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A STUDY ON EVALUATION OF SPARK CHARACTERISTICS FOR BETTER PERFORMANCE OF SI ENGINE

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Abstract

Injection of the fuel into the manifold of gasoline engines has become very common. Through the concept is not new, the advent of cost effective, compact and reliable electronic controls has a lot to do with the success of fuel injection in gasoline engines. Electronics has begun to play a key role in fuel management and ignition. The modern internal combustion has to meet extreme requirements of high power to weight ratio, low exhaust emission levels and high thermal efficiency. The precise control of the ignition timing, which is possible by electronic means, allows reliable combustion with low cycle by cycle variations. Such systems also allow the engine to run under conditions very close to knock onset so that maximum thermal efficiency can be realized. This paper deals with the review of early research work related to Electronic control of the injection system to select correct air fuel ratio for different operating conditions. The proposed control system reduces mal-distribution between cylinders and leads to extremely low levels of exhaust emissions. Stable idling can also be achieved through the use of electronic controls.

Key Words: Spark characteristics, Pulse current, Ignition Timing, SI Engine

1.Introduction

Electronics have been relatively slow in coming to the automobile primarily because of the relationship between the added cost and the benefits. Historically, the first electronic control systems were introduced into the commercial automobile during the late 1950s and early 1960s.[1] However, these features were not well received by customers, so they were discontinued from production automobiles [2].

Microelectronics will provide many exciting new features for automobiles. Environmental regulations and an increased need for economy have resulted in electronics being used within a number of automotive systems.

2. Ignition System

To produce power, the gasoline engine must not only have a correct mixture of fuel and air, but also some means of initiating combustion of the mixture. Essentially the only practical means is with an electric spark produced across the gap between a pair of electrodes of a spark plug. The electric arc or spark provides sufficient energy to cause combustion. This phenomenon is called ignition. Once a stable combustion has been initiated, there is no further need for the spark. Typically, the spark must persist for a period of about a millisecond (one thousandth of a second). This relatively short period makes spark ignition possible using highly efficient pulse transformer circuits in which a circuit having a relatively low average current can deliver a very high-voltage (high peak power) pulse to the spark plug. The ignition system itself consists of several components: the spark plug, one or more pulse transformers (typically called coils), timing control circuitry, and distribution apparatus that supplies the high-voltage pulse to the correct cylinder [7].

2.1 Spark Plug

The spark is produced by applying a high-voltage pulse of from 20 kV to 40 kV (1 kV is 1,000 volts) between the center electrode and ground. The actual voltage required to start the arc varies with the size of the gap, the compression ratio, and the air–fuel ratio. Once the arc is started, the voltage required to sustain it is much lower because the gas mixture near the gap becomes highly ionized. (An ionized gas allows current to flow more freely.) The arc is sustained long enough to ignite the air–fuel mixture. The spark plug consists of a pair of electrodes, called the center and ground electrodes, separated by a gap. The gap size is important and is specified for each engine. The gap may be 0.025 inch (0.6 mm) for one engine and 0.040 inch (1 mm) for another engine. The center electrode is insulated from the ground electrode and the metallic shell assembly. The ground electrode is at electrical ground potential because one terminal of the battery that supplies the current to generate the high-voltage pulse for the ignition system is connected to the engine block and frame.

3. High-Voltage Circuit and Distribution

The ignition system provides the high-voltage pulse that initiates the arc.. The high-voltage pulse is generated by inductive discharge of a special high-voltage transformer commonly called an ignition coil. The high-voltage pulse is delivered to the appropriate spark plug at the correct time for ignition by a distribution circuit. Before the advent of modern electronic controls, the distribution of high-voltage pulses was accomplished with a rotary switch called the distributor.

