DESIGN AND ANALYSIS OF COMBUSTION CHAMBER IN I.C ENGINE

[1] K.RAMASWAMY, [2] Dr. K VENKATA SUBBAIAH, [3] V TEJOVIKAS, [4] MEKALA SREEKANTH, [5] B.PRASHANTH KUMAR, [6] V RAMU,

[1] Assistant Professor, [2] Professor Dept. Of MECH, DRK INSTITUTE OF SCIENCE &TECHNOLOGY, BOWRAMPET,ON MIYAPUR, MEDCHAL HIGHWAY, JNTUH, NEAR PRAGATHI NAGAR, HYD-43,

[3, 4, 5, 6,] B Tech Students, Dept. Of MECH, DRK INSTITUTE OF SCIENCE &TECHNOLOGY, BOWRAMPET,ON MIYAPUR, MEDCHAL HIGHWAY, JNTUH, NEAR PRAGATHI NAGAR, HYD-43,

Abstract: *ICEs typically comprise reciprocating piston engines, rotary engines, gas turbines and jet turbines. The combustion process increases the internal energy of a gas, which translates into an increase in temperature, pressure, or volume depending on the configuration. In an enclosure, for example the cylinder of a reciprocating engine, the volume is controlled and the combustion creates an increase in pressure. In a continuous flow system, for example a jet engine combustor, the pressure is controlled and the combustion creates an increase in volume. This increase in pressure or volume can be used to do work, for example, to move a piston on a crankshaft or a turbine disc in a gas turbine. If the gas velocity changes, thrust is produced, such as in the nozzle of a rocket engine.*

I. INTRODUCTION

ICEs typically comprise reciprocating piston engines, rotary engines, gas turbines and jet turbines. The combustion process increases the internal energy of a gas, which translates into an increase in temperature, pressure, or volume depending on the configuration. In an enclosure, for example the cylinder of a reciprocating engine, the volume is controlled and the combustion creates an increase in pressure. In a continuous flow system, for example a jet engine combustor, the pressure is controlled and the combustion creates an increase in volume. This increase in pressure or volume can be used to do work, for example, to move a piston on a crankshaft or a turbine disc in a gas turbine. If the gas velocity changes, thrust is produced, such as in the nozzle of a rocket engine.

Petrol (gasoline) engine

ISSN: 2366-1313

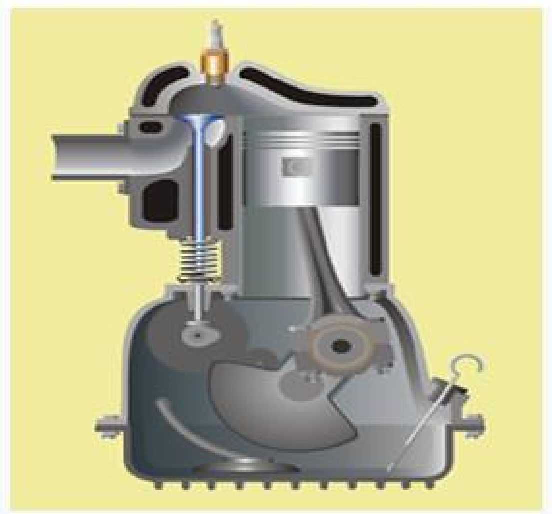

Fig 1.1 Side-Valve Engine Showing Combustion Chamber

At top dead centre the pistons of a petrol engine are flush (or nearly flush) with the top of the cylinder block. The combustion chamber may be a recess either in the cylinder head, or in the top of the piston. A design with the combustion chamber in the piston is called a Heron head, where the head is machined flat but the pistons are dished. The Heron head has proved even more thermodynamically efficient than the hemispherical head. Intake valves permit the inflow of a fuel air mix; and exhaust valves allow burnt gases to be scavenged.

