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Simulation Of Ic Engines Actuated By An Air System

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ABSTRACT

In this paper a developed method will be designed for compressing air within internal combustion engine. Also, how this method can be able to save the fuel, horsepower, safety by utilizing simple applications, in which that can be create the developed method for the internal combustion engine, in order to obtain the required power that specified requirements from efficiency and speed. The model will be implemented by using the Matlab software and the obtainable result will be examined from simulation of the developed method. The air that enters the engine must be filtered to attain a high concentration of oxygen, thus creating an enormously high specific power output.

Key-words: -Internal Combustion Engine, Actuated Air, Fuel, Horsepower, Simulation, horsepower.

I. INTRODUCTION

Transportation performs a significant role in the world's economic development and affluence. The engines and the fuels imitate more a century of modernization and technological improvement. The efficiency of the fuels which are operated and distributed to examine station pumps is remarkable. Fuel composition has developed to optimally equilibrium the ecological, performance, and price deliberations. Particularly, when the phase-out of lead anti-knock preservatives and diminutions in sulfur are combined with engine and after-treatment hardware advances, will result important outcomes. The composition of diesel and gasoline replicates a complicated optimization of refinery operations in order to maximize overall efficiency. [1,2].

Recently, engines have recognized important enhancements in efficiency, consistency, emissions, and stability. Hardware improvements have created important donations to the improvement of compacted and powerful engines. There are several hardware improvements such as turbo-charging, complicated fuel injection apparatus and composite engine control approaches. Throughout the past thirty years, after-treatment apparatuses have performed an important role in considerably decreasing automobile emissions.

The internal combustion engine has been continuously developed during the last century. However, until recently there was very little change in the fundamental subsystems such as those used for fuel delivery and air handling. The use of fuel injectors in place of the carburetor enabled better control of fuel delivery to the engine which helped optimize the engine operation for different load and speed conditions and led to significant improvements in the efficiency and reduction in the emissions of the engine. One of the main parameters that can play an important role in redesigning the internal combustion engines is the air-fuel ratio. Many papers and researchers discussed such issues, Pradeep G. et al. 2009, presented the modeling and control design of a new fully flexible engine valve actuation system which is an enabler for camless engines. Unlike existing electromechanical or servo actuated electro-hydraulic valve actuation systems, precise valve motion control is achieved with a hydro mechanical internal feedback mechanism. This feedback mechanism can be turned on or off in real-time using simple two state valves which helps reduce the system cost and enables mass production. Since the external control only activates or deactivates the internal feedback mechanism, the trajectory of the entire closed-loop system is purely dependent on the design parameters of the internal feedback system. A mathematical model of the system is developed to evaluate the effect of each of the design parameters, [14]. Youssef K. et al. 2012, developed a Continuously Variable Valve Lift [CVVL] mechanism to improve spark ignition engine part throttle fuel economy through the minimization of pumping losses and reduction of cam drive torque. The latest CVVL design is focused on meeting valve lift duration targets derived from combustion analysis at key speed and load points, reducing packaging envelope, and reducing part count for low cost, [13].

II. Methods and material

For fuel accumulating and destructive emission decreasing of an internal combustion engine, a precise managing of the in-cylinder air/fuel ratio stage is necessary. The amount of the fuel injection is simple to control with automatically controlled fuel injection system, but how to precisely decide the fresh accusation mass trapped in –cylinder at the final of the gas replace procedure. For passing process form of an automobile, the entering air pressure as well as engine velocity are instantly altering. There is no bodily airflow meter subsists that satisfy the measurement precision as well as response time. For computing the pressure oscillation close to the intake and exhaust ports as well as gathering the computing pressure signals, two dynamic pressure transducers will be used. In the internal combustion engine, the air with more oxygen concentration has more efficiency. Since, highly concentrated oxygen in the air helps to burn the fuel in more efficient way.

