

Plastic Conversion & Thermo-Structural Analysis of Two Wheeler Carburetor Using Cad/Cae

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ABSTRACT

One of the most important component in Fuel feed system of Spark ignition engines is Carburettor. It is placed between the fuel filter and induction manifold. It provides sufficient air-fuel ratio of varying proportions to compliment engine operating conditions. Carburettor's function is based on two laws, they are Vacuum and Venturi Effect.

The main objective behind undertaking the project "Plastic conversion and Thermo-structural analysis of two wheeler carburettor using CAD/CAE" is to study and evaluate the performance of carburettor under different operating conditions. The system is related to the plastic conversion of carburettor using CAD/CAE and RPT Technologies and evaluate the performance of carburettor under different operating conditions. The component is designed in a 3D cad tool CREO, imported and analysed in ANSYS for determining the Temperature distribution, Stress distribution, Von misses Stress and Strain in ANSYS, the material used in this process is polyamide. ANSYS is a flexible and cost effective tool. ANSYS is used in industries in order to solve several mechanical problems. An attempt is made to suggest the best combination of plastic material, which yields a low temperature variation around the inlet manifold and minimum von misses stress possible.

Keywords: Carburettor, Plastic conversion, Stress distribution, Temperature Distribution

INTRODUCTION

SI engines commonly use volatile liquids. The composition level of fuel-air mixture is done outside the engine cylinder. The fuel droplets that remain in suspension also continue to evaporate and mix with air during suction and compression processes, which results in incomplete combustion and also reduces the efficiency of the vehicle. So there is a necessity of carburetion to provide a combustible mixture of fuel and air in required quality and quantity and increase the fuel efficiency.

Carburettor function is based on two laws, they are Vacuum and Venturi Effect. Vacuum is simply suction, or air pressure below that of local atmospheric conditions. When a piston drops on its intake stroke, the intake valve above it opens and the resulting suction from the cylinder causes a vacuum to be created in the intake tract. The throttle plate regulate how much of the vacuum created in the intake tract gets to which of the carburettor's fuel circuits. While idling the engines intake vacuum is clenched downstream of the throttle plate, segregate the main fuel system and giving the pilot circuit the full effect of intake vacuum, because its fuel delivery downstream of the throttle plate.

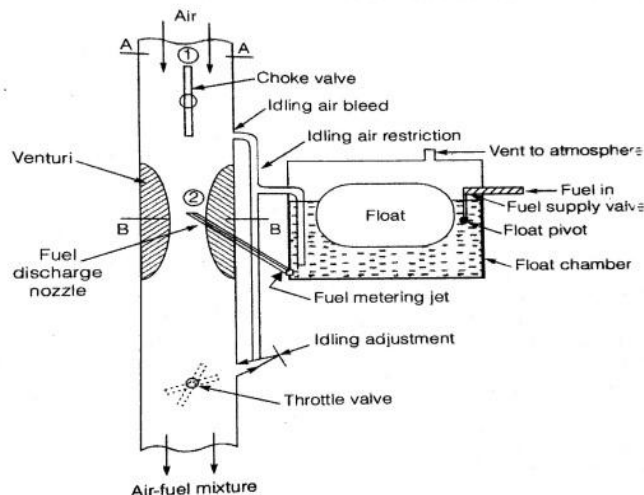


Fig. 1 Principle of Carburettor

The Venturi effect means that when a gas (air in this case) passes through a reduction in diameter of tube, the velocity of the gas increases and its pressure drops. The area of the carburettor throttle containing the slide is called venturi because it has tapered minimization in diameter and, with the restrained movement of the slide, it uses the venturi effect to create a controlled low pressure above the needle jet. Any pressure below ambient conditions acts as a vacuum, or source of suction. The rapid the air flow under the slide the greater the drop in pressure above the needle jet.

Factors influencing carburetion

1. The engine speed; the time available for preparation of mixture
2. Vaporization.
3. Incoming air Temperature.
4. The design of carburettor.

