Modelling of Internal Combustion Engine using GT Power

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Abstract - **The modelling of single cylinder four stroke diesel engine is done by one dimensional designing software. To design the engine model for further research, we used the commercial software of GT-SUITE v. 6.2. In this research work, one dimensional model of single cylinder four stroke direct injection diesel engine was developed for I. C. Engine laboratory of BRACT's VIT, Pune so that a model would be available for the students for performance analysis during the laboratory period. This model will facilitate students to carry out various performance analysis such as valve lift profile optimization, thermal analysis of cylinder, engine noise analysis at intake and exhaust, etc. The model design covers the full engine cycle consisting of intake, compression, power and exhaust.**

I. INTRODUCTION

GT-SUITE is a tool used by engine makers and suppliers which includes the GT-POWER Engine Library and is the leading engine and vehicle simulation software. It solves a wide range of issues related to vehicle and engine performance. The engine performance and acoustics library is designed for steady-state simulations. It is used for practically all types of Internal Combustion Engines and the user is available with many components within the software where he can simulate the whole engine model. The solution is based on one-dimensional fluid dynamics which represents the flow and heat transfer in the piping and other flow components of an engine system. Also the code has many other specialized models required for system analysis. GT-SUITE features an object-based code design that provides a powerful model building facility and reduces user effort. Models are built in and by highly versatile graphical user interface which is known as GT-ISE (Integrated Simulation Environment).

II. LITERATURE SURVEY

Payri et al (1990) discussed the processes of P-V diagram and T-S diagram of a diesel engine in detail. The experimental tests were conducted in a single cylinder, indirect injection Ricardo E6-MS/128/76 type diesel engine with variable loads and different engine speeds of 1000 rpm to 2200 rpm. The maximum work or power and the corresponding efficiency bounds are derived. Chen (1996) derived the relations between net power output and the efficiency of the Diesel and Otto cycles with considerations of heat transfer through a cylinder wall. Akash (2001) studied the thermodynamic analysis of an air standard diesel cycle and the effect of heat transfer.

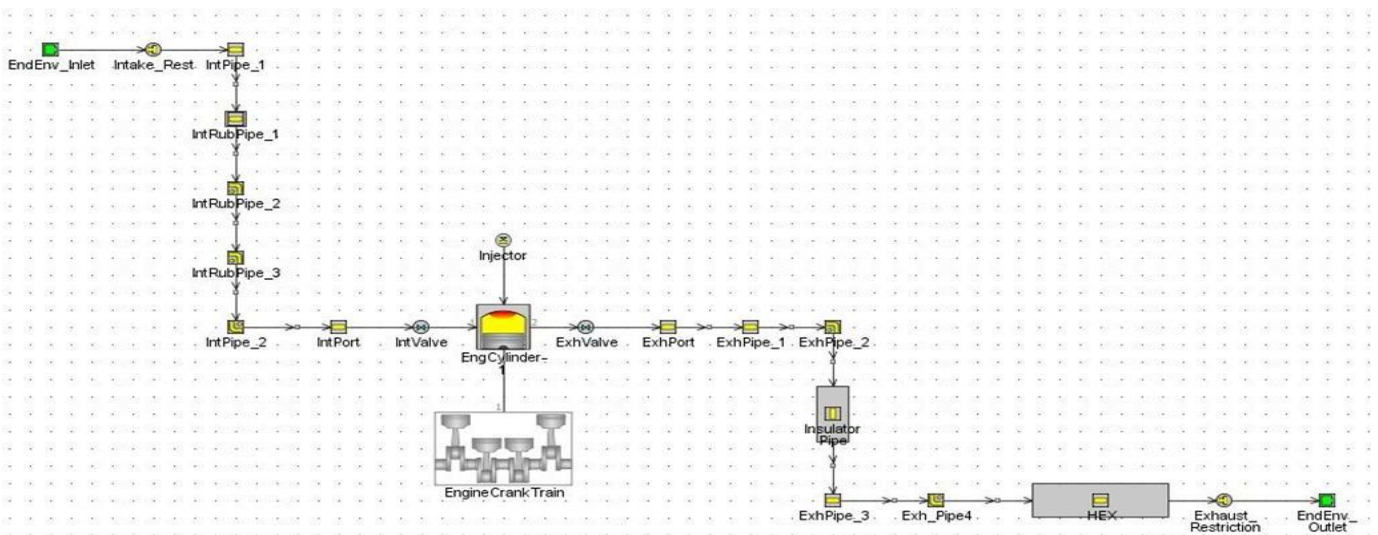## III. DESIGN APPROACH AND COMPONENTS USED