III. Results and discussion

Figure 1 below shows the MATLAB main model of the system. The main model composes of main system; the main system has four inputs and six outputs. The first input is a signal that is called TPS1, the second input (Fuel inj) is connected to the sixth output (Fuel_des) and the third inputs (Load) is constant and equal to 20 and fourth input (Spark Advance) is constant and equal to 15.

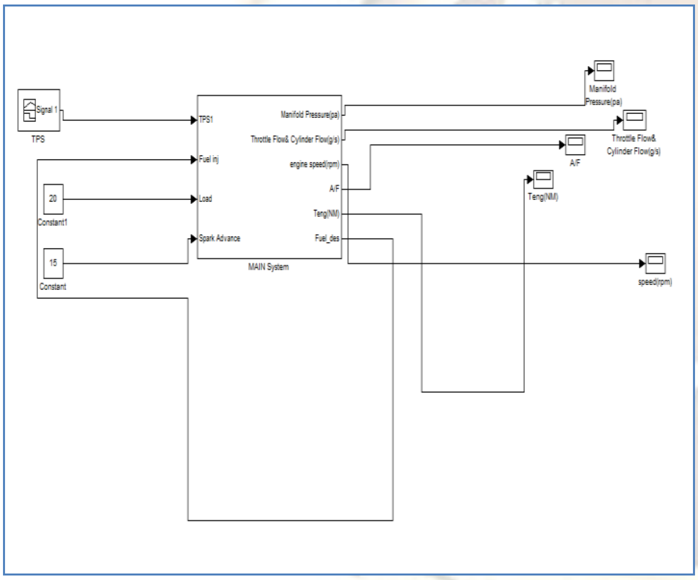

Fig. 1: The MATLAB model of the system

Figure 2 shows the MATLAB main system. The main system includes four sub-systems. The first sub system is air-sub; it has four inputs and five outputs, the first input is the input signal (TPS %) (Port number 1), the second input (n (rpm)) is connected at the output of the gain block, the third input (trigger) is connected the third output (trigger) of the second sub-system (compression), the fourth input is the (Fuel inj) (Port number 2). The first output (mass (k+1)) is connected to the first input (mass (k+1)) of the second sub-system (compression), the second output (Throttle Flow & Cylinder Flow (g/s)) is the output (Throttle Flow & Cylinder Flow (g/s) (Port number 2)), the third output (Manifold Pressure Pm (Pa)) is the output (Manifold Pressure (Pa) (Port number 1)), the fifth output (Fuel_des) is the output (Fuel_des (Port number 6)), the fourth output (fuel (k+1)) is connected to the second input (fuel (k+1)) of the second sub-system (compression). The second sub-system (compression) involves two inputs which are mass (k+1) and fuel (k+1), and three outputs, the first output (mass (K)) is connected to the first input (Air Change) of the third sub-system (Combustion & Vehicle Dynamics), the second output (fuel (k)) is connected to the second and third input (T_{load}, Fuel rate) also the Port number 3 (Load) is attached to the second and third input (T_{load}, Fuel rate), the fourth input (Spark Advance) is the Port number 4 (Spark Advance). The third sub-system (Combustion & Vehicle Dynamics) includes four inputs which are Air Change, T_{load}, Fuel rate and Spark Advanced, also includes three outputs, the first output (N (rad/s)) is amplified by constant (30/pi) which is the Port number 3 (engine speed (rpm)), the second output (A/F) is the Port number 4 (A/F) and the third output (Teng(NM)) is the Port number 5 (T_{eng}(NM)). The last sub-system (valve timing) has one output (edge180) that controls the second sub-system (compression) and one input (N) which is the signal that comes from the first output (N (rad/s)) of the third sub-system (Combustion & Vehicle Dynamics). [3,4,5].

