DESIGN EVALUTION AND OPTIMIZATION OF NOZZLE USED IN DIESEL ENGINE

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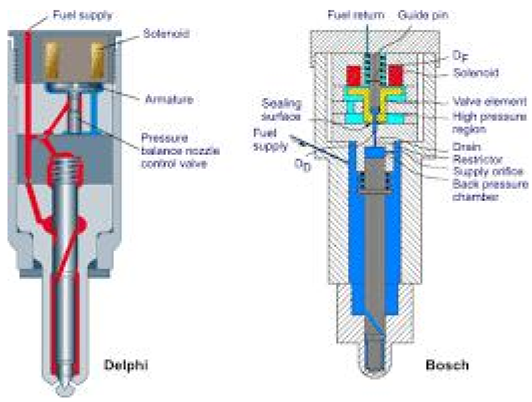
ABSTRACT:

The nozzle is used to convert the chemical thermal energy generated in the combustion chamber into kinetic energy. The nozzle converts the low velocity, high pressure, high temperature gas in the combustion chamber into high velocity gas of lower pressure and temperature. Nozzle is a device designed to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that exhaust from them. Nozzles come in a variety of shapes and sizes depending on the mission of the rocket, this is very important for the understanding of the performance characteristics of rocket. Convergent divergent nozzle is the most commonly used nozzle since in using it the propellant can be heated in combustion chamber. In this thesis the convergent divergent nozzle changing the different nozzle diameters and different fluids at different velocities. We modeled convergent divergent nozzle changing with different nozzle diameters and Analyzed the convergent divergent nozzle with different mass flow rates to determine the pressure drop, heat transfer coefficient, and velocity and heat transfer rate for the fluid by CFD technique.

Keywords — ANSYS, Catia, optimization of nozzle.

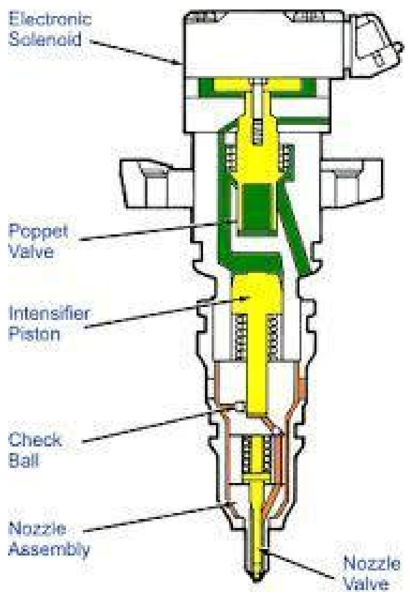
INTRODUCTION

The primary challenges towards developing new diesel engines for passenger cars lie in the strict future emission legislation in combination with the customer's demands for steadily 0improving performance. For example, the emission limitations of Tier 2 Bin 5 requires an advanced after treatment system and a robust combustion process that minimizes emissions in the process of them being formed. Advancements in the technology of Diesel Injection (DI) systems have played in important role in the improvements that have been made up to this point . Combining the reduction in nozzle orifice diameters through enhanced flow characteristics with increased injection pressures provides an opportunity to develop engines featuring high power density and reduced emissions. The primary drawback to these modern spray hole geometries is that they often suffer a reduction of power output during long term operation. Other studies have identified these critical formations of deposits as the main reason for this behavior.



Basic mechanisms can be used to explain the formation and removal of deposits in internal combustion engines These mechanisms act independently of the location of formed deposits (e.g. injection nozzles, heat changer) and of the combustion process (e.g. IDI, DI; diesel or gasoline).

The model described in the study illustrates the interaction of a wall with the enclosing flow regime. The transport of particles to the wall is based on the process of thermophores is This process results in the force of gas particles in the direction of the temperature depression. It is amplified with an increasing temperature differential between wall (cold)and fluid (hot). This process results is an increasing concentration of deposit-building particles near the wall



High 2 turbulence near the wall may reduce the force of the aerosol again to a mean value, compensating for an increased temperature difference. The deposits are composed of attached particles (solid and liquid) and gas (Figure 1).

Condensation and adsorption of gaseous compounds at the cold wall promotes the formation process. At this point, the growth of the deposits is now mainly influenced by the sticking, impaction and incorporation of particles The adsorption of gaseous components and the chemical reactions (as pyrolysis, dehydration and polymerization, etc.), lead to the compaction of the deposits]. The removal of deposits has analogous physical mechanisms.

