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Comparative Analysis of a Super Charger and a Turbo Charger in an Engine by CFD Analysis

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ABSTRACT
In this thesis comparative analysis are done for an IC engine by using super charger and turbo charger with CFD analysis. The models of the super charger and turbo charger are done in Creo 2.0.CFD analysis is done by varying the mass flow rates for different speeds 70Km/hr, 80Km/hr & 90Km/hr. The outputs of the CFD analysis are pressure, velocity and mass flow rates. Static analysis is done on the models by applying the pressures from the CFD analysis using different materials Stainless Steel and Aluminum alloy. Analysis is done in Ansys.

INTRODUCTION
TURBOCHARGER
It a simple air pump that is designed to operate utilizing the usually wasted energy in engine exhaust gas. Turbine wheel (hot wheel) and shaft coupled to a compressor wheel (cold wheel) are driven by these exhaust gases. The compressor wheel when rotated provides large volume of air to the combustion chambers of engine. Precisely built, the turbocharger is usually a durable machine yet is simple. As any other working machinery it needs maintenance and in the main flow of clean lubricating oil and a positive head.

SUPERCHARGER
A process that helps increasing IC engines suction pressure above the atmospheric pressure is known as Supercharging. Increasing the air charge per cycle and allowing the larger amount of fuel burning which thus increases the engine power output is the main objective of supercharger.

LITERATURE SURVEY
In the paper by Prashant.N.Pakale, etal [1], a review on the techniques utilized in turbo charging and supercharging to increase the output of engine and reduce the exhaust emission levels is provided. In the paper by Mohammed irafanuddin, K. Durga Sushmitha [3], we'll explain what superchargers are, how they work and how they compare to turbochargers. A supercharger is any device that pressurizes the air intake to above atmospheric pressure.

Both superchargers and turbochargers do this. In fact, the term "turbocharger" is a shortened version of "turbo supercharger," its official name. Therefore, you get more power from each explosion in each cylinder. Here in this project we are designing the compressor wheel by using Pro-E and doing analysis by using FEA package. An attempt has been made to investigate the effect of pressure and induced stresses on the blade.

By identifying the true design feature, the extended service life and long term stability is assured. A structural analysis has been carried out to investigate the stresses, strains and displacements of the blade. An attempt is also made to suggest the best material for an blade of a turbocharger by comparing the results obtained for different materials. Based on the results best material is recommended for the blade of a turbocharger.

In the paper by Mohd Muqeem, etal [4], is to provide a review on the current techniques used in turbo charging to improve the engine efficiency and exhaust emissions as much as possible.

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3D MODELING AND ANALYSIS OF SUPERCHARGER AND TURBOCHARGER

The base paper referred for this journal is Prashant.N.Pakale, S.U.Patel, Performance analysis of IC engine using supercharger and turbocharger-a review, International Journal of Research in Engineering and Technology e ISSN: 2319-1163 | p ISSN: 2321-7308, specified as [1] in References chapter.