Fig. 1 Engine Flow-Path Model (GT Power, Integrated Simulation Technology, Pune)

Fig. 2 Setup of I. C. Engine under modelling (I. C. Engine laboratory, BRACT's Vishwakarma Institute of Technology, Pune)

We used GT Power under guidance of Integrated Simulation Technology, Pune and built up a 1-D model of flow-path of I.C Engine which is present in the Internal Combustion Engine Lab of Vishwakarma Institute of Technology, Pune [Refer Fig. 2]. We tried to model the engine flow-path by taking the dimensions of each and every component participated in the flow-path. Components included cast iron pipes, intake and exhaust port and valves, exhaust pipe, calorimeter and plastic pipe joining the test rig and intake of engine. Fig. 1 depicts the engine flow-path model in GT Power. The Components used in Fig. 1 are explained as follows,

1. EndEnv_Inlet: This component depicts the surrounding environment of engine and takes into account the temperature, pressure and air flow of the environment.
2. Intake_Rest: It takes into account of air flow and pressure into intake pipe.
3. IntPipe_1: It depicts the cast iron pipe at inlet of engine. Every component depicting the pipe takes the input of Inner and outer diameter of pipe, length of pipe and material of pipe.
4. IntRubPipe_1: It depicts the straight rubber pipe at inlet after the cast iron pipe. The whole rubber pipe is divided into three parts viz. IntRubPipe_1, IntRubPipe_2 and IntRubPipe_3 due to change in curvature of pipe. IntRubPipe_2 and IntRubPipe_3 depicts the curvature of pipe.
5. IntPipe_2: It is the cast iron pipe connecting the inlet port of engine and the rubber pipe.
6. IntPort and ExhPort: The former depicts the inlet port and the latter depicts the exhaust port. Inputs to these components are type of port and inlet and outlet diameters of ports. The remaining data is already present in the software by default.

7. IntValve and ExhValve: It depicts the Inlet and Exhaust valve of engine and takes into account the type of valve.
8. EngCylinder: It depicts the engine cylinder. Inputs given to these components include number of cylinders, number of strokes, average temperature of cylinder head, diameter of cylinders, material of cylinder and piston, diameter of piston, power of engine and efficiency of engine.
9. Injector: It depicts the injector of engine. It takes into account the lift diagram of pistons of the fuel pump and rpm of fuel pump.
10. ExhPipe_1 and ExhPipe_2: They depict the whole exhaust pipe whereas the two components represents the straight pipe and the bend in pipe respectively. Inner and outer diameter, length of pipe and material of pipe are the inputs of these components.
11. Insulator Pipe: It depicts the insulation on the exhaust pipe to prevent the heat losses. It takes into account the thickness of insulation and the material of insulation.
12. ExhPipe_3 and ExhPipe_4: The former is the straight pipe and the latter is the bend to the same pipe. It connects the insulated pipe with the exhaust gas calorimeter. Inputs to these components are similar to that of ExhPipe_1 and ExhPipe_2.
13. HEX: It represents the exhaust gas calorimeter used to carry out Brake Power and efficiency of the engine.
14. Exhaust Restriction: It has similar inputs and role to that of Intake_Rest.
15. EndEnv_Outlet: It is the similar component to that of EndEnv_Inlet.
16. Engine Crank Train: This component has input of firing order of engine.

We assembled these components in GT software according to our actual test rig of I. C. Engine and given the required inputs by taking actual dimensions while disassembling the engine assembly whichever was possible and rest of the dimensions such as inlet port diameter were available with our professors and laboratory assistants.

IV. CONCLUDING REMARKS

1. We had studied various components of single cylinder 4 stroke diesel engine.
2. We studied how to model these components in GT Power software and how to input the required dimensions to these components.
3. We also studied what is 1-D designing technology and its advantages.

using the GT Power Simulation Software and thanks to my colleagues and laboratory assistants for making this modelling work a great accomplishment for our college laboratory".

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