozzle for 11° angle of divergence

II. ANALYSIS

The tool used to fluid flow analysis is ANSYS 18.2 and the solver chosen is Ansys fluent. The Energy, Momentum and Continuity equations are the main equations used to solve for the solution. To find the solution theoretically, Reynolds Averaged Navier Stokes (RANS) equations are used generally. But, a numerical method must be used to replace the RANS equations with the algebraic approximations for the real fluid flow problems.

The nozzle modeled in CATIA is imported to Ansys Workbench 18.2 where the solver chosen is Ansys fluent. As the nozzle flow simulation is an internal flow type, there is no further construction of geometry is required.. Meshing is done after modeling and importing of the design by giving respective details in ANSYS and the details are given in Table 3.

Table -3: Details and Sizing inputs of a mesh

Physics Preference	ANSYS
Solver Preference	Fluent
Advanced size function	On: Proximity & Curvature
Relevance centre	Fine
Smoothing	High
Maximum element size	1.1781e-004m
Growth rate	1.850

Depending on the type of fluid used, the material input and properties are given. In our analysis, the air is used as gas and the properties are given in Table 4.

Table-4: Material input and Properties for Air

Thermodynamic Properties	
Equation of State	Ideal gas (Air)
Molar mass	28.96 Kgk/mol
Specific heat Capacity	1004.4 J/KgK
Transport Properties	
Dynamic Viscosity	1.831e-05 Kg/ms
Thermal Conductivity	0.0261 W/mK

After window pop up as the Result is completed normally, the Post Processing stage is undergone with the contour plots as shown in Figures 3 and 4.

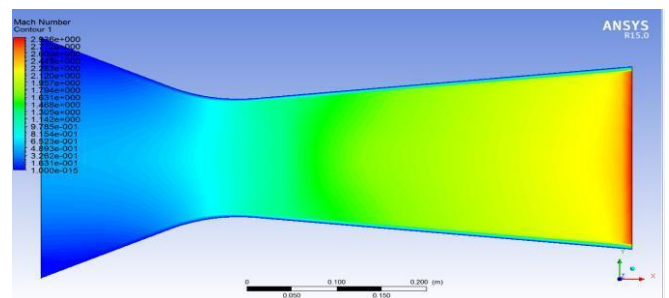


Fig-3: Mach Contours for 11° divergence angle

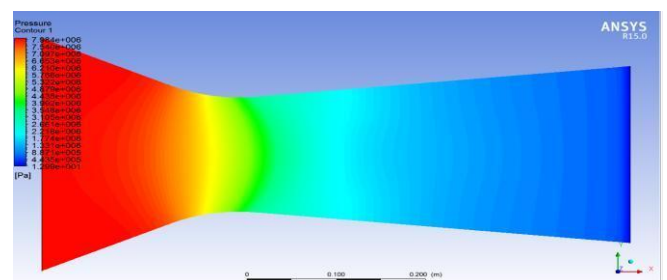


Fig-4: Pressure Contours for 11° divergence angle

III. EXPERIMENTAL SETUP

The Designed and fabricated CD Nozzle is then replaced with the ordinary exhaust system of the moppet and the results are comparatively taken using Chassis Dynamometer.

The Test was carried out by replacing the ordinary exhaust system in the moppet with our CD Nozzle type exhaust. Initially, no filter and catalytic convertor was attached in the exhaust to analyze the exhaust flow as it is.



Fig.4 Chassis Dynamometer with CD Nozzle type exhaust

The dynamometer consists of a metallic frame of 60 x 60 mm that is fitted in the ground with the help of rubber feet. The front wheel is held by the rubber piece on its sides. The 325 mm diameter iron is used as the roller. The mooring is done in the roller so that no other is required. The central band in the roller helps in tractioning the wheel. The front and top views of the chassis dynamometer are taken from [17] and the figure is shown in fig.5