Head types

Various shapes of combustion chamber have been used, such as: L-head (or flathead) for side-valve engines; "bathtub", "hemispherical", and "wedge" for overhead valve engines; and "pent-roof" for engines having 3, 4 or 5 valves per cylinder. The shape of the chamber has a marked effect on power output, efficiency and emissions; the designer's objectives are to burn all of the mixture as completely as possible while avoiding excessive temperatures (which create NOx). This is best achieved with a compact rather than elongated chamber.

Swirl & Squish

The intake valve/port is usually placed to give the mixture a pronounced "swirl" (the term is preferable "turbulence", which implies movement without overall pattern) above the rising piston, improving mixing and combustion. The shape of the piston top also affects the amount of swirl. Another design feature to promote turbulence for good fuel/air mixing is "squish", where the fuel/air mix is "squished" at high pressure by the rising piston. Where swirl is particularly important, combustion chambers in the piston may be favoured.

Flame front

Ignition typically occurs around 15 degrees before top dead centre. The spark plug must be sited so that the flame front can progress throughout the combustion chamber. Good design should avoid narrow crevices where stagnant "end gas" can become trapped, as this gas may detonate violently after the main charge, adding little useful work and potentially damaging the engine.

DIESEL ENGINE

Fig 1.2 Dished Piston for Diesel Engine

Diesel engines fall into two broad classes:

- Direct injection, where the combustion chamber consists of a dished piston
- Indirect injection, where the combustion chamber is in the cylinder head

Direct injection engines usually give better fuel economy but indirect injection engines can use a lower grade of fuel.

Harry Ricardo was prominent in developing combustion chambers for diesel engines, the best known being the Ricardo Comet.

Gas turbine

Main article: Combustor

The combustor is fed with high pressure air by the compression system, adds fuel and burns the mix and feeds the hot, high-pressure exhaust into the turbine components of the engine or out the exhaust nozzle.

II LITERATURE SURVEY

P GURUSAMY, et al [1] investigated experimentally on internal combustion engine, designed the inlet manifold through CFD. Analyzed the flow behavior through inlet manifold. Recommended to make modifications in the flow behavior to enhance heat transfer. Created a tumble flow for efficient combustion at maximum engine speed.

Tomas Zadravec, et al [2] used coupled modeling approach in designing the air staged combustion chamber in boiler. CFD simulation is used for validation for modification of energy grate fired boilers to determine the parameters which is processed for fuel conversion model boilers. Concluded the gas temperature inside combustion chamber has accurate forecast by relying on measurements.

Comb Arka Ghosh [3] worked on the requirements of combustion chamber in designing for complete combustion. Given essentials on effects of combustion chamber design with innovate technologies in engine. If fuel varies meant for combustion of fuel only to generate power.

Nagasundaram.S and Nester Ruban.J [4] investigated on emissions and efficiency of CI engine to reduce Knox emissions with the ICRAEM influence of air swirl combustion process. By using CFD on diesel engine which is 4-stroke unique configuration on pistons. Calculated the performance parameters like turbulent kinetic energy and heat dissipation.

Sourabh N Mahendrakar and Chandan KR[5] worked on hybrid engine by compressed air with gasoline. Modified 4 stroke IC engine to 6 strokes, accomplishing this task by UG-NX, Ansys and CFD. First 4 strokes incorporated by combustion process, remaining by compressed air. Revealed that overall efficiency of 60-70% and thermal efficiency of 35-40% has improved by hybridization.

Abdul Siddique, et al [6] presented the geometry of combustion chamber which deals with efficiencies engine, investigated on mini petered IC engine for agriculture purpose. Compared the results online petered diesel engine with baseline records. Concluded that turbulent impact is more than baseline geometry.

Gloria Boafo, et al [7] improved the performance of combustion chamber made with materials like aluminum, ceramic, and mild steel in cook stove. Improved parameters like specific fuel consumption, efficiency individually with three different material combustion chambers. Concluded ceramic made stove is the preferred material and worked on thermal mass reduced by air fuel ratio by providing insulation

P Abhilash, et al [8] done the experimental investigation on solar driven water pump and studied the power- voltage characteristics of solar panel. Increased the efficiency of pump with silicon material panel according to power demand.