The literature survey reveals in recent times lot of work has been carried out in the area of developing, designing and analyzing the carburettor using CREO and ANSYS. The analysis of carburetor has been carried out by applying thermal and structural loads. The present work particularly deals with the making of carburettor by using Rapid Prototyping to increase mass production, to achieve cost reduction, to achieve weight reduction and to prevent the component from getting corroded or undergoing corrosion.

Rapid Prototyping Technology

RPT is essentially a technology that lets us transform digital designs into 3-dimensional solid objects for production of machine parts, prototypes, models, and moulds. It builds solid objects one layer at a time, producing premium models overnight instead of taking weeks. 3D printing, also known as Additive Manufacturing, is the most commonly used technique for rapid prototyping.

Designing of Carburettor

CREO tools are used friendly. Although the execution of any operation using the tool can create a highly complex model. In CREO we will be dealing only with the major front-end module used for part and assembly design and model creation, and production of engineering drawings. The design criteria are taken from an existing 100cc engine. In this study the component is developed using CREO. All data is associative and interchangeable between the CAD, CAE and CAM modules without conversion. A product and its entire bill of materials (BOM) can be modeled accurately with fully associative engineering drawings, and revision control information.

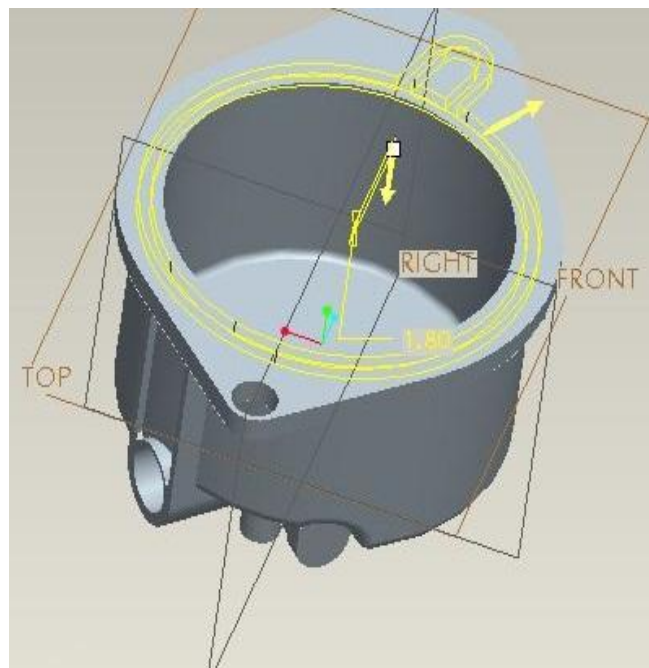


Fig. 2 Bowl of Carburettor

The associativity functionality in Creo Elements/Pro enables users to make changes in the design at any time during the product development process and automatically update downstream deliverables. This capability enables concurrent engineering design, analysis and manufacturing engineers working in parallel and streamlines product development processes.