The chemical mechanism is oxidation destroying the organic compounds in the coating Evaporation and desorption reduce the gaseous fraction dissolved in the deposits. Abrasion is caused by strong aerodynamic forces and breaking-off, due to high temperature changes, resulting in inhomogeneous extensions of the wall and deposit layer.

The corresponding shearing stresses initiate the breaking-off process The soluble fraction of the deposits is washed off by solvents (e.g. water as solvent for salt compounds)

2.LITERATURE REVIEW

Design and Optimization of Fuel Injection System in Diesel Engine Using Biodiesel – A Review H. M. Pate

Fuel injection is systems for supplying high pressurize fuel to maximum mixing of fuel with air in an internal combustion engine. Direct Injection (DI) Systems as used in DI engines, in which the fuel is injected directly into a combustion chamber formed in the clylinder itself. The fuel injector directly injects fuel into the direct fuel injection system. The injector is a very complicated part, and massive research has been done to improve it.In my work indicating the development of fuel injector system to reduce chocking problem which is generally happen in bio diesel engine. The injection nozzles and their respective nozzle holders are vitally important components situated between the in-line injection pump and the diesel engine, its functions are as metering the injection of fuel, management of the fuel, defining the rate-of-discharge curve, Sealing-off against the combustion, chamber. Mechanical type injectors used in direct injection system. When biodiesel is used in the diesel engine choking problem is created in fuel injector. Therefore, we optimize the design of fuel injector component, and tried to prevent the chocking problem. The diesel fuel injector system directly injects fuel into the system without chocking.

M. Volmajer et al [4] had numerical and experimental results of the nozzle fuel flow analysis for a four-hole injection nozzle Bosch DLLA 148 S 311376 are presented. The fuel

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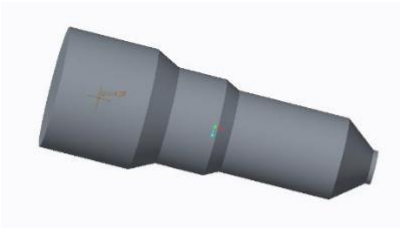
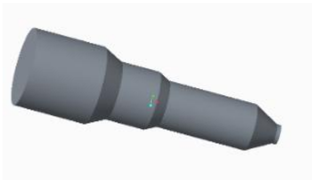
flow coefficients obtained from the experimental results at steady flow conditions in the nozzle are compared with the results of the CFD analysis. The fuel flow coefficients obtained from the experimental results at steady flow conditions in the nozzle are compared with the results of the CFD analysis. From the presented results the following conclusions could be made. Flow coefficient testing device constructed at the ERL yields sufficiently precision, with reasonable uncertainties of the measurement. To refine the precision of the measurement, by defining the exact value of the pressure difference, the pressure downstream of the nozzle should be measured, or the nozzle position should be changed so, that the fluid would be injected directly into the measuring Plexiglas. For the same purpose, Plexiglas cylinder with high ovalness should be replaced with the glasslPlexiglas cylinder with proper circle cross-section. the presented testing device also enables the measurement of the flow coefficient separately for each nozzle hole, which brings better comparison with the results of CFD analysis when the simplified models, introducing only one hole, are applied. Zhijun Li et al [5]had investigates the effects of manufacturing variations in fuel injectors on the engine performance with emphasis on emissions. The variations are taken into consideration within a Reliability-Based Design Optimization (RBDO) framework. A reduced version of Multi-Zone Diesel engine Simulation (MZDS), MZDS-lite, is used to enable the optimization study. The numerical noise of MZDS-lite prohibits the use of gradient-based optimization methods. Therefore, surrogate models are developed to filter out the noise and to reduce computational cost.

Three multi-objective optimization problems are formulated, solved and compared: deterministic optimization using MZDS-lite, deterministic optimization using surrogate models and RBDO using surrogate models.The obtained results confirm that manufacturing variation effects must be taken into account in the early product development stages. The effects of manufacturing variations in fuel injectors on the engine performance with emphasis on emissions. The results obtained using deterministic and probabilistic optimization formulations demonstrated the need for RBDO to improve not only performance but also reliability. LI Minghai et al [7] had indicated forced lubrication is adopted for the new injector nozzle matching parts, which can reduce failure rate and increase service life. If the patented product is used widely, economic efficiency and social efficiency will be obtained. Benny Paul et al [8] had indicated effect of helical, spiral, and helical-spiral combination manifold configuration on air motion and turbulence inside the cylinder. Swirl inside the engine is important for diesel engine. Hence, for better performance they recommended a helical-spiral inlet manifold configuration.