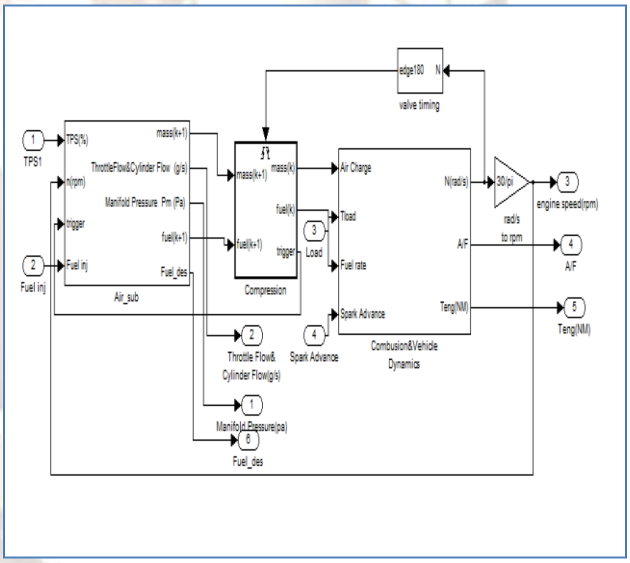

Fig.2: The main system

Figure 3 below shows the MATLAB Air_sub sub-system. This sub-system includes three sub-systems which are Throttle_model, Cylinder_model and fule_sub. Figure 4 shows the MATLAB Throttle_model sub-system; figure 5 shows MATLAB Cylinder_model sub-system and figure 6 shows MATLAB fule_sub sub-system, [5,6].

