ENFORCEMENT OF AN ELECTROMAGNETIC VALVE IN I.C ENGINES

T. Hari Chandrudu[1], Sarap Raghavendra[1 *].

[1]*Asst.Profs in Department of Mechanical Engineering, Lords Institute of Engineering and Technology, Hyderabad, 500008.*

Abstract

This thesis conveys a method for electromagnetically triggering valves used in IC engine. This technique for valve Enforcement aspects at employing the normal change to a 42V standard in motorized vehicles. It also provides a basic model detailing how this principle works. The benefit of Electromagnetic valve Enforcement is that it offers an easy method of infinitely varying the valve timing in IC engines. The connection among the desired open and closed intervals of the inlet and outlet valves operating with reverence to engine speed. While some car producers have established methods of changing valve timing, most of these are immobile mechanical methods, and don't allow for an extremely variable timing profile. Improved timing will result in compact fuel feeding and enhanced power in motorized vehicles. Characteristics of solenoids are studied. These characteristics are used to enterprise different mechanical layouts of the valve in instruction to diminish the vital force by the solenoids. With the usage of the Electromagnetics from James Kennedy's PUMA arm governor board, the working of the basic model is clarified. The software is presently written to produce a PWM signal for heavy the solenoid, and to alter that indication in reaction to an encoder input.

1. Introduction

The aim of this opinion is to afford a method for electromagnetically triggering valves used in IC engine. A basic model of an engine valve has been. lt to establish the principal behindhand this, and to offer a stage to determine the functionality of the software. The Electromagnetics to be used have been taken from James Kennedy's panel used in the Control of the PUMA 560 arm and detailed in his thesis, Design and Operation of a Distributed Digital Control System in a Manufacturing Robot. The reason behind electromagnetically triggering valves is to allow for easy and markedly adjustable valve timing to recover engine performance. Current mechanical methods used are difficult to change and when they are changed they don't allow more than a few possibilities for valve timing. The valve manager clarified in this thesis uses the Texas Tools TMS320F241 to lane a full bridge control converter to drive the DC solenoid used to actuate the valve. The old system wanted to be promoted, as it was bulky, untrustworthy and required an external PC to control it. This describes the design, building, installation and challenging of the hardware used. This thesis is useful in that the Electromagnetics on the board created for it are very similar to what is required by this thesis and so this board will be used [1]. It includes examples of the different timing employed in current cars and what these methods deliver in relations of performance and how to compute the mandatory forces used to open and shut the valves at quickness [2]. To know the necessary circuits to provide the solenoids with the required currents [3]. In specific it looks at an assemblage to permit the valves to be closed gently, thus reducing noise and increasing component life. This is of value to this opinion as it delivers a starting platform with respects to the mechanical layout of an electromagnetically actuated valve [4]. To offer a detailed explanation of how to design control loops required in real-world applications and to proposal an appropriate control process for the placing of the valve we use [5].

To covers the issues involved with valve timing and outlines approximately of the standards used in the field and helps to develop a working model of the controller [6].To give a dwelling to start in design of the solution and helps to explain the benefits involved [7]. It deals by the operation of valves in the engine and timing associated with them.

The timing diagrams and the specifics of the correctness obligatory for efficient presentation are taken by [8]. The working of of solenoids valves then their characteristics are studied from [9]. It offers a sample of an Enforcement method currently in production and helps to provide different methods of approaching the problem [10].

2. Design Considerations

For the purposes of this is to decide that the controller would be run up to speeds of 3000rpm. This is wild sufficient to be valuable in motorized vehicles but will need less force then to run at better speeds (for example of 6000rpm). Producing the forces compulsory to run the engine at up to 6000rpm was measured yonder the scope of this opinion. The Electromagnetic valve Enforcement design has to take into explanation of the following restraints: Force obligatory by solenoids must be minimalized in instruction to decrease the power mandatory and the hotness which must be dissolute by them. Force providing by solenoids reductions exponentially with the detachment the nozzle moves form the coil. At smaller engine speeds the force outstanding to inertia will be nearly zero, so that having actual stiff springs will mean that the solenoids will have to overcome these on their own. The valve is to follow a standard valve profile, as soft arrivals are obligatory by the valve for the equal reason they are used in a outmoded camshaft setup. That is, to decrease noise and wear on the valve, thereby cumulative the lifespan of the valve. Due to these restraints the mechanical strategy had to be set up in such a way as to decrease the obligatory force from the solenoids, while not being needy by the force drop off due to detachment. In instruction to attain this a mechanical design involving of two springs and solenoids was chosen. Two solenoids are to be charity so that one can be secure to pull when opening the valve and the other when closing the valve.

