

# **PRECISION MANUFACTURING AND ELECTRONIC GASEOUS FUEL INJECTION SYSTEM REDUCES EMISSION WHILE IMPROVING FUEL ECONOMY FOR SI ENGINE**

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## **Abstract**

Today's automobile engines have parts with tolerances of one micron. This precision manufacturing has enabled auto companies to reduce total emissions, improve fuel economy and make engines more reliable. Improvements in cutting tools, grinding systems and CNC technology let today's engine builders routinely achieve levels of precision that could not even be measured a decade ago. Automobile vehicles today are 96% cleaner and 50% more fuel efficient than in the 1970s because of innovations in fuel injection system, multiple valves and lighter materials.

## **Introduction**

The high standard of living of developed nations can be traced to the great contribution made by engineering manufacture, through innovation in product design and development and adoption of advanced manufacturing technologies. In the field of engineering manufacture, Flexible automation and application of precision engineering have emerged in the last decade. Flexible automation was necessitated by the customer preference for varieties and variants in products. It has led to the introduction of computer numerical control machine tools, flexible-manufacturing systems, and computer integrated manufacturing systems.

## **Precision engineering**

Precision engineering has contributed greatly to product developed through greater interchangeability, high service life, high reliability, better product quality and comfort to the user. Precision engineering forms a vital role in the field of automobile applications. The major emerging areas of application of precision engineering in automobile are in the field of sensors and actuators. The level of precision required for these products could be achieved through an effective synthesis of high precision manufacturing techniques and dimensional metrology associated with careful material processing techniques. The various manufacturing processes generally include high precision force machining, selective precision machining, ultra high precision machining, elastic emission machining, dry mechano-chemical polishing, lithographic etching technique, energy beam machining and ion processing. The ultra high precision has greatly enhanced the value added to achieve the required precision with minimal effect. It is important to select an appropriate design and the machining process to obtain maximum performance or life (1).

Precision engineering generally involves

### **i) High precision and ultra precision engineering**

Precision engineering as applied to general engineering products, relates to manufacturing to a tolerance of 1 to 10 microns over dimensions of 100 mm. In the manufacture of automobile products, high precision and ultra precision machine tools such as diamond turning machines, diamond-milling machines, ultra precision grinding and lapping machines and high precision Electro-discharge machines are used. Apart from the human skill, the other important ingredients for precision manufacture are good metrology practices and special environmental conditions such as controlled temperature, humidity, ground vibrations and dust level.

### **ii) Micro engineering**

Micro engineering is a subset of precision engineering. This new field, also known as Micro system technology and Micro electro mechanical system, relates to devices and machines of extremely small size comprising tiny but highly sophisticated elements which allow to perform minute and complicated tasks. They are invariably integrated with signal processing electronic circuitry. Miniaturization through micro engineering imposes simplicity in design and brings about reduction in the cost of manufacture.

The applications in automobiles alone will justify the investments on facilities and processes to fabricate micro mechatronic devices, accelerometers for smart automobile suspensions, for safety air bag development and for antilock braking systems, micro actuators, micro gears, sensors, transducers, connectors, electronic fuel injectors, flow sensors, micro valves and gas sensors to control the optimal engine operation and emission control in automobiles.

### **iii) Micro fabrication techniques**

Integrated circuit batch processing techniques such as photolithography, oxidation, diffusion, ion implantation, epitaxy and film deposition are used in making micromachined devices. In addition to the standard Integrated circuit processes, silicon fusion bonding, anodic bonding of silicon to pyrex glass, electrochemical drilling of glass wafers are also used for making microelectronic devices. Various approaches to micro electro mechanical systems such as Polysilicon surface micromachining, high aspect-ratio techniques Photolithography, Masks, Photoresists, Etching, Diffusion, Vapor deposition, lithography, electroplating, and molding process.

