

## Lectures

### 8<sup>th</sup> Semester B. Tech. Mechanical Engineering

#### Subject: I C Engines Lab

#### In-charge Course: Prof M Marouf Wani

#### Chapter: Engine Testing

#### Topic: Measurement of CO, CO<sub>2</sub>, HC, NO<sub>x</sub> and O<sub>2</sub> Emissions From I C Engines – 07-05-2020

##### 1. Measurement of Emissions:

A 5 gas exhaust gas analyzer is used for the measurement of emissions produced by the engines. The emissions that can be measured by the 5 gas exhaust gas analyzer are CO, CO<sub>2</sub>, Unburned HC, NO<sub>x</sub> and excess O<sub>2</sub>

#### Principle behind the measurement of CO, CO<sub>2</sub>, and HC emissions

##### Non-dispersive infrared measurement technique:

The instrument used for the measurement of CO, CO<sub>2</sub> and HC emissions consists of an infrared emitter fitted on one side of this measuring cell and a detector fitted on the opposite side of this cell. The cell makes use of the selective absorption of a particular range of wave length or part of energy, by a particular gas under observation, from the broadband or broader wavelength range based infrared radiation (or total energy emitted ) passed through it.

The infrared light is generated by an emitter on one side of the measuring cell and passed through the gas under observation. Some of its wavelength ranges are absorbed by the gas and the remaining parts of the infrared radiation are transmitted through the gas and detected by a detector fitted on the opposite side of the cell.

**The comparison of the original intensity of the infrared radiation and the intensity of light detected by the detector in the presence of gas is calibrated in terms of the relative amounts of CO, CO<sub>2</sub> and HC in the gases.**

Three cells are needed for measurement of the concentration of three gases in the exhaust gas of the engine with each cell being calibrated for each gas under consideration.

##### (i) CO emissions:

**Principle: Non-dispersive infrared measurement technique.**

##### (ii) CO<sub>2</sub> emissions:

**Principle: Non-dispersive infrared measurement technique.**

##### (iii) HC emissions:

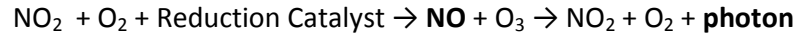
**Principle: Non-dispersive infrared measurement technique.**

(iv) **NO<sub>2</sub> and NO ( NO<sub>x</sub> emissions):**

**Nitrogen Oxide Sensor:**

**Principle: Chemiluminescence detector, CLD**

This makes use of the chemical reaction between nitric oxide and ozone.



The nitrogen compounds in exhaust gas are a mixture of NO and NO<sub>2</sub> described as NO<sub>x</sub>.

In the detector the **NO<sub>2</sub> is first catalytically reduced to NO.**

Next the sample of NO is reacted with **ozone**, generated by an electrical discharge through oxygen at low pressure in a vacuum chamber.

In presence of O<sub>3</sub> the **NO gets oxidized to NO<sub>2</sub>** and emits **light (or photon)** which is measured by a photomultiplier calibrated in terms of the concentration of NO<sub>x</sub> in the sample.

(v) **Excess O<sub>2</sub>:**

**Principle: electrochemical cell fitted with membrane permeable to o<sub>2</sub>.**

1. Analyzer uses an **electrochemical cell** to measure oxygen concentration.
2. The cell consists of two electrodes separated by an electrically conductive liquid.
3. It is mounted behind a **polytetrafluorethene membrane** through which oxygen can diffuse. The diffusion of oxygen into the conductive liquid of the electrochemical cell changes the electrical properties of the conductive liquid. The device therefore measures the oxygen partial pressure.
4. A polarizing voltage is applied between the electrodes of the cell and the resultant current is proportional to the oxygen partial pressure.
5. The change in the flow of current for the cases of neat conductive liquid and the conductive liquid saturated with oxygen is calibrated in terms of oxygen concentration in the exhaust gas of the I C engine.

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References:

1. User Manual
2. Wikipedia