3. Mat lab Modelling

In order to compute the best likely design, the obligatory forces were modelled in Mat lab. Due to difficulties finding a valve profile in a form that could be readily entered into a computer, a Kaiser Window function was used. The Kaiser space allows for a shape parameter â that be able to be modified. The Kaiser window is defined as:

$$w[n] = \frac{I_0[\beta(1-[(n-\alpha)/\alpha]_2)_{1/2}]}{I_0\beta}, 0 \le n \le M,$$

0, otherwise

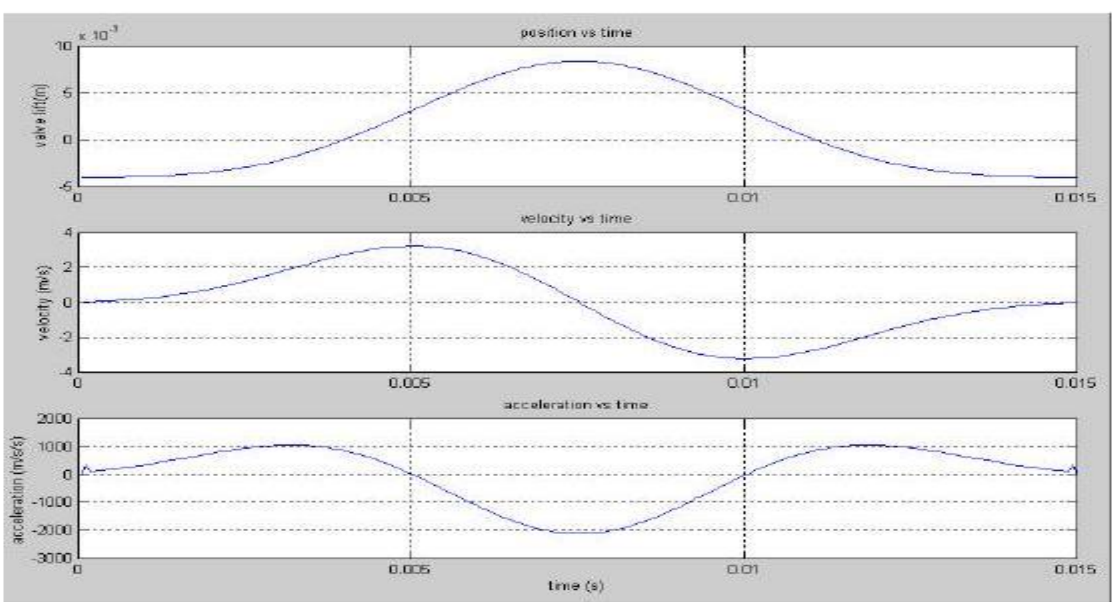

Fig. 1 Valve Profile Demonstrating in Mat lab

A â of 10 best simulates a valve profile, helpful all the required factors include soft landings so as to decrease noise and wear on the valve. The valve position with reverence to time could then be entered into Mat ab as shown at the upper of fig.1. From there the position curve is integrated to give the velocity against time graph (middle graph) and then again to give the acceleration against time graph (bottom graph). Then by using a predictable mass of 150grms (to allow for the mass of the valve plus any heaviness due to the Enforcement system) the power due to inertia on the valve can be designed.

Initially overlooking forces due to resistance and the change in pressure confidential the cylinder and out, the force vital by the solenoids for given spring factors can be intended. This power is equivalent to the helix force additional to the power due to inertia. By script a Mat lab script that runs this (see Appendix A.1), and as this is such a general model, the values of the spring constants can be readily changed, as fine as the initial offset of the valve. A model using one spring and one solenoid was initially looked at. It was create that no quantity of operation of the spring constant could decrease the force essential by the solenoids to a realizable level. The trouble was that developed engine speeds required a harder spring, while at inferior engine speeds, as the forces due to inertia were nearly zero, the solenoids were taking to work solely compared to the helixes and the solenoid was taking to provide the most force when it was fully open.