### **Electronic fuel injection**

To meet the demands of high specific output, low exhaust emission, modest fuel consumption and good driveability of the vehicle, modern electronics technology is opening up new perspectives in automotive design. Electronic fuel injection is generally more efficient than carburetors because it is able to compensate for a variety of operating conditions. This compensating ability allows the system to deliver the optimum fuel mixture needed, resulting in good throttle response and fuel economy. Over the years various technologies such as ceramic coating of piston and cylinder wall, use of catalytic converters, exhaust gas recirculation, charge stratification, use of intake resonators, active thermo-atmosphere combustion, use of air assisted

fuel injection etc., have been suggested to improve fuel economy and reduction of pollutants for SI engine. Amongst all, precision manufacturing, precision sensor and electronic gaseous fuel injection system proves to be most effective (2).

In daily life, the reliability of sensor systems even under extreme conditions is of vital importance for automobile applications. The success of most technical applications depends strongly on the technology used to develop a suitable sensor system. Sensor technology increases process efficiency and reduces cost of products. High measuring accuracy and long term consistency characterize the sensors used in electronic control. For electronic system to play a major role in fuel control the following requirements have to be met: High precision and reproducibility, higher safety, wide working temperature region, corrosion resistance, vibration resistance, interference suppression, friction free sensors, long working life.

The extreme accuracy of fuel delivery by the electronic control unit, at any load and speed, provides the engine with air-fuel mixtures that fall within a tiny window of accuracy required for maximum power or maximum economy. Electronic fuel injection system (Fig (1)) generally permits greater flexibility of intake manifolds designed to achieve higher inlet airflow rates and consistent cylinder to cylinder air-fuel distribution. More efficient, higher compression ratios are usable, due to accurate fuel metering (3). The most commonly sensed inputs are Engine speed, Engine load, Throttle position, Intake manifold pressure, Air temperature, Fuel pressure, mass of airflow, Crank position.

The microcontroller receives the signals from these sensors and determines the precise quantity of fuel to be injected per cycle for the particular load and speed conditions of the engine. The injection starts on receiving the signal from the crank position sensor. The injection duration pulse width is controlled by the microcontroller through one of the ports. On line control of the injection duration is also provided through another port for optimization of the engine performance.

## **Results and discussions**

Figure (2) shows improvement in tolerances in machining the automobile components over the years, and Fig (3) shows reduction of pollutants with machine tooling accuracy. Figure (4) shows a comparison of CO emissions. In electronic gaseous fuel injection mode, significant lower concentration of CO is observed. This shows that a better-controlled air-fuel ratio can be maintained over entire range of operation. Figure (5) shows a comparison of HC emissions. Lower HC emissions were observed in electronic gaseous fuel injection mode.

## **Conclusion**

The advantage of the electronic gaseous fuel injection system is precise online control of the quantity of fuel injected per cycle and the air-fuel ratio for any particular load, speed and can be optimized for the best engine performance and low emissions.

## **References:**

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**Key words:** Precision manufacturing, electronic gaseous fuel injection, calibration of sensors, microcontroller, SI engine.