P. Abhilash and R Nandakumar [9] numerical investigation on carburetor diameter in variation of size. Done the CFD analysis on flow of fluid for flow behavior and thermal analysis on different materials.

P. Abhilash, et al [10] selected hair pin heat exchanger model for thermal analysis on aluminum and titanium carbide nano fluids. Thermal analysis on silver and copper materials. Provided better heat transfer coefficient values on suitable fabricated material with titanium nano fluid as flowing fluid.

N Rajashekar Reddy, etal [11] experimental investigation on

ISSN: 2366-1313

enhancement of heat transfer in radiator with aluminum nano fluid. Enhanced 13% of heat transfer with nano fluid compared to water as coolants in radiator. Analyzed the size of nano particle with help of X ray diffraction method.

P Abhilash, et al [12] designed the radiator with fixed and helical channels with different types of fluids, done the CFD analysis of each fluid individually in Straight tube and helical tube and properties and fluids are taken as an input for analysis for improvement of better heat transfer rate.

III METHODOLOGY

Materials Used: Materials used are steel and cast iron for thermal analysis with different fluids to enhance the heat transfer coefficient at suitable flowing fluid

In all of these approaches the same basic procedure is followed.

During pre-processing

- The geometry (physical bounds) of the problem is defined.
- The volume occupied by the fluid is divided into discrete cells (the mesh). The mesh may be uniform or non-uniform.
- The physical modelling is defined – for example, the equations of motion + enthalpy + radiation + species conservation
- Boundary conditions are defined. This involves specifying the fluid behaviour and properties at the boundaries of the problem. For transient problems, the initial conditions are also defined.

The simulation is started and the equations are solved iteratively as a steady-state or transient.

Finally, a postprocessor is used for the analysis and visualization of the resulting solution.

IV DESIGN PROCEDURE

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing

ISSN: 2366-1313

operations. The term **CADD** (for Computer Aided Design and Drafting) is also used.

Its use in designing electronic systems is known as electronic design automation, or **EDA**. In mechanical design it is known as mechanical design automation (**MDA**) or **computer-aided drafting** (**CAD**), which includes the process of creating a technical drawing with the use of computer software.

CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space.

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals, often called DCC digital content creation. The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry.

4.2 Part Design: The most essential workbench needed for solid modelling. This CATIA module makes it possible to design precise 3D mechanical parts with an intuitive and flexible user interface, from sketching in an assembly context to iterative detailed design.

4.3 Generative Shape Design: allows you to quickly model both simple and complex shapes using wireframe and surface features. It provides a large set of tools for creating and editing shape designs. Though not essential, knowledge of Part Design will be very handy in better utilization of this module.

4.4 Assembly: The basics of product structure, constraints, and moving

ISSN: 2366-1313

assemblies and parts can be learned quickly. This is the workbench that allows connecting all the parts to form a machine or a component.

Kinematic Simulation: Kinematics involves an assembly of parts that are connected together by a series of joints, referred to as a mechanism. These joints define how an assembly can perform motion. It addresses the design review environment of digital mock-ups. This workbench shows how a machine will move in the real world. These are only four of the many workbenches that CATIA offers. A few of the other modules include Machining, Equipment & System, Infrastructure and Ergonomics Design & Analysis. And of course, there are many other CATIA workbenches, each important in its own way.

4.5 ADVANTAGES OF CATIA PARAMETRIC SOFTWARE

1. Optimized for model-based enterprises
2. Increased engineer productivity
3. Better enabled concept design
4. Increased engineering capabilities
5. Increased manufacturing capabilities
6. Better simulation
7. Design capabilities for additive manufacturing