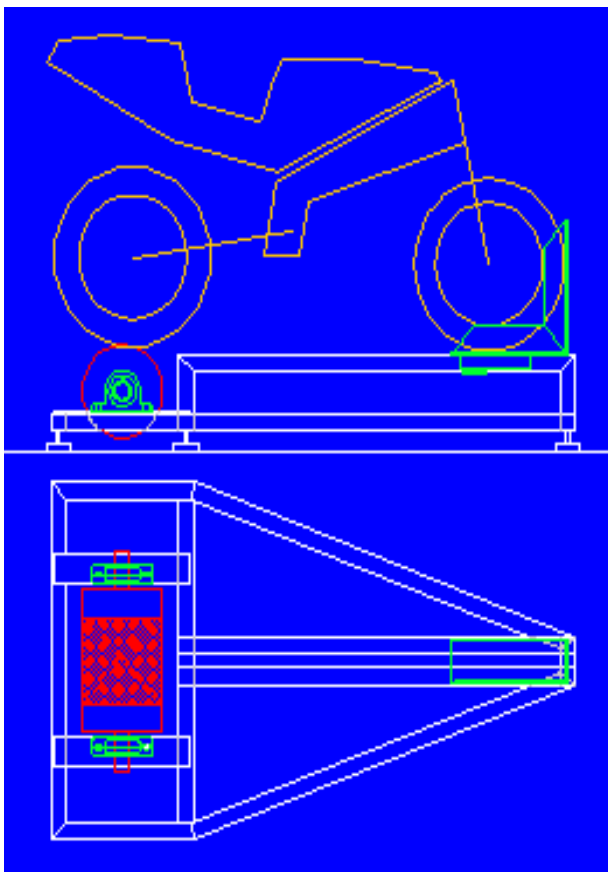


Fig 5: Front and top view of the roller in chassis dynamometer

The moppet is held in the Dynamometer and the connections are given to the display. By giving acceleration, a graph can be attained for time to torque, horsepower and engine RPM. In this performance analysis, the graph for both the normal moppet exhaust system and CD Nozzle exhaust system was shown.

IV. RESULT AND DISCUSSION

The graph of time to torque, horsepower and engine RPM for both the convergent (CD Nozzle) and Divergent (Ordinary exhaust) respectively are shown in Figure .6

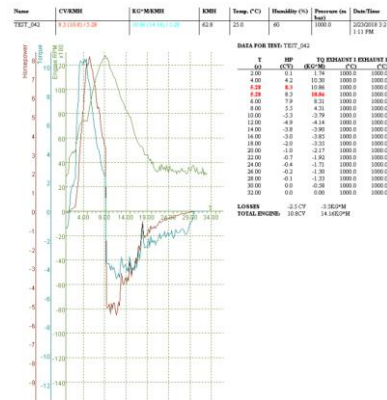
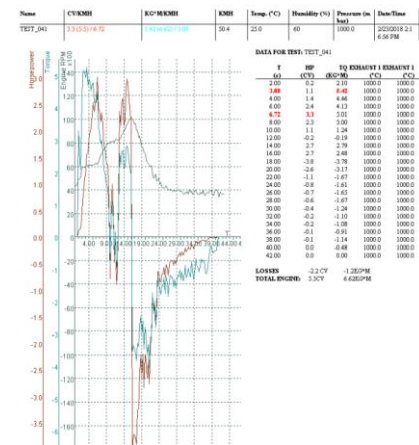
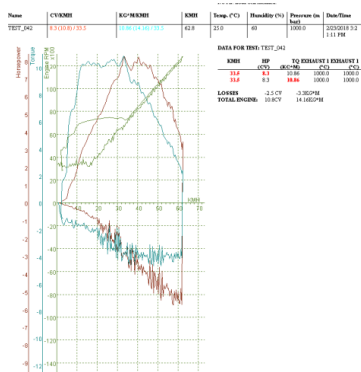


Fig 6: Graph between Time to Horsepower, Torque and Engine RPM

The graph of time to Km-h, Engine RPM and Torque are as



Shown in figure 7



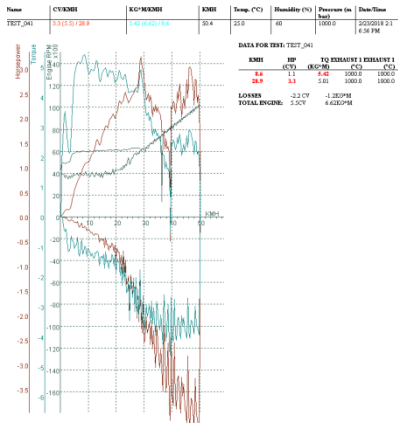


Fig.7.1 The graph plotted between time(s) and Km-h

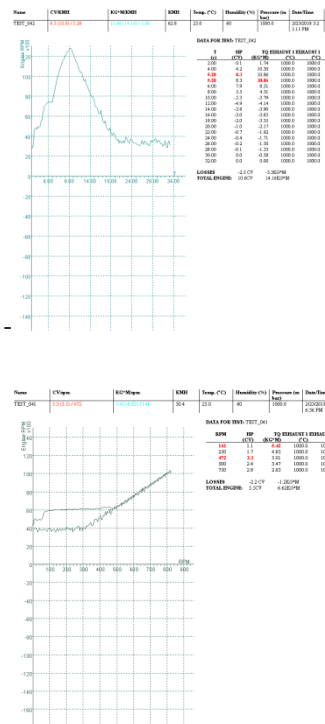


Fig.7.2 The graph plotted between time(s) and Engine RPM
 By comparing the above two exhaust systems, the engine RPMs are 12,030 and 10,100 for CD Nozzle and Divergent Exhaust respectively. The Torque for CD Nozzle and Divergent Nozzle are 10.8 Nm and 5.2 Nm respectively. And the total engine is given to be 10.8 CV and 5.5 CV for our exhaust and default exhaust respectively.

