SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

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DEPARTMENT OF AUTOMOBILE ENGINEERING

COURSE NAME : 19AUB204 – AUTOMOTIVE ELECTRICAL AND ELECTRONICS ENGINEERING

II YEAR / IV SEMESTER

Unit 4 – Sensors and Actuators

Topic : Throttle Position and Exhaust Oxygen Level Sensor

THROTTLE SENSOR

- The throttle position sensor is a critical component in modern engine management systems, ensuring optimal engine performance, fuel efficiency, and driveability.
- Its accurate monitoring of throttle position allows for precise control of air-fuel mixture and ignition timing, contributing to smooth acceleration and overall vehicle performance.
- The TPS monitors the position of the throttle valve in the engine's intake manifold and sends this information to the engine control unit (ECU) or powertrain control module (PCM).
- Based on this data, the ECU adjusts the air-fuel mixture and ignition timing for optimal engine performance and efficiency.

COMPONENTS

- **Sensor Housing**: This is the outer casing or housing that encloses the internal components of the TPS. It provides protection and support for the sensor components.
- **Throttle Shaft**: The throttle shaft is connected to the throttle valve or butterfly valve in the engine's intake manifold. As the throttle valve opens or closes, the throttle shaft rotates, allowing the TPS to detect changes in throttle position.

COMPONENTS

- **Potentiometer**: The potentiometer is the core sensing element of the TPS. It typically consists of a resistive track and a wiper arm that moves along the track as the throttle shaft rotates. The position of the wiper arm on the resistive track determines the voltage output of the TPS, which corresponds to the throttle position.
- **Wiper Arm**: The wiper arm is connected to the throttle shaft and moves along the resistive track of the potentiometer. It provides variable resistance based on the position of the throttle shaft, allowing the TPS to generate a voltage signal proportional to the throttle position.

COMPONENTS

- **Spring Mechanism**: A spring mechanism is often used to provide resistance to the throttle shaft and ensure smooth operation of the TPS. It helps maintain consistent contact between the wiper arm and the resistive track, preventing signal fluctuations due to vibration or sudden throttle movements.
- **Connector and Wiring Harness**: The TPS is connected to the vehicle's wiring harness via an electrical connector. The wiring harness carries the electrical signals generated by the TPS to the ECU or PCM, allowing the vehicle's onboard computer to adjust engine parameters based on throttle position.

PRINCIPLE USED

- Potentiometer is a resistor with three terminals.
- Out of the three terminals – one is varying, whereas the rest two are fixed.
- It is an electric component used to measure the unknown voltage by comparing it with the known one, which can be drawn by a cell or any of the other supply sources.