TURBO CHARGER

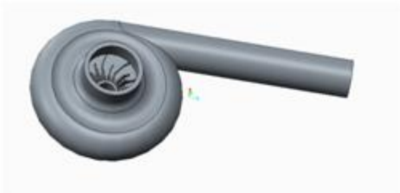

Fig – Final blade assembly

SUPERCHARGER

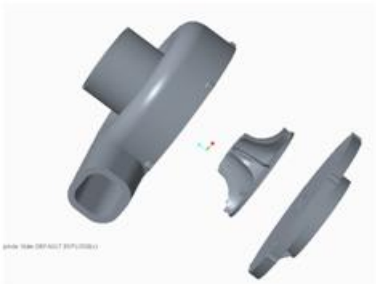

Fig – Exploded view of supercharger

SPEED - 70km/hr

CFD ANALYSIS OF TURBOCHARGER

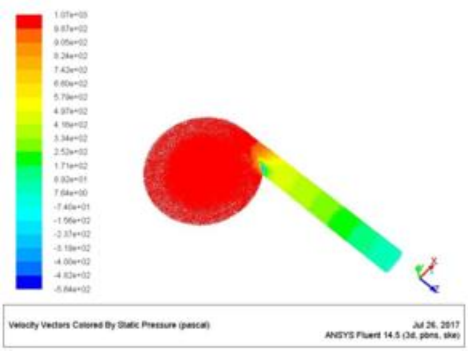

Fig. Pressure of Turbocharger at 70Km/hr

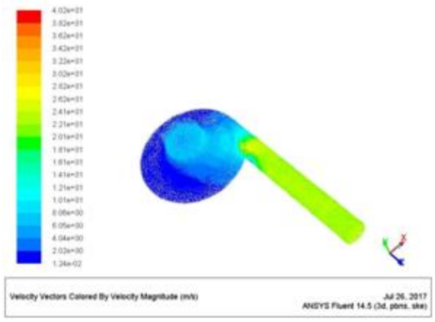

Fig. Velocity of Turbocharger at 70Km/hr

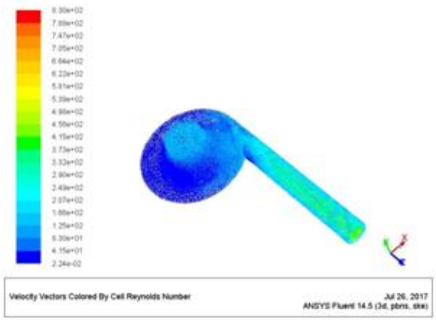

Fig – Reynolds Number of Turbocharger at 70Km/hr

Mass flow rate of Turbocharger at 70Km/hr

Mass Flow Rate	(kg/s)
Contact_region_2-src	2.0360785e-06
Contact_region_2-trg	-2.0369423e-06
inlet	0.019400001
Interior-19	2.0353755e-06
Interior-impeller	0.0017828076
Interior-inandout	0.035834908
Outlet	-0.019298291
----------------	--------------------
Net	0.00010170887

Total heat transfer rate of Turbocharger at 70Km/hr

Total Heat Transfer Rate	(w)
inlet	36.120777
outlet	-35.932869
wall-10	-0.00040311483
wall-10-shadow	0.00074158137
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Net	0.18824664

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CFD ANYALSIS OF SUPERCHARGER

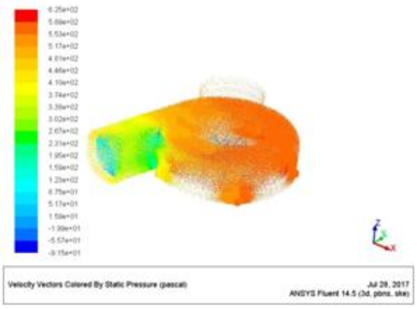


Fig – Pressure of Supercharger at 70Km/hr

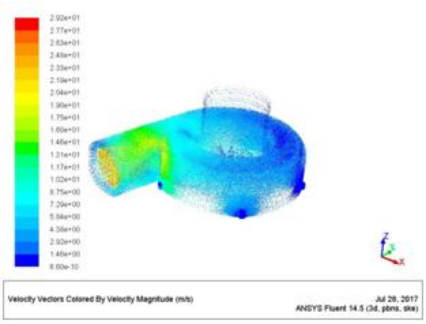


Fig – Velocity of Supercharger at 70Km/hr

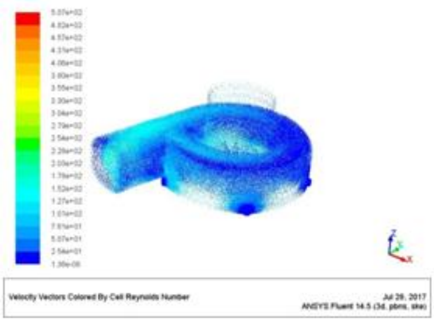


Fig – Reynolds Number of Supercharger at 70Km/hr

Mass Flow Rate of Supercharger at 70Km/hr

Mass Flow Rate (kg/s)

-------------------------------- --------------------

Inlet 0.019399997
interior-compressor blower -1.2184229e-11
Interior-supercharger -0.01570843
Outlet -0.019405957