The below figure shows the assembled view of the carburettor

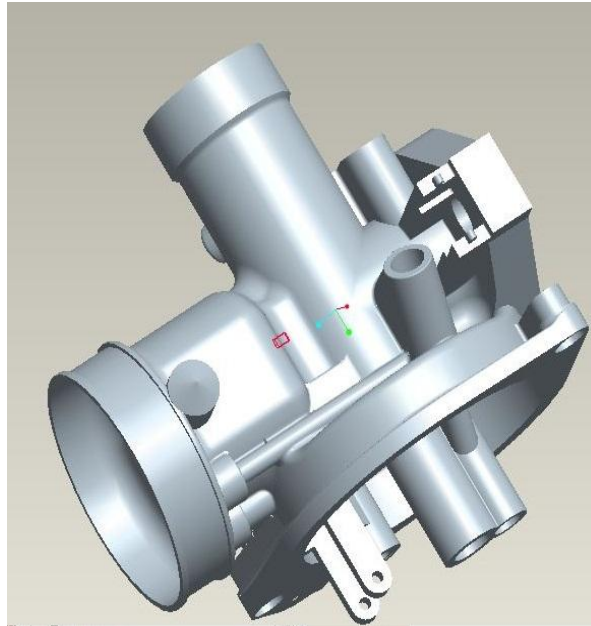


Fig. 3 Assembled view of Carburettor

ANALYSIS OF CARBURETTOR

ANSYS is an Engineering Simulation Software (computer aided Engineering). Its tools cover Thermal, Static, Dynamic, and Fatigue finite element analysis along with other tools all designed to help with the development of the product. The ANSYS Workbench platform is an environment that offers an methodical and intuitive user interface, superior CAD integration, automatic meshing, and access to design parameters as well as to the functionality available within the ANSYS. Mechanical products, Mechanical simulation with ANSYS Workbench builds upon the core ANSYS solver technology the industry has recognized and offers the following benefits for advanced analysis.

Structural Analysis:

Structural Analysis is the evaluation of material structure and their respective elements when a load/pressure is applied. It helps to optimize the product design and also reduce the cost of physical testing of the component.

Different types of structural analysis are:

- Static analysis
- Modal analysis
- Harmonic analysis
- Transient dynamic analysis
- Spectrum analysis
- Bucking analysis
- Explicit dynamic analysis

Static Analysis:

In this project, we use static analysis. A static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time varying loads. A static analysis can, however, include steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads (such as the static equivalent wind and seismic loads commonly defined in many building codes).

Static analysis is used to determine the displacements, stresses, strains, and forces in structural components caused by loads that do not induce significant inertia and damping effects. Steady loading and response are assumed to vary slowly with respect to time. A static analysis can be either linear or non-linear. All types of non-linearities can be accessed such as hyper elastic elements, large deformations, creep stress, plasticity, stiffening, contact (gap) elements and so on.

The different types of loading that come under static analysis are

- Externally applied forces and pressures
- Steady-state inertial forces (such as gravity or rotational velocity)
- Imposed (non-zero) displacements
- Temperatures (for thermal strain)
- Fluencies (for nuclear swelling)

Over-view of steps in a static analysis:

The procedure for a Static analysis consists of three main steps:

1. Build the model/ import the model.
2. Apply loads
3. Solve the problem.
4. Review the results

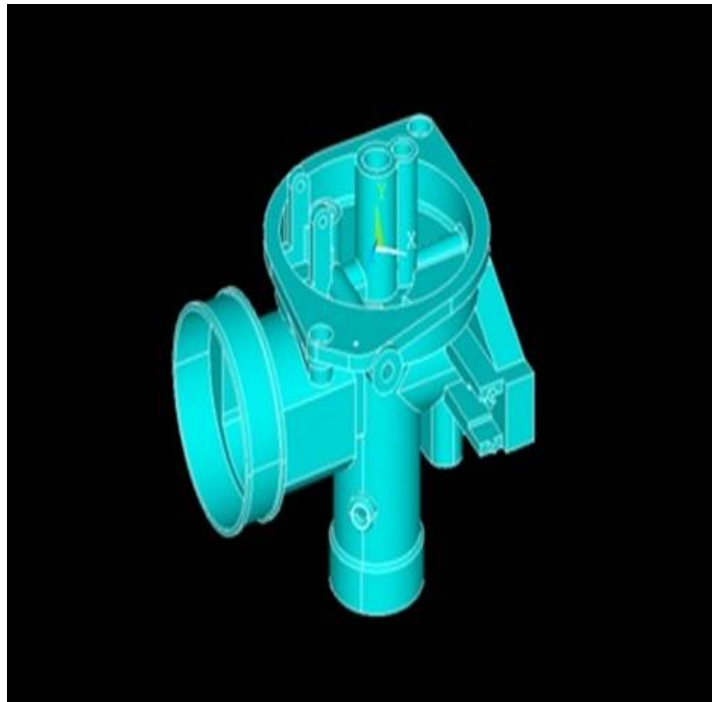


Fig. 4 Imported component

Here, the part designed in CAD (CREO)file is imported into CAE Software(ANSYS) in IGES (Initial Graphic Exchange System). Then the component is plotted.