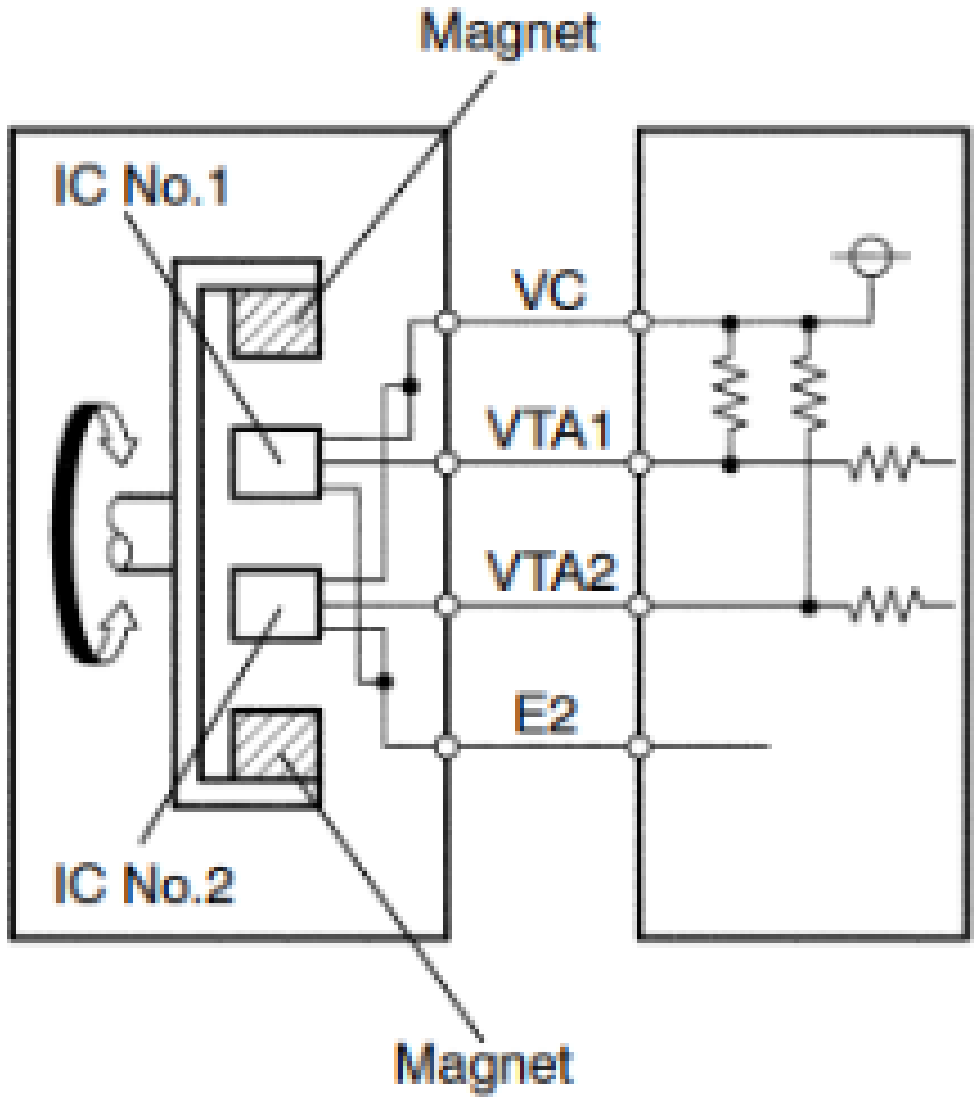
WORKING

- The TPS is typically mounted on the throttle body assembly, directly connected to the throttle shaft or butterfly valve.
- The core of the TPS relies on a potentiometer, a variable resistor. As the throttle valve opens or closes in response to driver input via the accelerator pedal, the throttle shaft rotates.
- The throttle shaft movement causes a wiper arm (connected to the throttle shaft) to move along a resistive track inside the TPS.
- The position of the wiper arm along the resistive track varies the resistance between the wiper arm and one end of the resistive track.

WORKING

- A constant voltage is applied across the two ends of the resistive track.
- As the resistance between the wiper arm and one end of the track changes with throttle movement, the voltage output at the wiper arm terminal also changes proportionally.
- The varying voltage signal generated by the TPS is sent to the ECU or PCM.
- This signal indicates the position of the throttle valve (throttle position), ranging from idle to wide-open throttle.

WORKING



ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- Improved Engine Performance:
- Enhanced Fuel Efficiency
- Emission Control
- Quick Response

DISADVANTAGES

- Potential for Failure
- Costly Replacement
- Complexity in Diagnosis

APPLICATIONS

- Engine management
- Fuel Injection Control
- Idle Control
- Transmission Control
- Emission Control
- Cruise Control

EXHAUST OXYGEN LEVEL SENSOR

- The Exhaust Oxygen Level Sensor, commonly referred to as the oxygen sensor or O2 sensor, is a vital component in the exhaust system of modern vehicles.
- Its primary function is to monitor the oxygen content in the exhaust gases and provide feedback to the engine control unit (ECU)

COMPONENTS

- **Sensing Element:** This is the core component of the oxygen sensor responsible for measuring the oxygen content in the exhaust gases. In most modern vehicles, the sensing element is made of zirconia or titania, which undergo chemical reactions in the presence of oxygen.
- **Heater Element:** Many oxygen sensors are equipped with a built-in heater element to bring the sensor up to operating temperature quickly. This heater element helps improve sensor accuracy and responsiveness, especially during cold starts when exhaust temperatures are low.

COMPONENTS

- **Housing:** The sensing and heating elements are housed within a protective casing made of stainless steel or other heat-resistant materials. The housing protects the sensor from damage due to high temperatures and corrosive exhaust gases.
- **Connector:** The oxygen sensor is equipped with an electrical connector that allows it to interface with the vehicle's wiring harness. The connector typically contains multiple pins for transmitting sensor signals and providing power to the heater element.