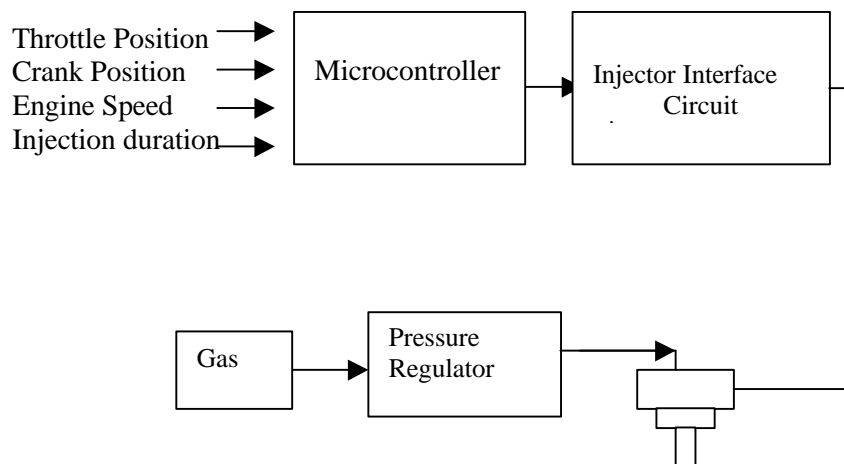
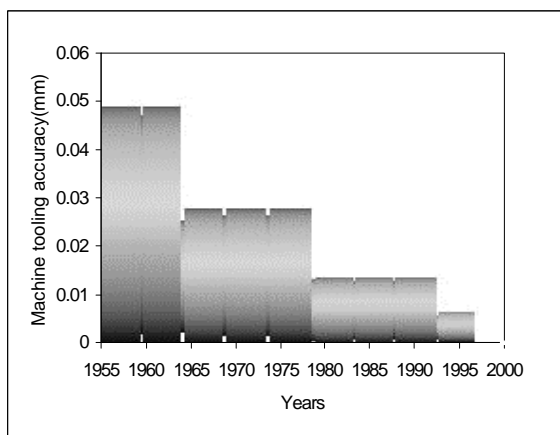
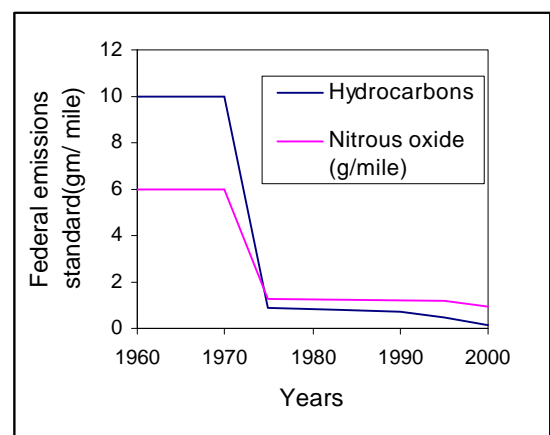


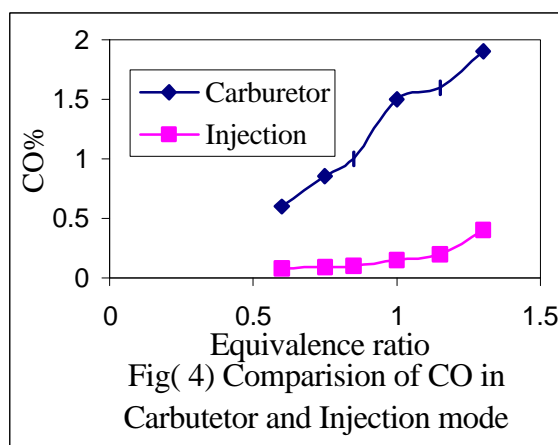
Fig (1) Electronic fuel injection system



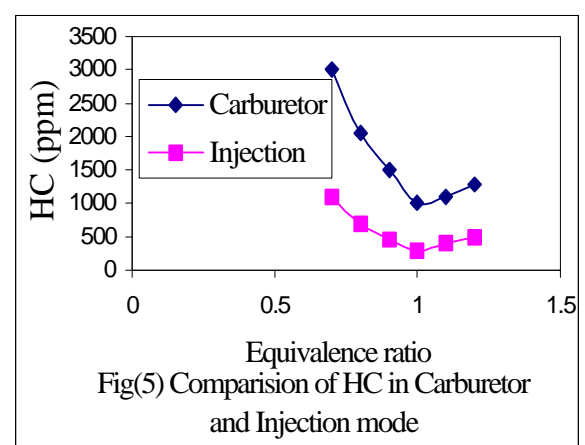
Fig(2) Machine tooling accuracy



Fig(3) Reduction of pollutants with machine tooling accuracy



Fig( 4) Comparision of CO in Carbutetor and Injection mode



Fig(5) Comparision of HC in Carburetor and Injection mode