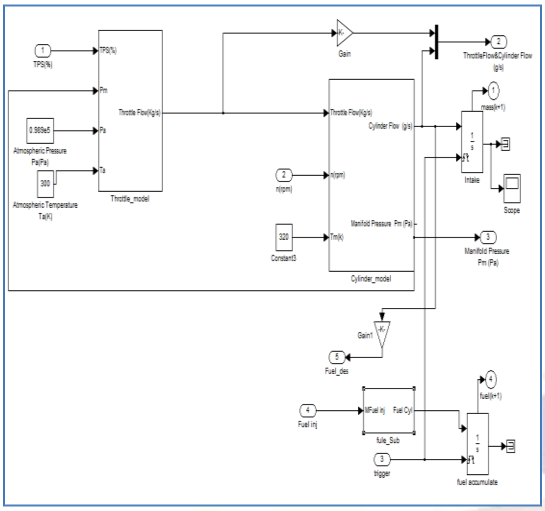

Fig.3: the MATLAB Air_sub sub-system

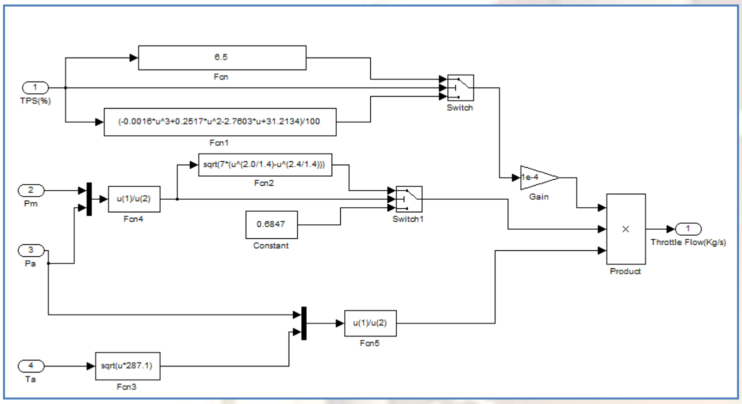

Fig.4: the MATLAB Throttle_model sub-system

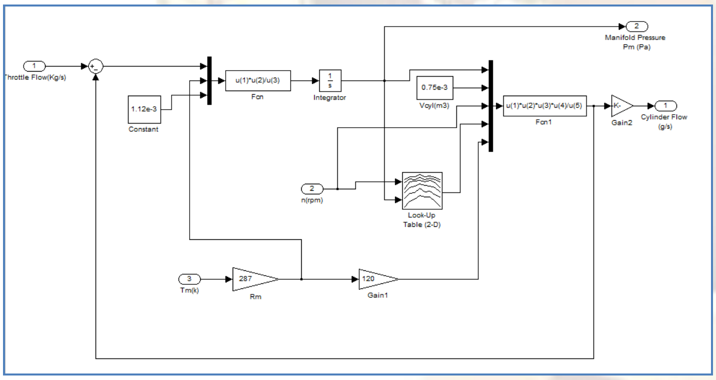

Fig.5: the MATLAB Cylinder_model sub-system

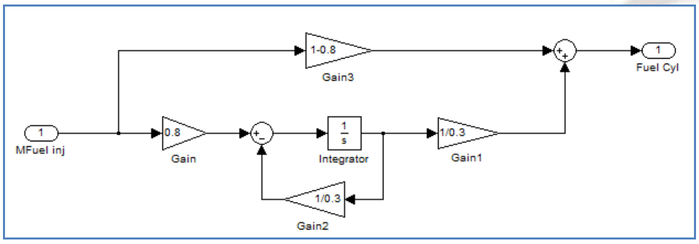

Fig.6: the MATLAB fule_sub system

Figure 7 shows the resultant Manifold Pressure (Pa), the signal suddenly increases until it reaches the value $9.5 * 10^4 Pa$ at time $0.3s$, then starts to steady at value $9.45 * 10^4 Pa$. At time $7s$, the voltage reaches the minimum value $9.1 * 10^4 Pa$, then it starts to increase.

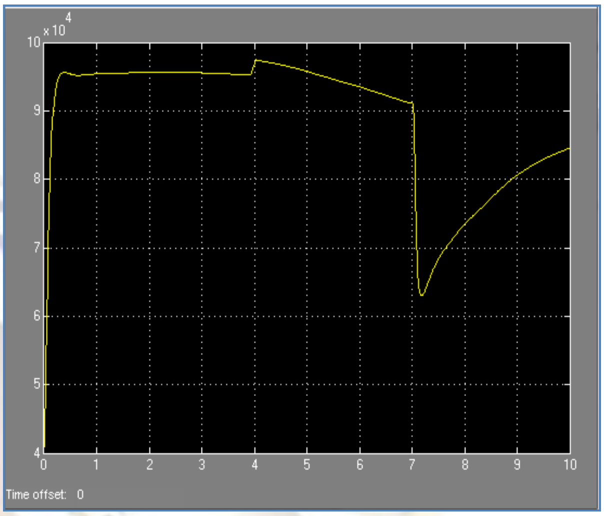

Fig.7: the resultant Manifold Pressure (Pa)

Figure 8 shows the resultant throttle flow and cylinder flow. The throttle flow starts with $6.1\ g/s$ and cylinder flow $0.1\ g/s$. the two signals starts to increase until they reaches the same maximum flow value which equals to $16.4\ g/s$ at time $7s$, then suddenly the two signals go back to the minimum value, the minimum value throttle flow signal is $8\ g/s$ at time $7s$. Then they decrease slowly. [7,8,9,10,11]

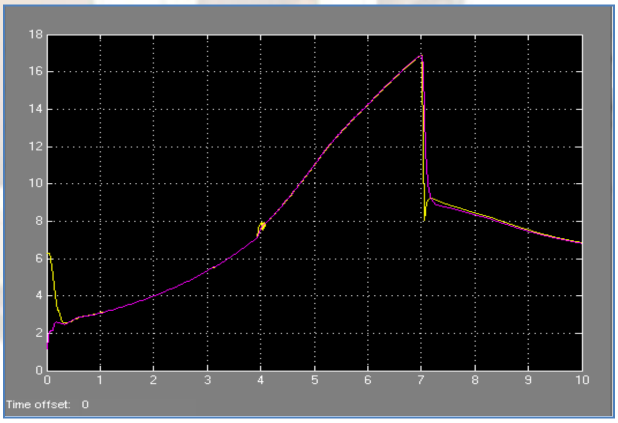

Fig.9: Throttle Flow & Cylinder Flow (g/s)

Figure 10 shows the resultant speed (rpm), the speed starts at $1250\ rpm$, then decrease to the minimum value $500\ rpm$ at time $0.1s$. After that the signal starts to increase until the reaches the peak value at $3010\ rpm$ at time $7.1s$. Then the speed decreases slowly.