Plastic Conversion

The Designed component is now assigned with material properties of polyamide. It has a young's modulus of 2400 Mpa and Poisson ratio of 0.37.

Polyamide plastic offers:

- High wear Resistance,
- High Thermal stability,
- Gives good strength and Hardness,
- Good sliding properties,
- Good chemical Resistance.

Polyamides are thermoplastics of very high performance in the stream of Engineering. It can withstand a temperature of range 180C to 240C.

Meshed shape of Carburetor in ANSYS:

The component is converted into a FEA model by meshing process in free meshing type. After meshing the component is divided in to nodes on to which thermal and structural stresses are applied. The type of Mesh used in this project is

free mesh, because of the complex design of the carburettor.



Fig. 5 Meshed component

When pressure and temperature is applied:

After completion of FEA model, the component is subjected to pressure and temperature distribution by selecting of areas around the venturi cross-sectional area of the carburettor. The values of temperature and pressure are applied on the nodes of the component created by the free mesh. Solution is obtained by Assigning loads (i.e poin or pressure) and constraints (i.e translational and rotational) and finally solve the resulting set of equations.

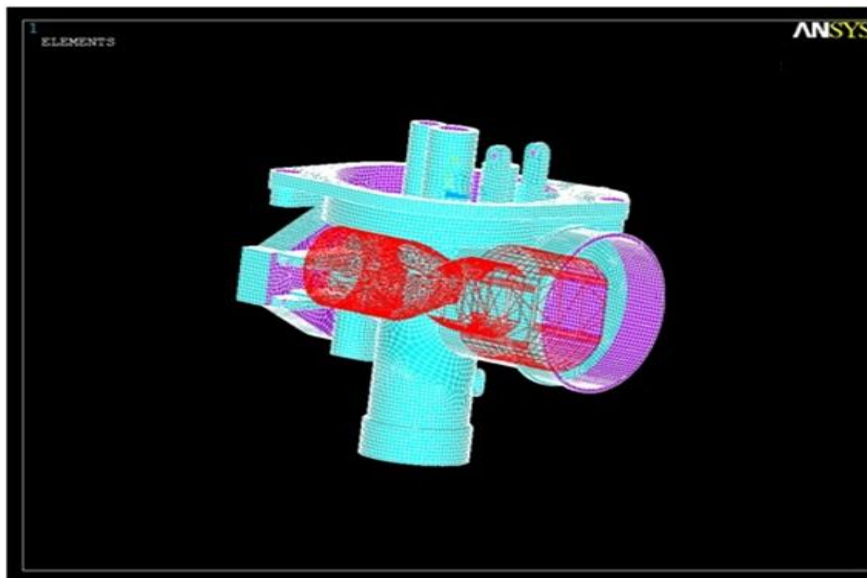


Fig.6: Loads Applied

The constraints, maximum stress concentration and pressure distribution at the nodes can be identified from the above figure. The nodal displacement results in maximum stress and strain.

RESULTS AND DISCUSSIONS

The tensile stress is applied on the venturi cross-sectional area, so the figure below shows the stress distribution in the

carburettor.

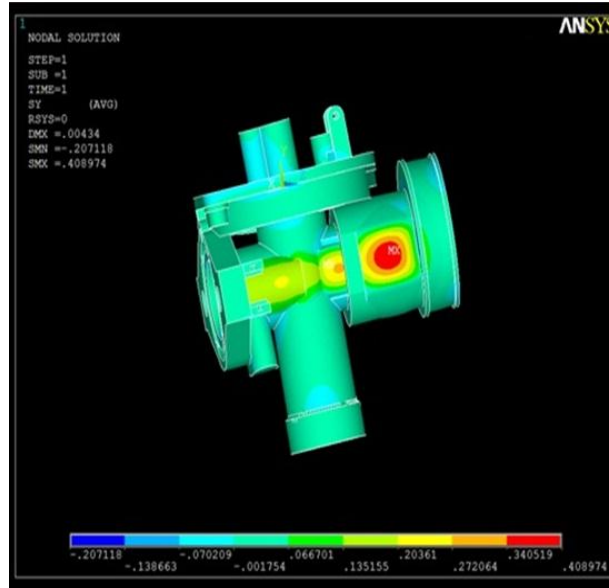


Fig. 7 Stress distribution

The Static analysis has performed on the carburettor by constraining top and bottom positions and applying 0.04 Bar Pressure.