COMPONENTS

- **Wire Harness:** The wire harness connects the oxygen sensor to the vehicle's electrical system. It carries signals from the sensor to the ECU and provides power to the heater element. The wire harness is often equipped with weatherproof connectors to ensure reliable operation in harsh environmental conditions.
- **Mounting Threads:** Oxygen sensors are designed to be threaded into the exhaust system at specific locations, such as the exhaust manifold or catalytic converter. The mounting threads ensure secure installation and proper positioning of the sensor within the exhaust stream.

PRINCIPLE USED

- O2 sensors utilize a zirconia-based sensing element that generates voltage based on the difference in oxygen concentration between the exhaust gas and the surrounding atmosphere.
- This voltage output varies depending on whether the exhaust gas is rich (high oxygen concentration) or lean (low oxygen concentration).
- The engine control unit (ECU) interprets this voltage signal to adjust the air-fuel mixture for optimal combustion efficiency and emissions control.

WORKING

- The heart of the O2 sensor is its sensing element, typically made of zirconia or titania ceramic material. The sensing element is located within the exhaust stream, either in the exhaust manifold or downpipe, where it's exposed to the gases exiting the combustion chamber.
- Surrounding the outer surface of the sensing element is a chamber filled with reference air or ambient air. This creates a comparison between the oxygen content i the exhaust gas and the reference air.
- As exhaust gases pass over the sensing element, a chemical reaction occurs on the surface of the zirconia or titania material.