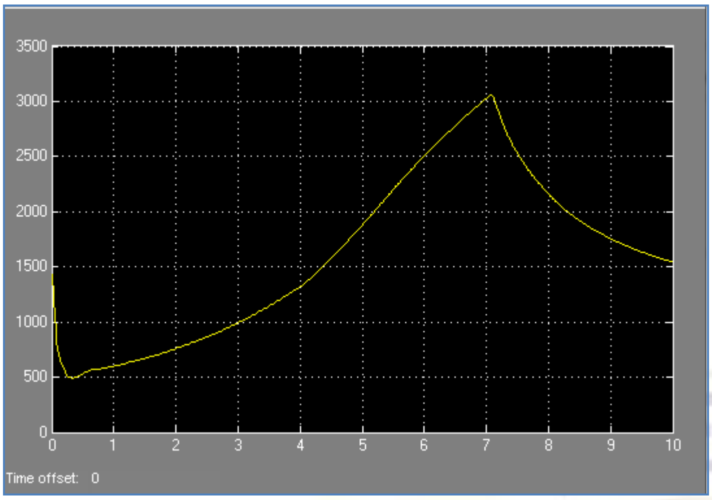

Fig.10: speed (rpm)

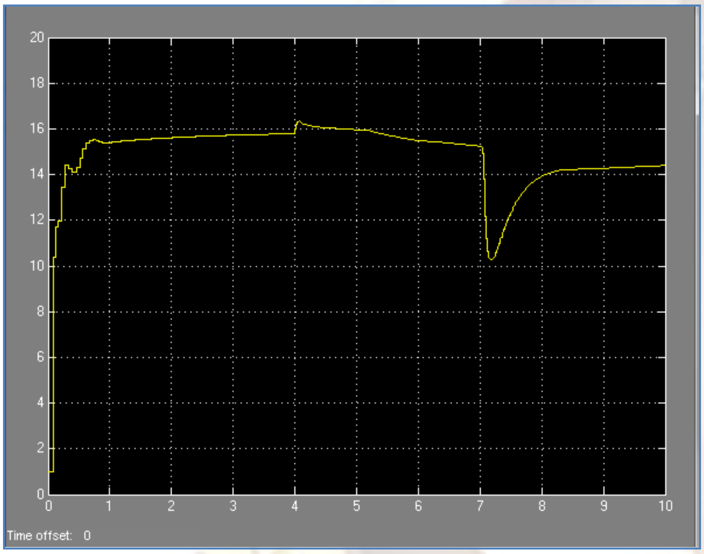

Fig.11: A/F

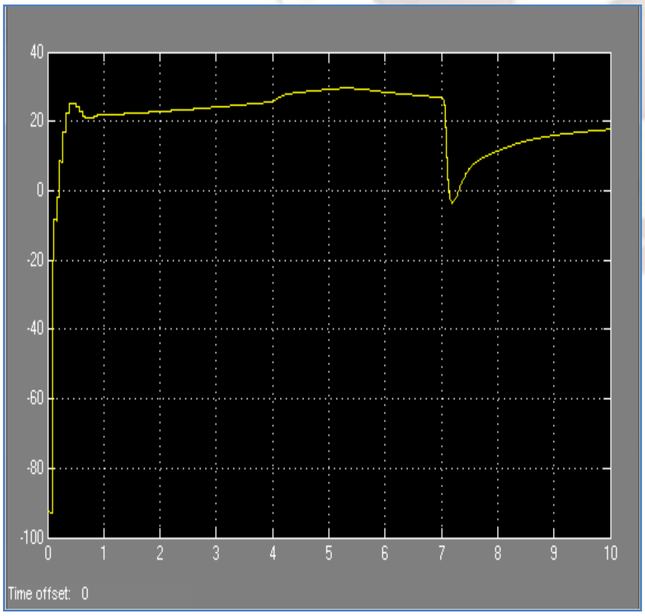

Fig.12: Teng (NM)