By means of the two-spring arrangement with a balance which could be measured by the variances between the difficulty of the two springs these difficulties were overcome and the obligatory forces were significantly reduced. In knowledge to run an engine at hurries of up to 3000rpm we practice joint spring constants of 70000 with the helixes set so that the valve will be 4 mm exposed when at rest.

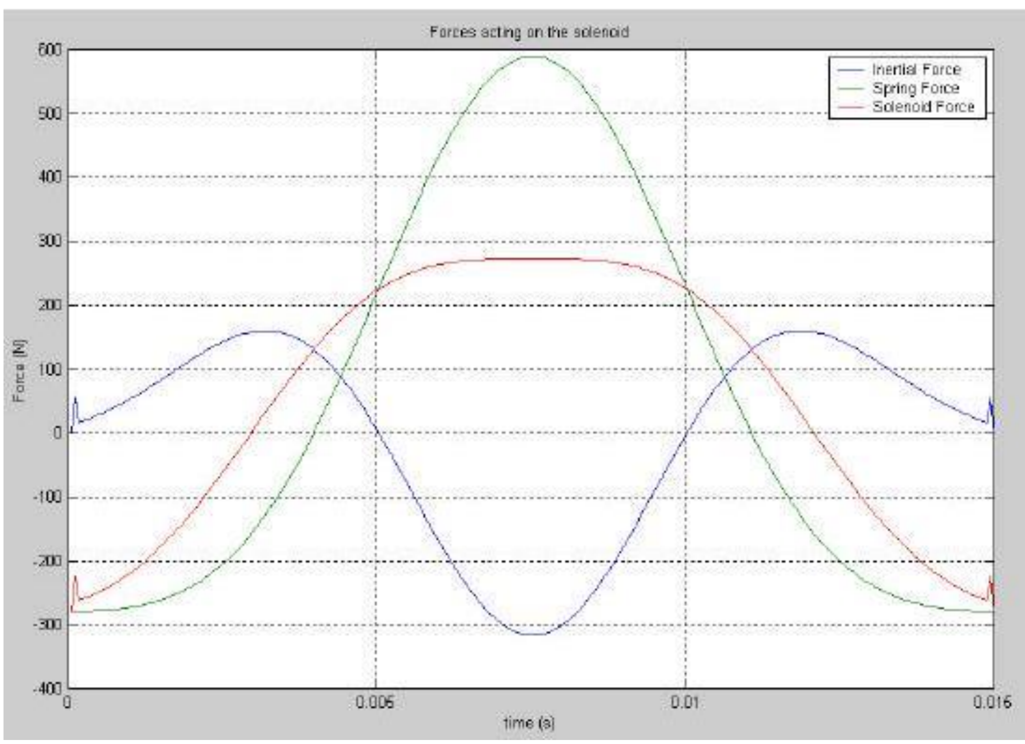

Fig.2 Forces performing on the Valve

Using these characteristics stretches us the vital forces as seen in fig.2. From this it can be gotten that the force essential by the solenoids to ride at 3000rpm is 273N, and, by means of the two solenoid design, the solenoids are essential to exert their extreme force when the gap they are annoying to act across is at its smallest.