4.6 CATIAPARAMETRIC MODULES:

- Sketcher
- Part modelling
- Assembly
- Drafting

3D MODEL

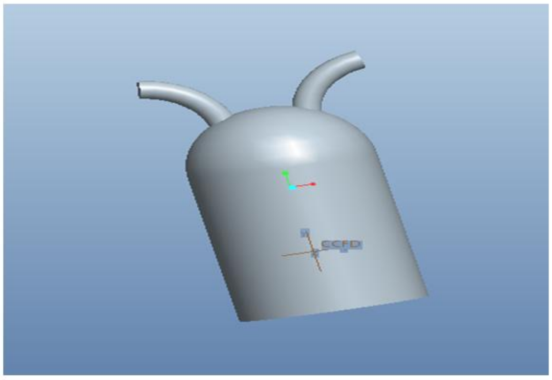

Fig 4.1 3D Model of Combustion Chamber

V ANALYSIS PROCEDURE

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 of elasticity can be used to calculate analytically the stresses

ISSN: 2366-1313

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) behaviour 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.

INTRODUCTION TO ANSYS

Structural Analysis

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

ANSYS Mechanical

ANSYS Mechanical is a finite element analysis tool for structural analysis, including linear, nonlinear and dynamic studies. This computer simulation product provides finite elements to model behavior, and supports material models and equation solvers for a wide range of mechanical design problems. ANSYS Mechanical also includes thermal analysis and coupled-physics capabilities involving acoustics, piezoelectric, thermal–structural and thermo-electric analysis.

ISSN: 2366-1313

Materials used

Steel

Young's modulus = 205000mpa

Poisson's ratio = 0.3

Density = 7850kg/mm³Cast iron

Young's modulus = 110000 mpa

Poisson's ratio = 0.28

Density = 7200

THERMAL ANALYSIS OF COMBUSTION CHAMBER MATERIAL-STEEL

Open work bench 14.5>select **steady state thermal** in analysis systems>select geometry>right click on the geometry>import geometry>select **IGES** file>open

IMPORTED MODEL

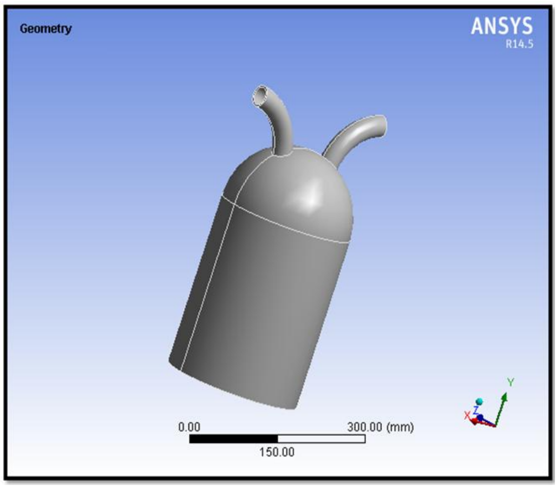

Fig5.1 Imported Model

MESHED MODEL

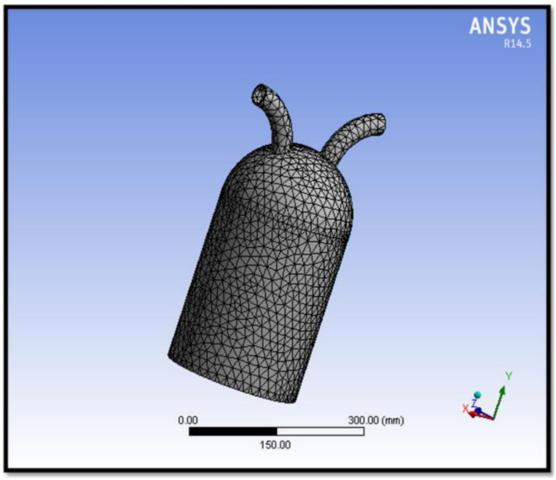

Fig 5.2 Meshed Model

Finite element analysis or FEA representing a real project as a "mesh" a series of small, regularly shaped tetrahedron connected elements, as shown in the above fig. And then setting up and solving huge arrays of simultaneous equations. The finer the mesh, the more accurate the results but more computing power is required.