2.1 3D MODEL OF DIESEL NOZZLE WITH 50DIA



2.2 NOZZLE WITH 40DIA



2.3 NOZZLE WITH 30DIA

3. INTRODUCTION TO FEA

Finite element analysis is a method of solving, usually approximately, certain problems in engineering and science. It is used mainly for problems for which no exact solution, expressible in some mathematical form, is available. As such, it is a numerical rather than an analytical method. Methods of this type are needed because analytical methods cannot cope with the real, complicated problems that are met with in engineering. For example, engineering strength of materials or the mathematical theory

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of elasticity can be used to calculate analytically the stresses and strains in a bent beam, but neither will be very successful in finding out what is happening in part of a car suspension system during cornering.

One of the first applications of FEA was, indeed, to find the stresses and strains in engineering components under load. FEA, when applied to any realistic model of an engineering component, requires an enormous amount of computation and the development of the method has depended on the availability of suitable digital computers for it to run on. The method is now applied to problems involving a wide range of phenomena, including vibrations, heat conduction, fluid mechanics and electrostatics, and a wide range of material properties, such as linear-elastic (Hookean) behavior and behavior involving deviation from Hooke's law (for example, plasticity or rubber-elasticity).

Many comprehensive general-purpose computer packages are now available that can deal with a wide range of phenomena, together with more specialized packages for particular applications, for example, for the study of dynamic phenomena or large- scale plastic flow. Depending on the type and complexity of the analysis, such packages may run on a microcomputer or, at the other extreme, on a supercomputer. FEA is essentially a piece-wise process. It can be applied to one-dimensional problems, but more usually there is an area or volume within which the solution is required. This is split up into a number of smaller areas or volumes, which are called finite elements. Figure 1 shows a two-dimensional model of a spanner that has been so divided: the process is called discretisation, and the assembly of elements is called a mesh.

4.INTRODUCTION TO ANSYS

4.1 Structural Analysis

ANSYS Autodyn is computer simulation tool for simulating the response of materials to short duration severe loadings from impact, high pressure or explosions.

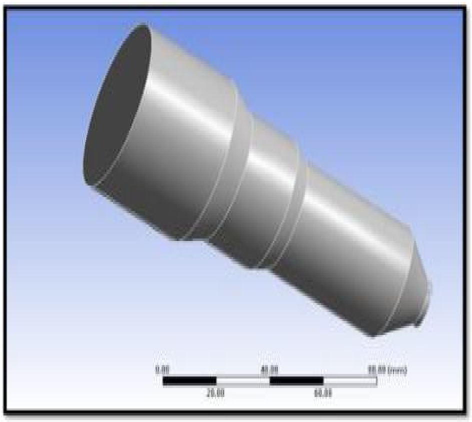
4.2 Fluid Dynamics

ANSYS Fluent, CFD, CFX, FENSAP-ICE and related software are Computational Fluid Dynamics software tools used by engineers for design and analysis. These tools can simulate fluid flows in a virtual environment — for example, the fluid dynamics of ship hulls; gas turbine engines (including the compressors, combustion chamber, turbines and afterburners);
aircraft aerodynamics;pumps,
fans, HVAC systems,
mixing vessels, hydro cyclones, vacuum cleaners, etc.

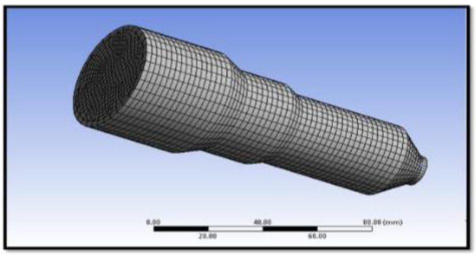
4.3 CFD ANALYSIS OF DIESEL ENGINE NOZZLE

FLUID- DIESEL

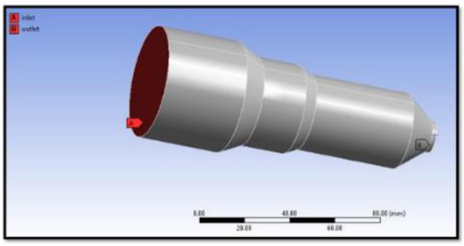
Velocity inlet = 200m/s, 300m/s & 400m/s