V. CONCLUSION

From this analysis we have done, the following conclusions have been drawn.

- The Engine maximum RPM is obtained by using the special exhaust of lower cc automobile.
- The torque achieved is higher when compared to the existing exhaust.
- The horsepower is increased while using the special exhaust system.

Thus this paper concludes that, the engine performance, torque and power will be increase while using this special type exhaust.

VI. REFERENCE

- [1] G. Satyanarayana, Ch.Varun and S.S.Naidu., "CFD analysis of a Convergent-Divergent nozzle" ACTA TECHNICA CORVINIENSIS-Bulletin of Engineering TOME VI (2013) fascicule 3 IISN 206-3809
- [2] Omid Joneydi Shariatzadeh, Afshin Abrishamkar, and AliakbarJoneidi jafari "Computational Modeling of aTypical Supersonic Convergent-Divergent Nozzle and Validation by Real Measured Data", JOCET 2015 vol.3(3): 220-225.ISSN:1793-821X, DOI: 10.7763/JOCET.2015. V3.198
- [3] Fred W.Steffen, H.George Krull and Ralph F.Schmiedlin., "Effect of Divergence angle on the internal performance characteristics of several conical convergent-divergent nozzles, National Advisory Committee for Aeronautics
- [4] "Jet nozzles, Type DUK" from TROX company, retrieved 15 October 2013 from http://www.troxaustralia.com/xpool/download/en/technical_documents/diffusers/leaflets/t_1_2_2_duk.pdf GFC Rogers, and Cohen, H. Gas Turbine Theory, p.108 (5th Edition), HHH Saravanamuttoo "Nozzle design (converging/diverging - CD nozzle)". NASA.gov. Retrieved 19 January 2009.
- [5] "Chassis definition and meaning | Collins English Dictionary". www.collinsdictionary.com. Retrieved 2017-05-21.
- [6] Association of Licensed Automobile Manufacturers (U.S.) (1922). Official Handbook of Automobiles. National Automobile Association. p. 180. OCLC 6360726. Retrieved 10 September 2010.
- [7] Sturme, Henry (2 April 1908). "The Use of Unsuitable Vehicles". Commercial Motor. 7 (160): 146–147. Retrieved 10 September2010.
- [8] Grenzeback, Lance R.; Lin, Sandi; Meunier, Jacob (2005). Operational Differences and Similarities among the Motorcoach, School Bus, and Trucking Industries. Transportation Research Board. p. 13. ISBN 978-0-309-08821-3. Retrieved 10 September 2010. Starr p. 45, 79, 129, 143, 153, etc.
- [9] Khandpur, Raghbir Singh (2006). Troubleshooting Electronic Equipment. McGraw-Hill Professional. p. 45. ISBN 978-0-07-147731-4. Retrieved 10 September 2010.
- [10] Stackpole, Beth (June 5, 2012). "ANSYS Takes Aim at Embedded Software". Design News. Retrieved June 10,2017.
- [11] Jenkins, Bruce (January 26, 2015). "Design Exploration Outlook: Acquisitions and Mergers 2015". Virtual Desktop. Retrieved June 10, 2017.
- [12] "Mergers, acquisitions and joint ventures review – 2013". Reinforced Plastics. Elsevier BV. 58 (1): 42–46. 2014. doi:10.1016/s0034-3617(14)70042-6. ISSN 0034-3617.
- [13] Newton, Randall (April 1, 2014). "Ansys acquires SpaceClaim for \$85 million". GraphicSpeak. Retrieved June 17, 2017.
- [14] Reh, Stefan; Beley, Jean-Daniel; Mukherjee, Siddhartha; Khor, Eng Hui (2006). "Probabilistic finite element analysis using ANSYS". Structural Safety. Elsevier BV. 28 (1-2): 17–43. doi:10.1016/j.strusafe.2005.03.010. ISSN 0167-4730.
- [15] Dadkhah, F.; Zecher, J. (2009). Ansys Workbench Software Tutorial with Multimedia CD: Release 12. SDC publications. Schroff Development Corporation. p. 1-PA5. ISBN 978-1-58503-581-6. Retrieved June 16, 2017.
- [16] Ariff Farhan Ibrahim –"Motorcycle Dynamometer" ppt.