Simulation results and design was done in SolidWorks 2011 as shown in figure 13 and figure 14

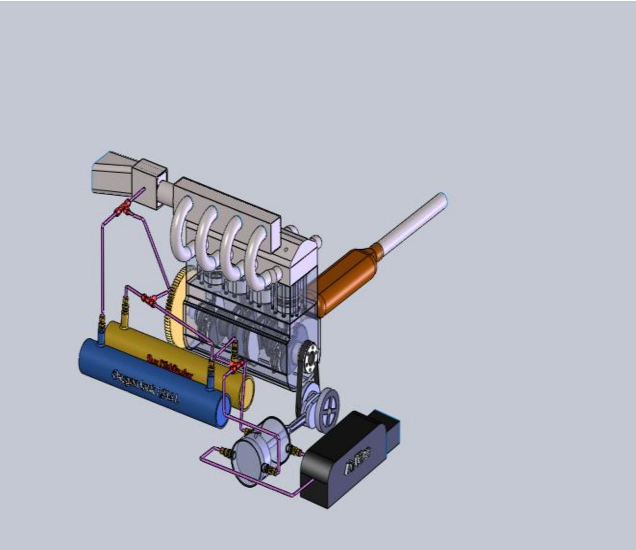

Fig.13: Model of system

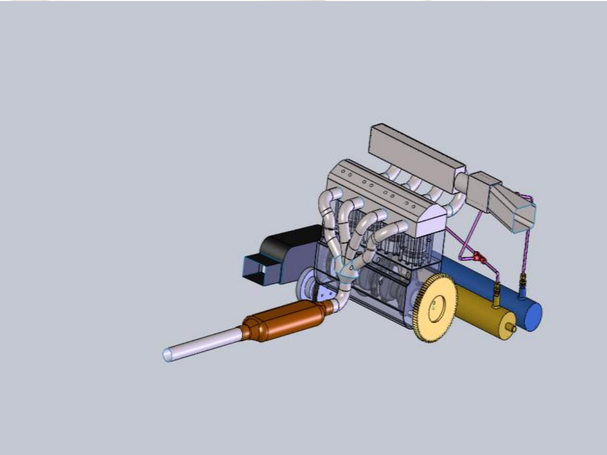

Fig.14: Side view of system model

The loss in pressure in the filtration process has been simulated in SolidWorks Flow Simulation with these inputs parameters: table 1. [11,12].

Initial Conditions

Table 1 initial conditions

Thermodynamic parameters	Static Pressure: 8669865.00 Pa Temperature: 293.20 K
Concentrations	Substance fraction by mass Oxygen 0.2000 Nitrogen 0.8000
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 8.703e-004 m

Material Settings: *Fluids:***Oxygen, and Nitrogen**

The outputs of the simulation are shown in the following figures: figure 15 shows the simulated model.