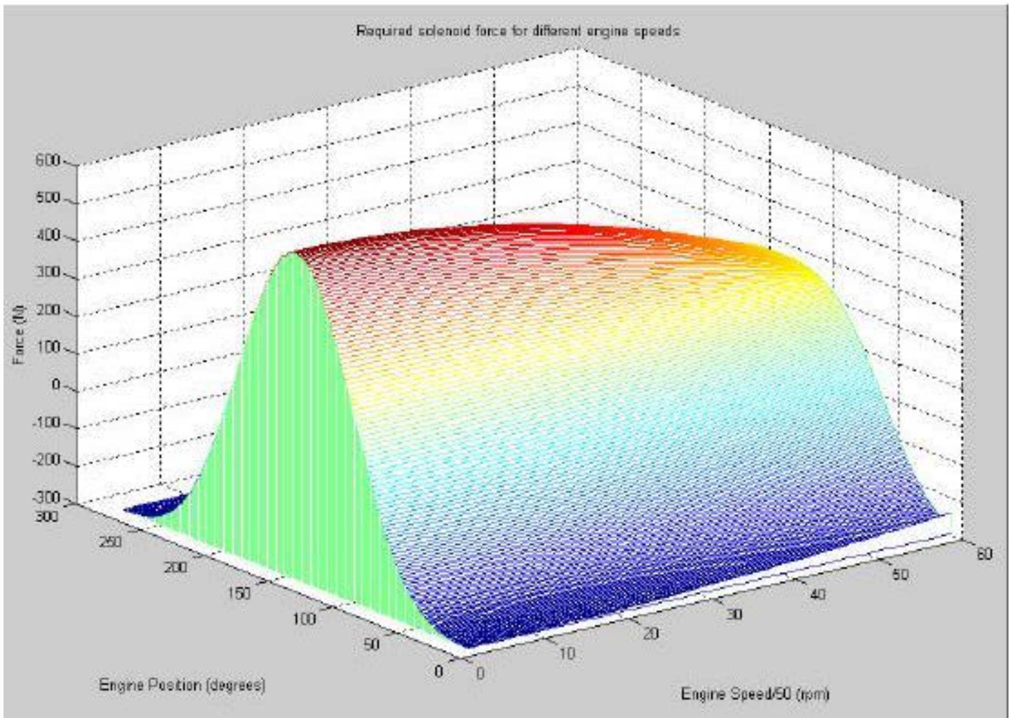

Fig. 3 Obligatory Force with Changing Speeds

Fig. 3 displays that as the engine speed decreases down towards 0rpm the essential force from the solenoids increases to 600N. It is not actually much applied to run an engine at speeds much under 1000rpm and the power compulsory at this speed is 495N.

4. Recommendations and Conclusion

This thesis met its goals of coming up with a possible mechanical design for Electromagnetic valve Enforcement. It looked at the opportunity of Electromagnetic valve Enforcement. Before this system is ready to run in an IC engine there are several more factors essential to be looked at. These include

i. Looking at different methods of position sensing in the valve. While revolving encoder is suitable for use on a bench top, a more robust solution is needed for use in an engine. A probable solution can be the usage of sensing the induction in the solenoids.

ii. Methods to integrate the Electromagnetic valve timing into use with an engine. These comprise sensing the crankshaft angle and by means of this to check current preferred valve location, and detecting engine speed to govern the desired overlap among the inlet and outlet valves' opening periods.

iii. Design of a board specific for use with Electromagnetic valve Enforcement. This is not paramount and reliable solutions to about of these other problems need to be found first, so that they can be built onto this board as well.

iv. Perhaps using a different DSP chip. Although the TMS320F241 fixes the job, since it was ended Texas Instruments have released quite a lot of newer DSP chips which offer more features and allow for greater ease of use and less chance of making mistakes with respects to programming them.

v. Design of a mechanical model for use in Electromagnetic valve Enforcement. This includes looking at several different mechanical layouts, running Mat lab simulations to minimalize the essential forces and looking at designs from the perspective of using them in an engine and replacing current mechanical systems.

Software modules for each of the components have been written and tested on the DSP. It is expected that by the close of semester these modules will have been integrated together and tested fully.

5. References

[1] J. Kennedy, *Design and Implementation of a Distributed Digital Control System in an Industrial Robot,* Undergraduate Thesis, Univ. of Queensland, Computer Science and Electrical Engineering, 1999.

[**2**] L.C. Lichty, *Internal Combustion Engines*, McGraw-Hill, New Your, 1951.

[**3**] N. Mohan, T.M. Undeland and W.P. Robbins, *Power Electromagnetics: Converters, Applications, and Design,* John Wiley & Sons, New York, 1989.

[**4**] F. Liang, and C. Stephan, *Electromechanically Actuated Valve with Soft Landing and Consistent Seating Force,* US patent 5645019, to Ford Global Technologies, Inc, Patent and Trademark Office, Washington D.C., 1997.

[**5**] N. S. Nise, *Control Systems Engineering 3rd Ed,* John Wiley & Sons Inc, New York, 2000.

[**6**] H. Bauer et al., *Automotive Handbook 4th Ed,* Rubert Bosch BmgH, Germany, 1996.

[**7**] *Electromechanical Valve Control,* http://www.fev-et.com/03eng/02ed/e_ed_vt.html (current April 27th, 2001) .

[**8**] R. Stone, *Introduction to Internal Combustion Engines 2nd Ed,* Society of Automotive Engineers, Warrendale, 1992.

[9] V.D. Toro, *Electric Machines and Power Systems,* Prentice Hall, New Jersey, 1985.

[**10**] *Porsche 911 variocam page,* http://www.us.porsche.com/english/911/turbo/engine/variocam.htm (current 13th October 2001).