MESHED MODEL



SPECIFYING THE BOUNDARIES FOR INLET & OUTLET



4.4 FLUID- DIESEL

DIESEL ENGINE NOZZLE DIA. 50MM

HEAT TRANSFER COEFFICIENT

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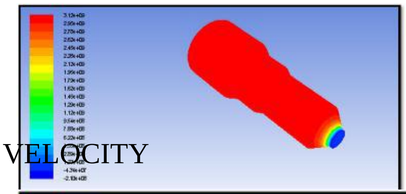
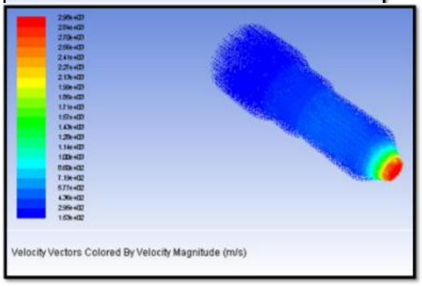
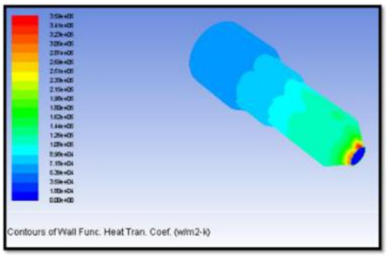
VELOCITY INLET = 200m/s
PRESSURE



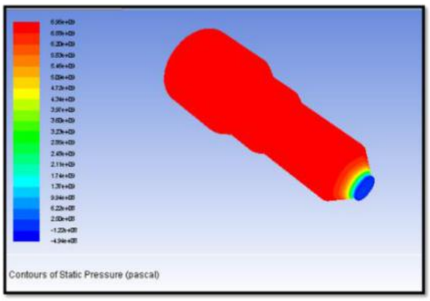
VELOCITY



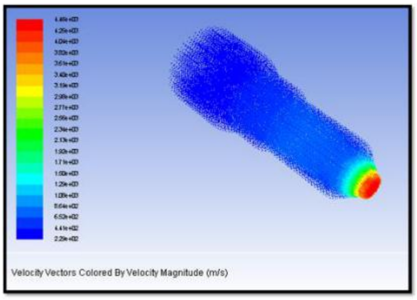
HEAT TRANSFER COEFFICIENT



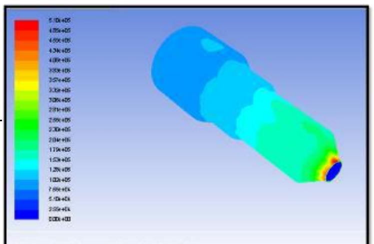
4.5 VELOCITY INLET = 300m/s
pressure



VELOCITY



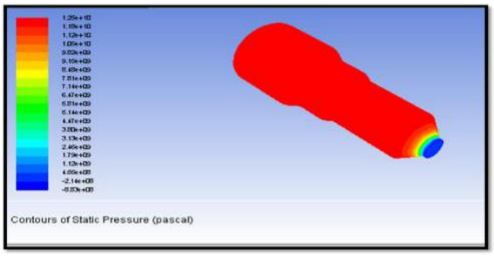
HEAT TRANSFER COEFFICIENT



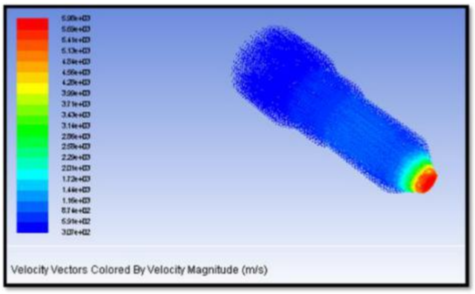
MASS FLOW RATE & HEAT TRANSFER RATE

Mass Flow Rate	(kg/s)
inlet	427.56219
interior-___msbr	26587.756
outlet	-427.85144
wall-___msbr	0
Net	-0.28924561
otal Heat Transfer Rate	(w)
inlet	4333986
outlet	-4336913.5
wall-___msbr	0
Net	-2927.5

4.6 VELOCITY INLET = 400m/s
PRESSURE



VELOCITY



CONCLUSION

Nozzles come in a variety of shapes and sizes depending on the mission of the rocket, this is very important for the understanding of the performance characteristics of rocket. Convergent divergent nozzle is the most commonly used nozzle since in using it the propellant can be heated in combustion chamber.

In this thesis the convergent divergent nozzle changing the different nozzle diameters and different fluids at different velocities. We modeled convergent divergent nozzle changing with different nozzle diameters.

By observing the cfd analysis of diesel engine nozzle the pressure, velocity, heat transfer rate and mass flow rate values are increases by increasing the inlet velocities and decreasing the nozzle dia.
By observing the thermal analysis, heat flux is more for aluminum alloy compared with brass material.

So it can be concluded the diesel engine nozzle efficiency were more when the nozzle dia. decreases.

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