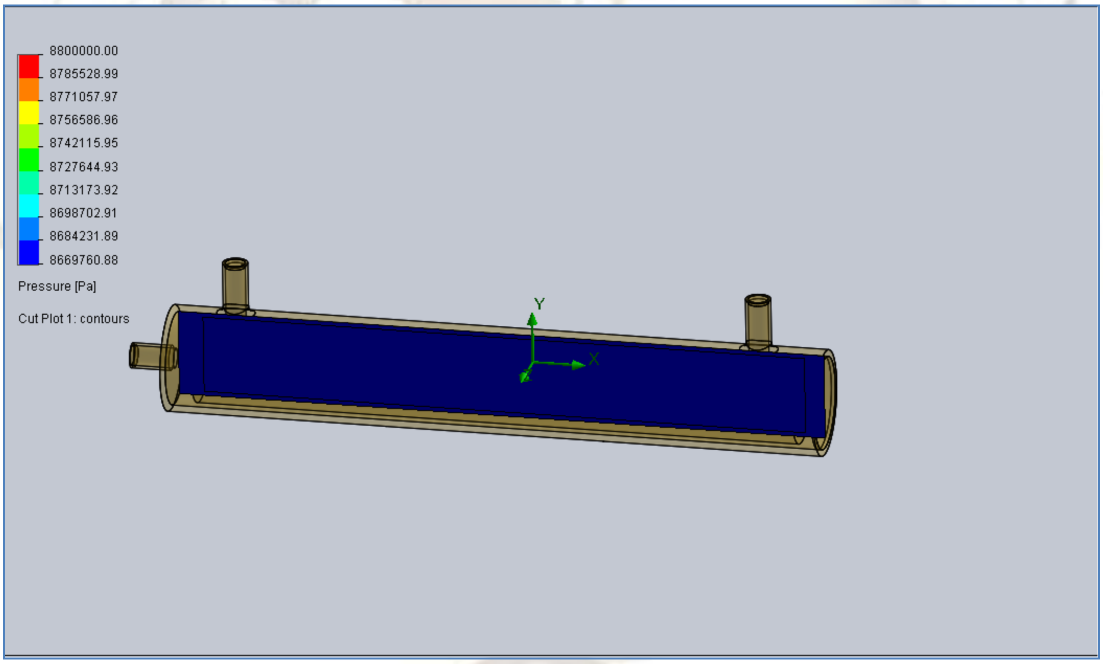

Fig.15: the simulation of the model

Figure 16 shows the relationship between the pressure and the length of the cylinder. The pressure starts at 8670114 Pa, it decreases suddenly to 8670106 Pa at 0.01 m, then increases to 8670117 Pa and decrease slightly to 8670116 Pa, then the pressure increase slowly.

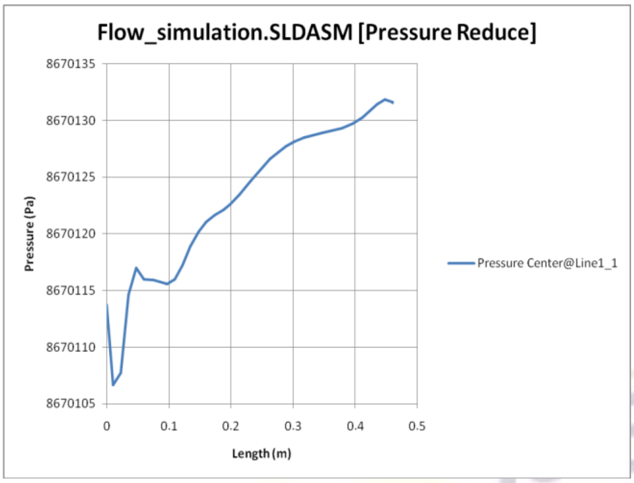

Fig.16: Pressure reduce

IV. Conclusion

The reciprocating internal combustion engine (iso-engine) is an original thermodynamic with potential in order to attain a net electrical plant efficiency of 58% in a 7 MW part burning natural gas and about 60% with liquid concentrate fuel. The iso-engine will propose comparable thermal performance to that of joint cycle industrial gas turbine plants of above 250 MW outputs, when the engineering improvement is successful. Principal prices of the iso-engine are predicted to be only somewhat more than those of contending diesel and reciprocating gas engines. Through-life prices will be considerably minor due to the lower fuel price. The iso-engine will be very appropriate for flexible on-site as well as allocated power production or for CHP with heat in the form of hot water.

