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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.

Key Words: *Nozzle, Diesel engine, fuel injector, CREO software, ANSYS*

1. 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 improving performance. For example, the emission limitations of Tier 2 Bin 5 require 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.

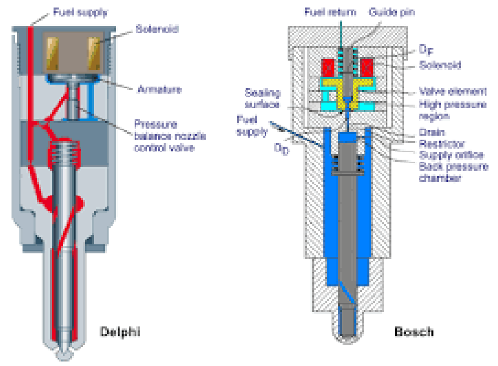


Fig-1.1: A sectional view of fuel injector

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 are an increasing concentration of deposit-building particles near the wall.

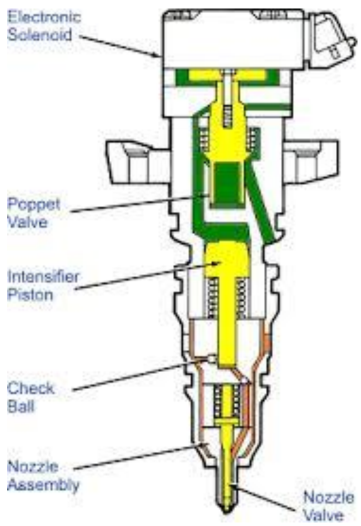


Fig-1.2: Components in fuel injector

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. INTRODUCTION TO ANSYS

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.

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.