---------------- --------------------

Net 5.9604645e-06

Total Heat Rate of Supercharger at 70Km/hr

Total Heat Transfer Rate (w)

-------------------------------- --------------------

Inlet 36.12077
Outlet -36.132267
Wall-11 0.00077761442
Wall-11-shadow -9.5975611e-06

---------------- --------------------

Net -0.010729481

RESULTS TABLE

Turbocharger

Speed (Km/hr)	Pressure (Pa)	Velocity (m/s)	Reynolds number	Mass flow rate (Kg/s)	Total heat transfer rate (W)
70	$1.07e^{03}$	$4.02e^{01}$	$8.30e^{02}$	0.0001017	0.018824
80	$1.31e^{03}$	$4.60e^{01}$	$9.46e^{02}$	0.0004734	0.07279
90	$1.53e^{03}$	$5.14e^{01}$	$1.03e^{03}$	0.0006660	1.1931

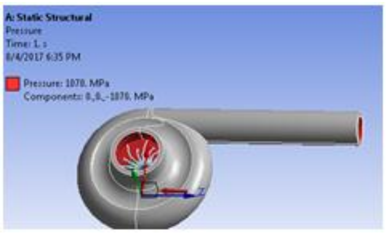
Supercharger

Speed (Km/hr)	Pressure (Pa)	Velocity (m/s)	Reynolds number	Mass flow rate (Kg/s)	Total heat transfer rate (W)
70	$6.25e^{02}$	$2.92e^{01}$	$5.70e^{02}$	0.00000596	0.0107
80	$7.89e^{02}$	$3.36e^{01}$	$3.74e^{02}$	0.00000613	0.11401
90	$1.4e^{03}$	$3.86e^{01}$	$3.89e^{02}$	0.00000321	0.0599

MATERIAL – STAINLESS STEEL

STATIC STRUCTURAL ANALYSIS OF TURBO CHARGER

Static analysis is performed on both the models by applying the pressuresfrom CFD analysis results. The model from the Creo software is imported to Ansys, meshed, applied forces and solved to determine deformations, stresses and strains.



Displacement is applied in the hole of casing

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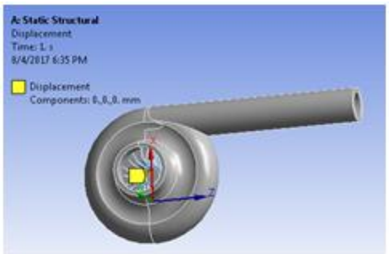
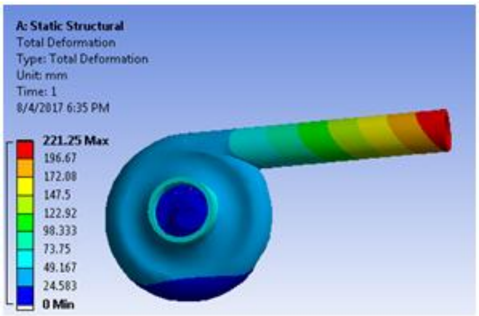
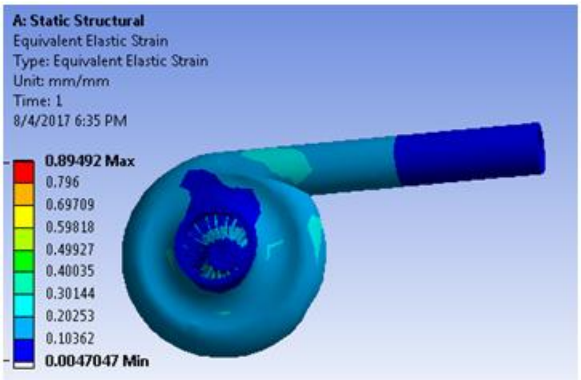
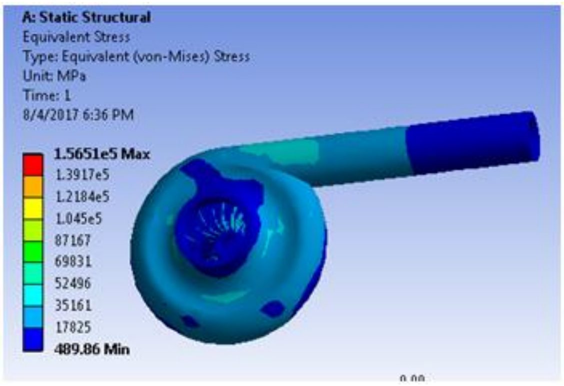