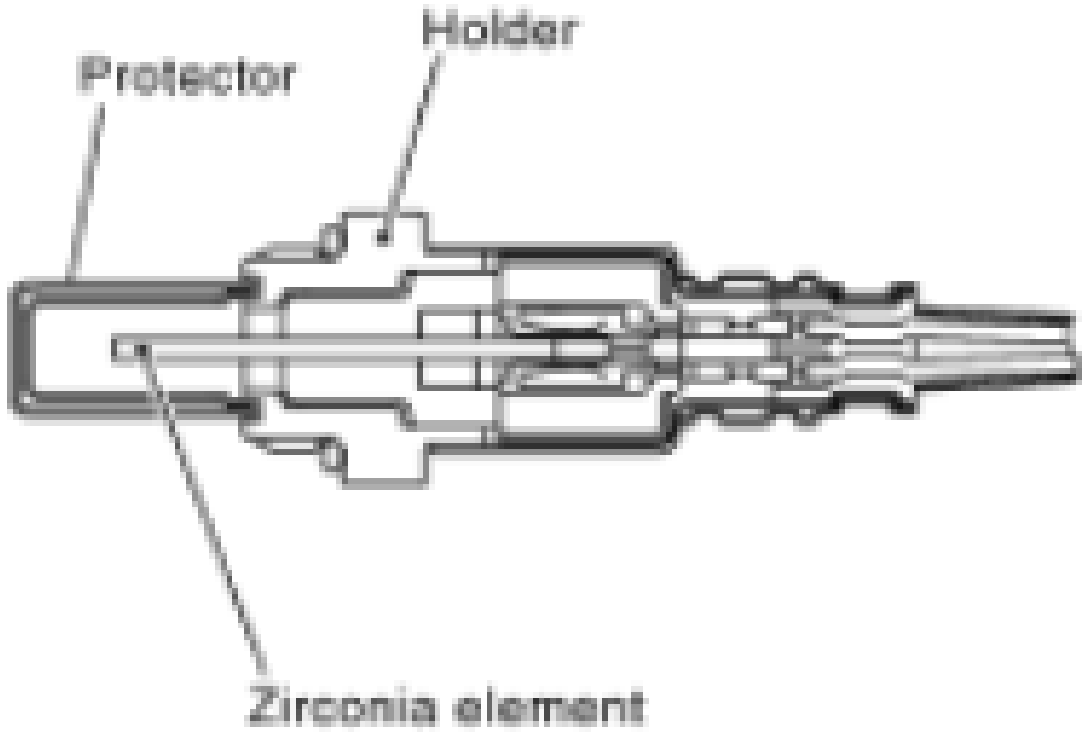
WORKING

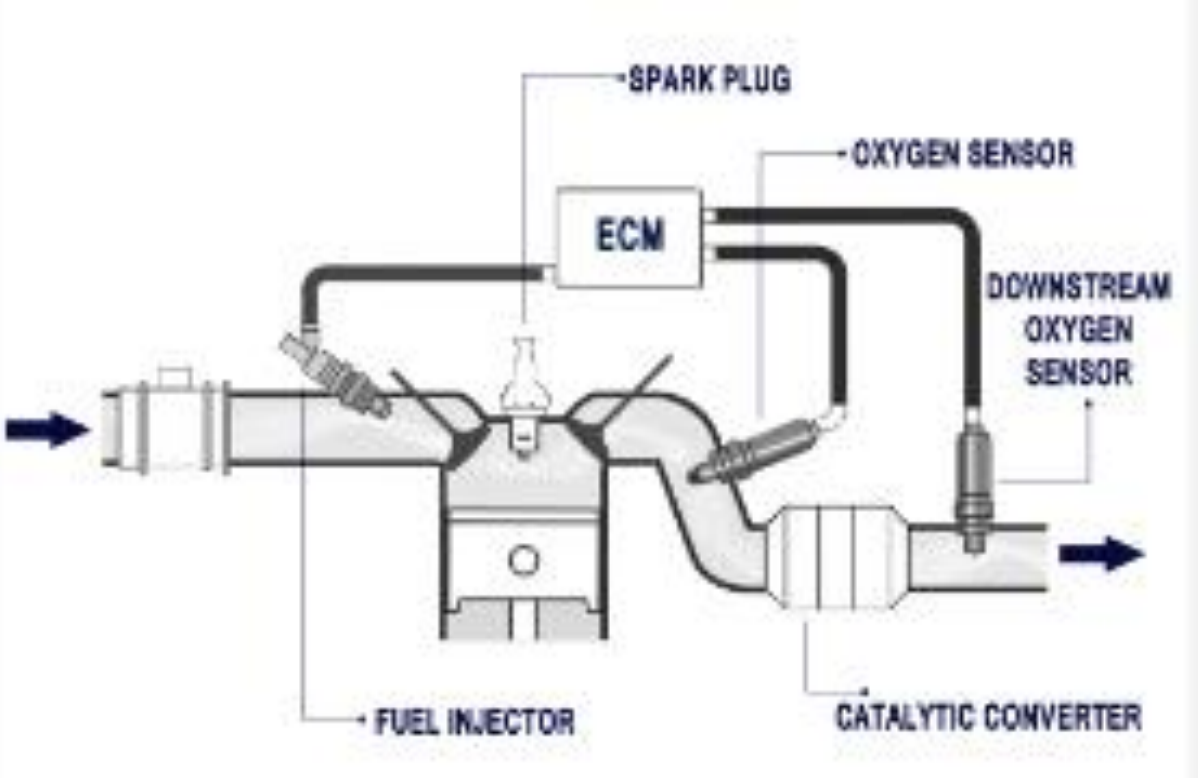
- This reaction generates a voltage signal that varies based on the difference in oxygen levels between the exhaust gas and the reference air.
- When the exhaust gas is rich (high oxygen content), the voltage output from the O2 sensor is low. Conversely, when the exhaust gas is lean (low oxygen content), the voltage output is high.
- This voltage signal is sent to the engine control unit (ECU).
- The ECU interprets the voltage signal from the O2 sensor and uses it to adjust the air-fuel mixture being delivered to the engine.

WORKING

- This adjustment is part of a closed-loop control system, where the ECU continuously monitors and adjusts the fuel injection and ignition timing based on feedback from the O2 sensor.
- By maintaining an optimal air-fuel ratio (typically around 14.7 parts air to 1 part fuel for gasoline engines), the engine can achieve efficient combustion, maximize power output, and minimize harmful emissions such as nitrogen oxides (NOx) and hydrocarbons (HC).

WORKING


Holder
Protector
Zirconia element


SPARK PLUG
OXYGEN SENSOR
ECM
DOWNSTREAM
OXYGEN
SENSOR
FUEL INJECTOR
CATALYTIC CONVERTER

ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- Improved Fuel Efficiency
- Emission reduction
- Enhanced Engine performance
- Diagnostic Capability

DISADVANTAGES

- Sensor Deterioration
- Costly Replacement
- Potential for failure

APPLICATIONS

- Closed loop fuel control
- Emission Control
- Catalytic Converter operation
- Engine performance optimization
- Fuel Economy Improvement

THANK YOU !!!