2.1 CFD ANALYSIS OF DIESEL ENGINE NOZZLE

FLUID- DIESEL

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

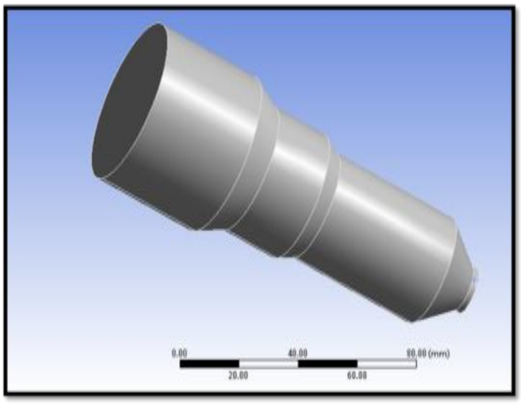


Fig-2.1: Imported model

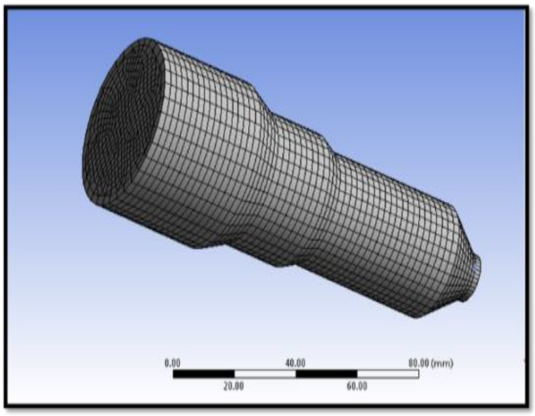


Fig-2.2: MESHED MODEL

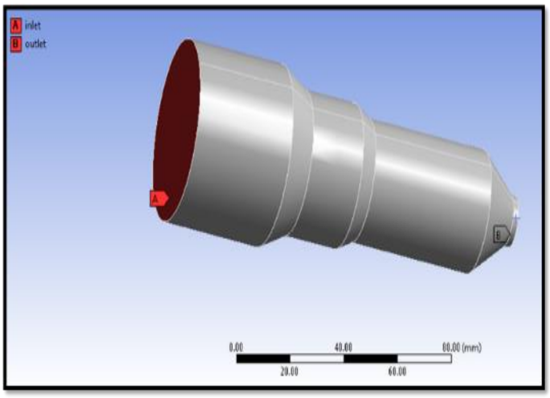


Fig-2.3: SPECIFYING THE BOUNDARIES FOR INLET & OUTLET

Update

2.2 FLUID- DIESEL

DIESEL ENGINE NOZZLE DIA. 50MM

VELOCITY INLET = 200m/s

PRESSURE

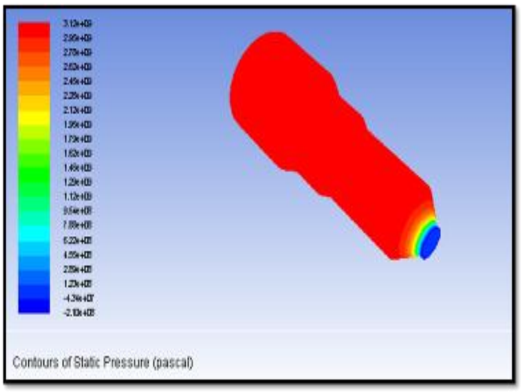


Fig-2.4: PRESSURE

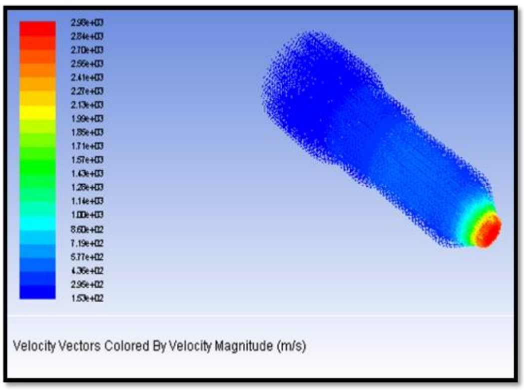


Fig-2.5: VELOCITY

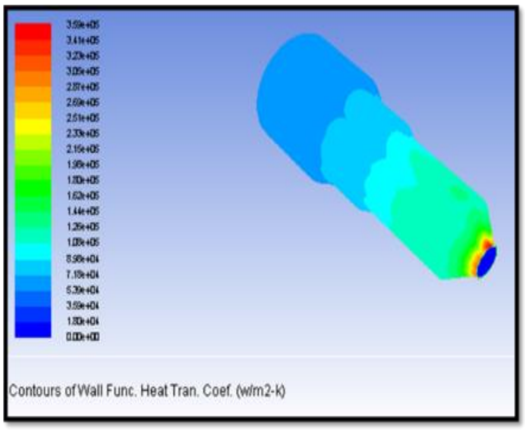


Fig-2.6: HEAT TRANSFER COEFFICIENT

2.3 VELOCITY INLET = 300m/s

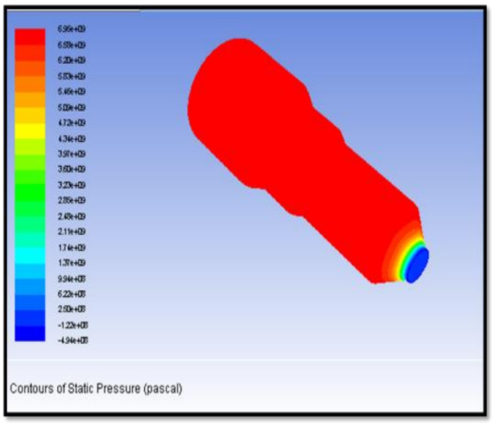


Fig-2.7: PRESSURE

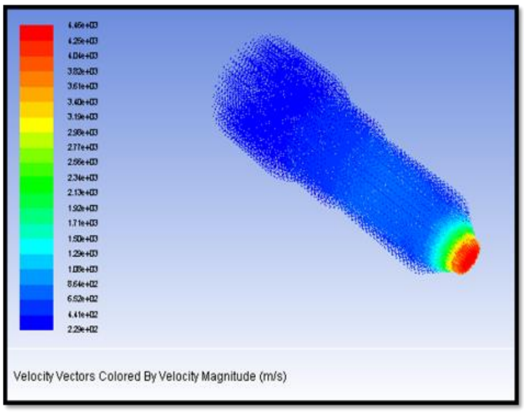


Fig-2.8: VELOCITY

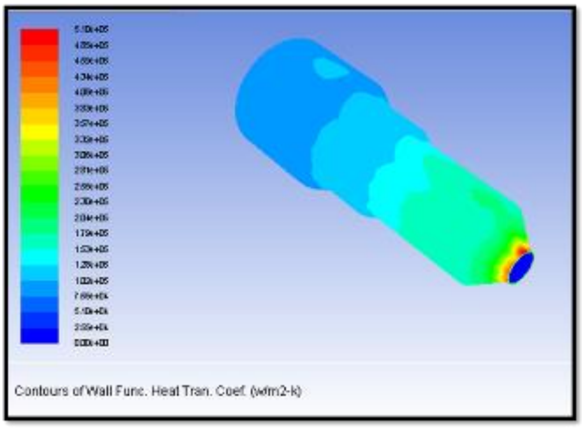
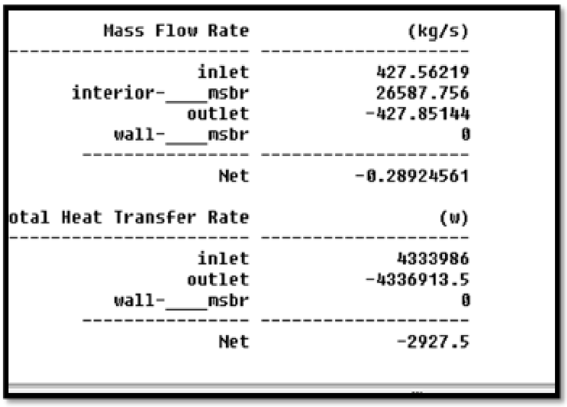


Fig-2.9: HEAT TRANSFER COEFFICIENT



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                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
```

Fig-2.10: MASS FLOW RATE & HEAT TRANSFER RATE