Deformation of Turbocharger at 70Km/hr using Stainless Steel

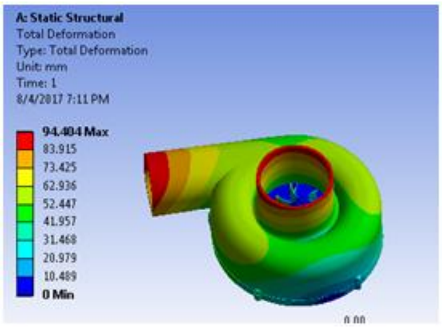


Strain of Turbocharger at 70Km/hr using Stainless Steel

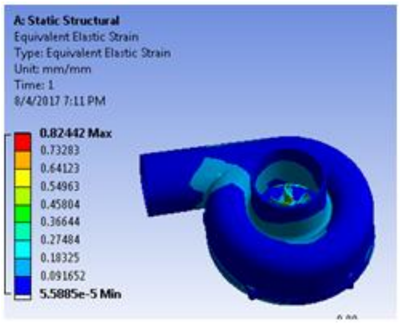


Stress of Turbocharger at 70Km/hr using Stainless Steel

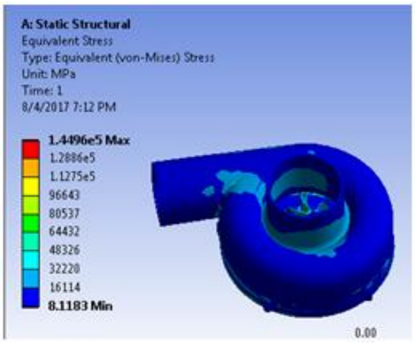
STATIC STRUCTURAL ANALYSIS OF SUPER CHARGER



Deformation of Supercharger at 70Km/hr using Stainless Steel



Strain of Supercharger at 70Km/hr using Stainless Steel



Stress of Supercharger at 70Km/hr using Stainless Steel

RESULTS TABLE

Turbo Charger

Stainless Steel

	70 km/hr	80km/hr	90 km/hr
Deformation (mm)	221.25	270.88	316.37
Strain	0.8949	1.0956	1.2796
Stress (MPa)	$1.5615e^5$	$1.916e^5$	$2.2379e^5$

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Aluminium alloy

	70 km/hr	80km/hr	90 km/hr
Deformation (mm)	603.9	739.36	863.57
Strain	2.4253	2.96	3.468
Stress (MPa)	$1.5609e^5$	$1.9109e^5$	$2.231e^5$

Super charger
Stainless steel

	70 km/hr	80km/hr	90 km/hr
Deformation (mm)	94.404	119.18	211.47
Strain	0.8242	1.0407	1.8467
Stress (MPa)	$1.4496e^5$	$1.83e^5$	$3.2471e^5$

Aluminium alloy

	70 km/hr	80km/hr	90 km/hr
Deformation (mm)	254.83	321.7	570.82
Strain	2.1985	2.7754	4.924
Stress (MPa)	$1.4373e^5$	$1.8144e^5$	$2.2195e^5$

CONCLUSION

By observing CFD results, the pressure, mass flow rate, velocity, heat transfer rate are more for Turbocharger when compared with that of Supercharger. The pressure is increasing by about 40%, velocity is increasing by about 27%, mass flow rate is increasing by about 90% and heat transfer rate is increasing by about 43%.The stresses are increasing for Turbocharger since their pressures are higher when compared with that of Supercharger. The stress values are increasing by 7% when Stainless Steel is used and by 8% when Aluminum alloy is used for Turbocharger. Using Aluminum alloy is better since the stresses are lesser than that of Stainless Steel and also less weight of components.

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