Limitations

There some limitations that are related to IC engines as the reciprocating internal combustion engine generates air pollution emissions as a result of partial combustion of carbonaceous fuel. The main pollutants that are produced from combustion fuel procedure are carbon dioxide (CO_2), water and particulate matter (PM). The outcomes of gasping particulate matter have been investigated in individuals and animals, as well as involve cardiovascular topics, asthma, lung cancer and early death. Also, there are extra artifacts of the combustion procedure such as nitrogen oxides, sulfur and un-combusted hydrocarbons, relying on the working circumstances and the fuel-air ratio.

References

[1] CHIESA, P, LOZZA, G, MACCHI, E and CONSONNI, S. 1995. An assessment of the thermodynamic performance of mixed gas steam cycles: part B—water injected and HAT cycles. Journal of Engineering for Gas Turbines and Power. pp.499–508.

[2] CHOMIAK, J, LILJENFELDT, G. 2001. Performance analysis of a steam injected diesel (STID) engine. Proceedings of the 23rd CIMAG World Congress of Combustion Engine Technology for Ship Propulsion, Power Generation, Rail Traction. Hamburg.

[3] CONEY, M, LINNEMANN, C, SUGIURA, K and GOTO, T. 2004. Iso-engine data analysis and future design options. Proceedings of the 24th CIMAC World Congress on Combustion Engine Technology. Kyoto, Japan.

[4] CONEY, M.W, STEPHENSON, P, MALMGREN, A, LINNEMANN, C, MORGAN, R.E and RICHARDS, R.A. 2002. Development of a reciprocating compressor using water injection to achieve quasi-isothermal compression. Proceedings of the 16th International Compressor Engineering Conference at Purdue, Lafayette. Indiana, USA.

[5] CONEY, M.W. LINNEMANN, C and ABDALLA, H.S. 2004. A thermodynamic analysis ofa novel high efficiency reciprocating internal combustion engine (iso-engine). pp. 2585–2600

[6] CREUTZIG, F, PAPSON, A, SCHIPPER, L and KAMMEN, D. M. 2009. Economic and environmental evaluation of compressed-air cars. pp. 1-9

[7] LINNEMANN, C, CONEY, M.W, MORGAN, R.E, BANCROFT, T.G and SAMMUT, R.M. 2002. A novel internal combustion engine with simultaneous injection off duel and pre-compressed pre-heated air. Proceedings of the Fall Technical Conference of the ASME Internal Combustion Engine Division. 39. pp. 67–77.

[8] PETERS, K. E, WALTERS, C. C and MOLDOWAN, J. M. 2004. The Biomarker Guide, Biomarkers and Isotopes in Petroleum Exploration and Earth History. 1(2). Cambridge University Press, Cambridge, UK.

[9] SCHUMACK, M and BODKE, S. 2010. IMPROVING THE ENERGY DENSITY OF HYDRAULIC HYBRID VEHICLES (HHVS) AND EVALUATING PLUG-IN HHVS. pp. 1-19

[10] WANG, Y and LIU, Y, 2008. An oxygenating additive for reducing the emission of diesel engine," The 2nd Int'l Conf. on Bioinformatics and Biomedical Engineering (ICBBE 2008), pp. 3931-3933

[11] YE, Z and LI, L. 2003. Control options for exhaust gas after treatment and fuel economy of GDI engine systems. *Proc. 42nd*

Conf. on Decision and Control. **2.** pp.1783-1788.

[12] HAIFENG, S, YOUTONG, Z, JUN, Wand LIANDA L. 2008. Researches of common-rail diesel engine emission control based on cylinder pressure feedback. *Vehicle Power and Propulsion Conf. (VPPC08)*. pp. 1-6

[13] Youssef Kazour, Michael Knauf, James Sinnamon, Edward Suh and Daniel Glueck, 2013, Development of Continuously Variable Valve Lift Mechanism for Improved Fuel Economy, SAE International, doi:10.4271/2012-01-0163.

[14] Pradeep Gillella and Zongxuan Sun, 2009, Modeling and Control Design of a Camless Valve Actuation System, 2009 American Control Conference, Hyatt Regency Riverfront, St. Louis, MO, USA.