VI RESULT TABLE

THERMAL ANALYSIS

MATERIAL	TEMPERATURE(k)		HEAT FLUX(W/mm²)
	MIN	MAX	
STEEL	421.07	500	1.5307
CAST IRON	`410.52	500	1.4979

- ❖ In this thesis, the combustion chamber is designed according to the IC engine specifications and analysed for its heat transfer rate using Finite Element analysis software ANSYS. Modelling will be done in CATIA parametric software.

ISSN: 2366-1313

- Thermal analysis is to determine the heat transfer rate per unit area i.e., heat flux and temperature distribution for two materials steel and cast iron.

VII CONCLUSION

The combustion process increases the internal energy of a gas, which translates into an increase in temperature, pressure, or volume depending on the configuration. In an enclosure, for example the cylinder of a reciprocating engine, the volume is controlled and the combustion creates an increase in pressure. In a continuous flow system, for example a jet engine combustor, the pressure is controlled and the combustion creates an increase in volume. This increase in pressure or volume can be used to do work, for example, to move a piston on a crankshaft or a turbine disc in a gas turbine. If the gas velocity changes, thrust is produced, such as in the nozzle of a rocket engine

By observing thermal analysis is heat flux is more for steel so we conclude that steel is better compare to the cast iron

REFERENCES

[1]. modelling of combustion systems: practical approach by Joseph coniine.

[2]. Combustion chambers for jet propulsion engines by v. S.

[3] Guruswamy, Thirupathiraja S, Rajs H K and Kumar J L 2020 Experimental investigation and CFD analysis of inlet manifold in internal combustion engine.

[4] Zadravec T, Bostjan, Kokalj F and Niko Samec, CFD modelling of air staged combustion in a wood pellet boiler using coupled modelling approach Materials

[5] Arka Ghosh, Combustion Chambers in CI Engines: A Review, digitalxplore.org3 (8) 196-198.

[6] Nagasundaram.S and Nester R Design and Analysis of an Internal Combustion Engine Piston Head to Increase the Torque on Crankshaft, International Journal of Innovative Research in Science, Engineering and Technology 20165, Issue 5.

[7] Sourabh N Mahendrakar and Chandan K R, Design and Analysis of Internal Combustion Compressed Air Hybrid Engine (Inco), International Journal of Research in Engineering and Technology 2015.4 Issue 12.

[8] Saddique A, Azeez Shaik and Mohammed Raffi (2016). Simulation and CFD Analysis of Various Combustion Chamber Geometry of C.I Engine Using CFX. International Refereed Journal of Engineering and Science.

[9] Gloria BM, Kwadwo M and Darkwa G L, Effect of combustion chamber material on the performance of an improved biomass cook stove.

[10] Abhilash P, Nanda Kumar and Praveen Kumar R, Solar powered water pump with single axis tracking system for irrigation purpose, Materials Today: Proceedings, 2020.

[9] Abhilash P and Nanda Kumar R, Performance analysis of two stroke petrol engine on basis of variation in carburettor main jet diameter, Materials.

[11] Abhilash P, Raghupati U and Nanda Kumar R. Design and CFD Analysis of Hair pin Heat Exchanger Using Aluminium and Titanium Carbide Nano fluids, Materials Today: Proceedings, 2020.

[12] Rajasekar, Abhilash P and Rahul M. Enhancement of Heat Transfer in Radiator Using Copper Oxide Nano Fluids, Materials Today: Proceedings, 2020.

[13] Prasadu Peddi (2017) "Design of Simulators for Job Group Resource Allocation Scheduling in Grid and Cloud Computing Environments", ISSN: 2319-8753 volume 6 issue 8 pp: 17805-17811.

[14] Prasadu Peddi (2016), Comparative study on cloud optimized resource and prediction using machine learning algorithm, ISSN: 2455-6300, volume 1, issue 3, pp: 88-94.

[15] Prasadu Peddi (2021), "Deeper Image Segmentation using Lloyd's Algorithm", ZKGINTERNATIONAL, vol 5, issue 2, pp: 1-7.