Thermal analysis :

The Thermal analysis has performed on the carburettor by constraining top and bottom positions and applying 70°C Temperature.

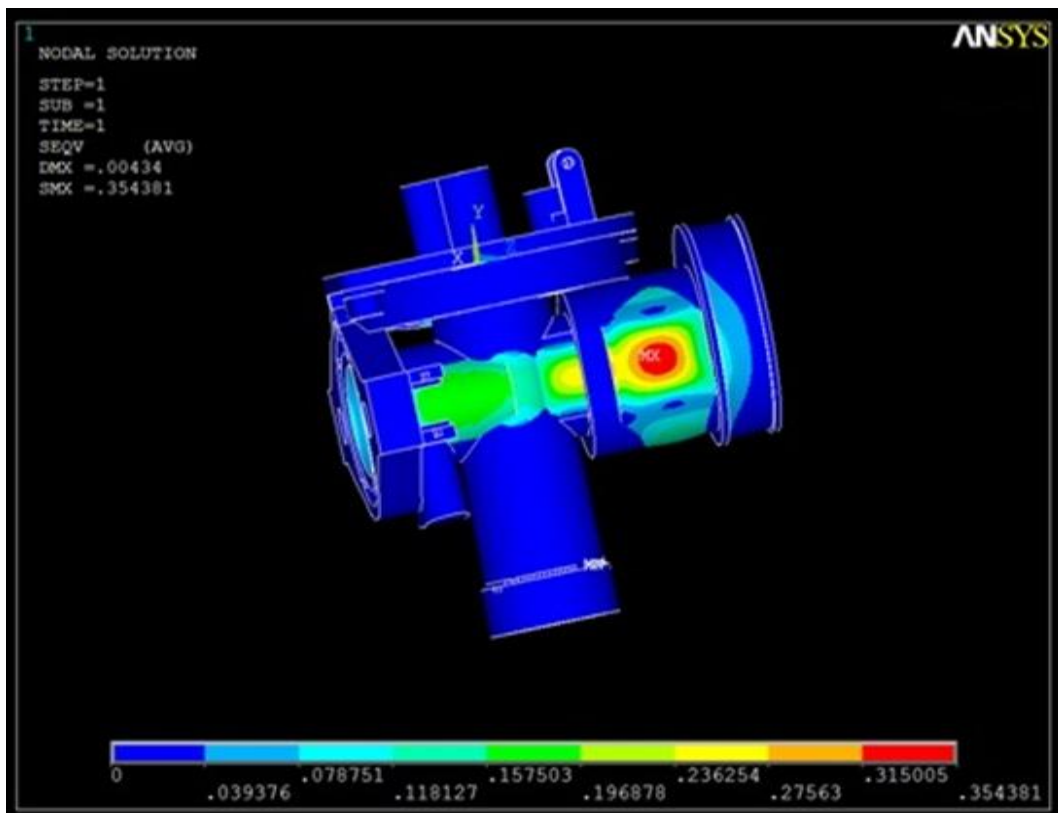


Fig. 8 Temperature distribution

The stress obtained from Thermal analysis is 0.4 N/mm² , which is in the limit of the carburettor material strength as 1.3 mpa. From this result, the carburettor modeled is safe to use. From this result, the carburettormodel can withstand

the thermal load and it is safe to use.

The following figure shows the carburetor using RPT (RAPID PROTOTYPING) process.



Fig. 9 RPT model

CONCLUSIONS

- The Carburettor model was successfully designed and analyzed .
- The design is done by 3D modeling tool called CREO software; analysis is done by using FEA software called ANSYS .
- The design was developed after the studying the design of the carburettor of 100cc Hero Honda splendor bike and analysis is performed by applying the pressure and temperature .

The values obtained from analysis are satisfied and are within the limits of the material strength.

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