3.1 Spark Pulse Generation

The actual generation of the high-voltage pulse is accomplished by switching the current through the primary circuit. The mechanism in the distributor of a traditional ignition system for switching the primary circuit of the coil consists of opening and closing the breaker points (of a switch) by a rotary cam in the distributor. During the intervals between ignition pulses (i.e., when the rotor is between contacts), the breaker points are closed (known as dwell). Current flows through the primary of the coil, and a magnetic field is created that links the primary and secondary of the coil. The distributor in a conventional ignition system uses a mechanically activated switch called breaker points. The interruption of ignition coil current when the breaker points open produces a high-voltage pulse in the secondary. At the instant the spark pulse is required, the breaker points are opened. This interrupts the flow of current in the primary of the coil and the magnetic field collapses rapidly. The rapid collapse of the magnetic field induces the high voltage pulse in the secondary of the coil. This pulse is routed through the distributor rotor, the terminal in the distributor cap, and the spark plug wire to the appropriate spark plug. The capacitor absorbs the primary current, which continues to flow during the short interval in which the points are opening, and limits arcing at the breaker points.. The primary current increases with time after the points close (point a on waveform). At the instant the points open, this current begins to fall rapidly. It is during this rapid drop in primary current that the secondary high-voltage pulse occurs (point b). The primary current oscillates because of the resonant circuit formed between the coil and capacitor.

4. Ignition Timing

The point at which ignition occurs, in relation to the top dead center of the piston's compression stroke, is known as ignition timing. Ignition occurs some time before top dead center (BTDC) during the compression stroke of the piston. This time is measured in degrees of crankshaft rotation BTDC. For a modern SI engine, this timing is typically 8 to 10 degrees for the basic mechanical setting with the engine running at low speed (low rpm). This basic timing is set by the design of the mechanical coupling between the crankshaft and the distributor. The basic timing may be adjusted slightly in many older cars by physically rotating the distributor housing.

As the engine speed increases, the angle through which the crankshaft rotates in the time required to burn the fuel and air mixture increases. For this reason, the spark must occur at a larger angle BTDC for higher engine speeds. This change in ignition timing is called spark advance. That is, spark advance should increase with increasing engine rpm. In a conventional ignition system, the mechanism for this is called a centrifugal spark advance. As engine speed increases, the distributor shaft rotates faster, and the weights are thrown outward by centrifugal force. The weights operate

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through a mechanical lever, so their movement causes a change in the relative angular position between the rubbing block on the breaker points and the distributor cam, and advances the time when the lobe opens the points. In addition to speed-dependent spark advance, the ignition timing needs to be adjusted as a function of intake manifold pressure. Whenever the throttle is nearly closed, the manifold pressure is low (i.e., nearly a vacuum). The combustion time for the air–fuel mixture is longer for low manifold pressure conditions than for high manifold pressure conditions (i.e., near atmospheric pressure). As a result, the spark timing must be advanced for low pressure conditions to maintain maximum power and fuel economy. The mechanism to do this is a vacuum-operated spark advance. The vacuum advance mechanism has a flexible diaphragm connected through a rod to the plate on which the breaker points are mounted. One side of the diaphragm is open to atmospheric pressure; the other side is connected through a hose to manifold vacuum. As manifold vacuum increases, the diaphragm is deflected (atmospheric pressure pushes it) and moves the breaker point plate to advance the timing. Ignition timing significantly affects engine performance and exhaust emissions; therefore, it is one of the major factors that is electronically controlled in the modern SI engine. The performance of the ignition system and the spark advance mechanism has been greatly improved by electronic control systems. Because ignition timing is critical to engine performance, controlling it precisely through all operating conditions has become a major application of digital electronics, that ignition timing is actually computed as a function of engine operating conditions in a special-purpose digital computer known as the electronic engine control system. This computation of spark timing has much greater flexibility for optimizing engine performance than a mechanical distributor and is one of the great benefits of electronic engine control.

5. Conclusion

- An efficient electronic control unit (ECU) circuit consisting of monostable multivibrators can be designed and fabricated for the proper control of fuel injection, spark pulse generation, and ignition timing
- This helps to improve combustion for better power output and to reduce emission of exhaust.
- The results of the ECU can be verified by the simulation for injection and ignition using MAT LAB Software.
- The review of earlier research work helps to carry out the research work to improve the performance of SI Engines

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