2.4 VELOCITY INLET = 400m/s

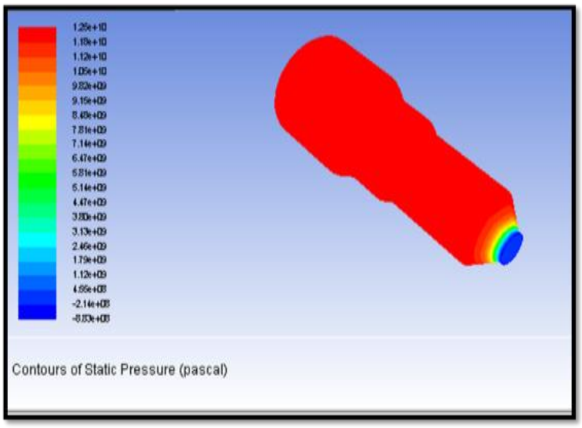

Fig-2.11: PRESSURE

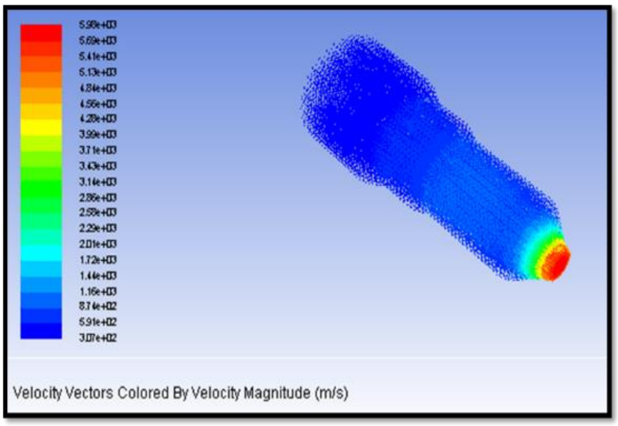

Fig-2.12: VELOCITY

3. RESULT TABLE

Nozzle dia.	Inlet velocity (M/s)	Pressure (Pa)	Velocity (M/s)	Heat transfer coefficient (w/m2-k)	Mass flow rate (KG/s)	Heat transfer (W)
50	200	3.12e+09	2.98e+03	3.59e+05	1.138945	11540.5
	300	6.96e+09	4.46e+03	5.10e+05	0.289245	2927.5
	400	1.25e+10	5.99e+03	6.56e+06	3.087343	31294
40	200	4.53e+09	3.58e+03	3.76e+05	1.0457764	10600
	300	1.03e+10	5.38e+03	5.30e+05	2.192199	22219
	400	1.83e+10	7.17e+03	6.80e+05	2.9847107	30249
30	200	1.04e+10	5.36e+03	6.90e+05	0.16120148	1634.3125
	300	2.34e+10	8.05e+03	8.05e+03	0.44642	4520.625
	400	4.18e+10	1.07e+04	1.25e+06	0.8333587	8450.75

3.1 Thermal analysis result table

Material	Temperature (K)		Heat flux (W/mm^2)
	Min	Max	
Brass	320.02	350	0.76451
Aluminum	323.59	350	0.87036

4. CONCLUSIONS

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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BIOGRAPHIES

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