Politechnika Wrocławska

Combustion Engines

Fuel supply system of SI engine

Combustion - a chemical reaction between flammable material or fuel and an oxidant, with the **release of heat and light.**
If combustion burns out in the combustion process, we talk about total combustion.

To complete combustion, the fuel-air mixture must have optimal quantity of air.

- For SI engines fueled with petrol to burn 1 kg of fuel, 14.7 kg of air is needed.

- Air Fuel Ratio AFR

- AFR = mass of air/ mass of fuel

- Stoichiometric AFR - 14.7:1

- It is used to determine the proportion of components of the air-fuel mixture we need **Air-fuel equivalence ratio (λ)**

- **Air-fuel equivalence ratio (λ) -** is the ratio of actual AFR to stoichiometry for a given mixture.

$$\lambda = \frac{\mathrm{AFR}}{\mathrm{AFR}_{\mathrm{stoich}}}$$

If in the mixture consist of too much fuel or too little air then λ <1 (rich mix)

- if there is too little fuel in the mix or too much air then λ > 1 (lean mix)
- if there is a suitable amount in the mixture then λ= 1 (ideal mix)

The ideal blend is referred to as the **stoichiometric mixture**

- Air to fuel Ratio - AFR
- AFR = m_{air}/m_{fuel}

- Ideal (petrol) - 14.7:1

- Lambda- fuel equivalence ratio
- Lambda= ARF/AFR stoich.
- AFR- what we have, stoichio- what we need

1.1 AIR FUEL RATIO

This is the ratio of the mass of air used to the mass of fuel burned.

Air Fuel Ratio = m_a/m_f

The ideal value that just completely burns all the fuel is called the *STOICHIOMETRIC RATIO*.

In reality, the air needed to ensure complete combustion is greater than the ideal ratio. This depends on how efficient the engine is at getting all the oxygen to meet the combustible elements. The volume of air drawn into the engine is theoretically equal to the capacity of the engine (the swept volumes of the cylinders). The mass contained in this volume depends upon the pressure and temperature of the air. The pressure in particular depends upon the nature of any restrictions placed in the inlet flow path.

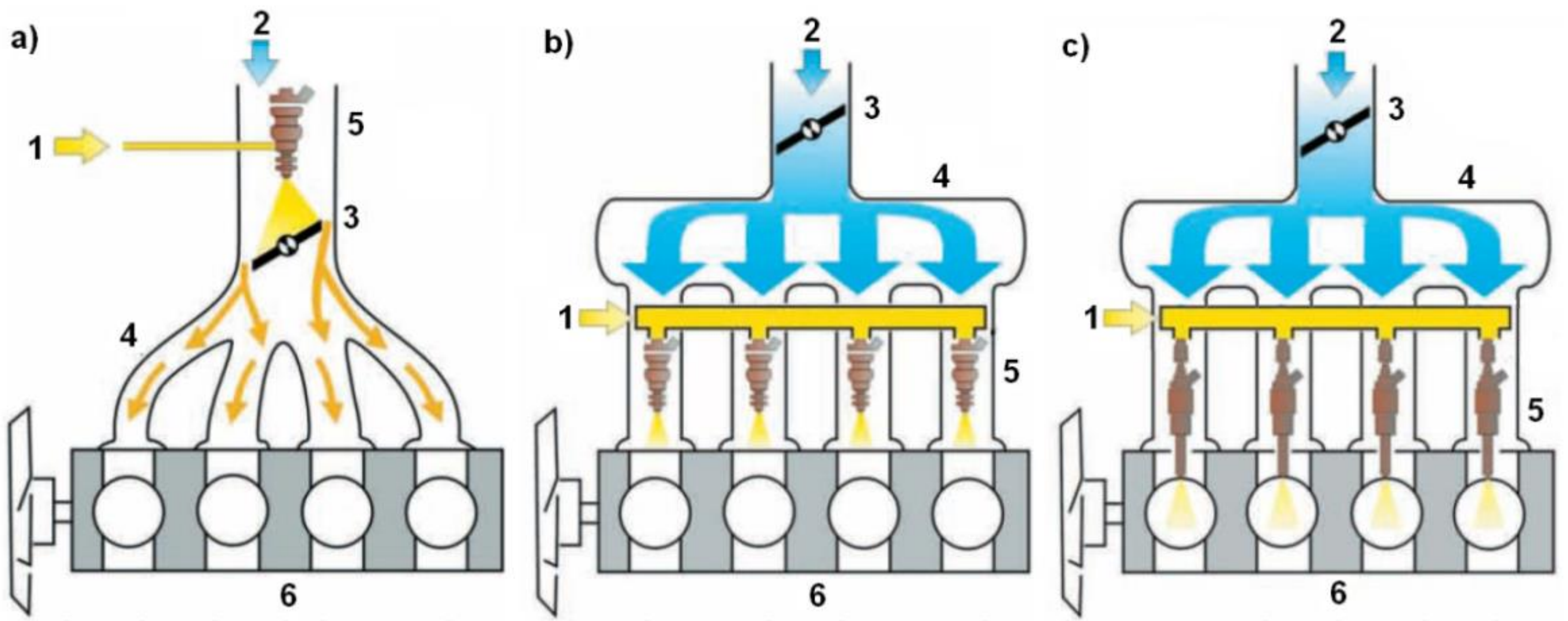
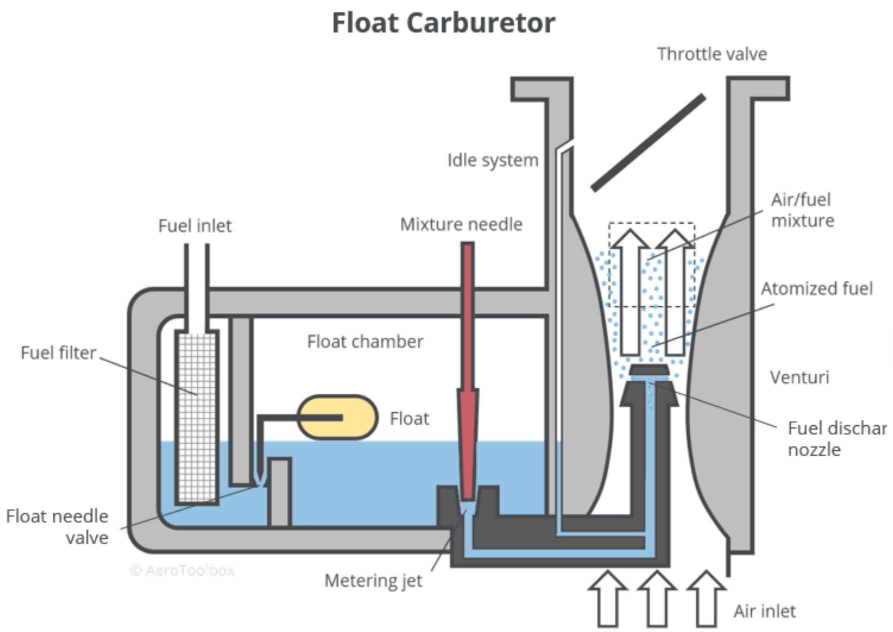
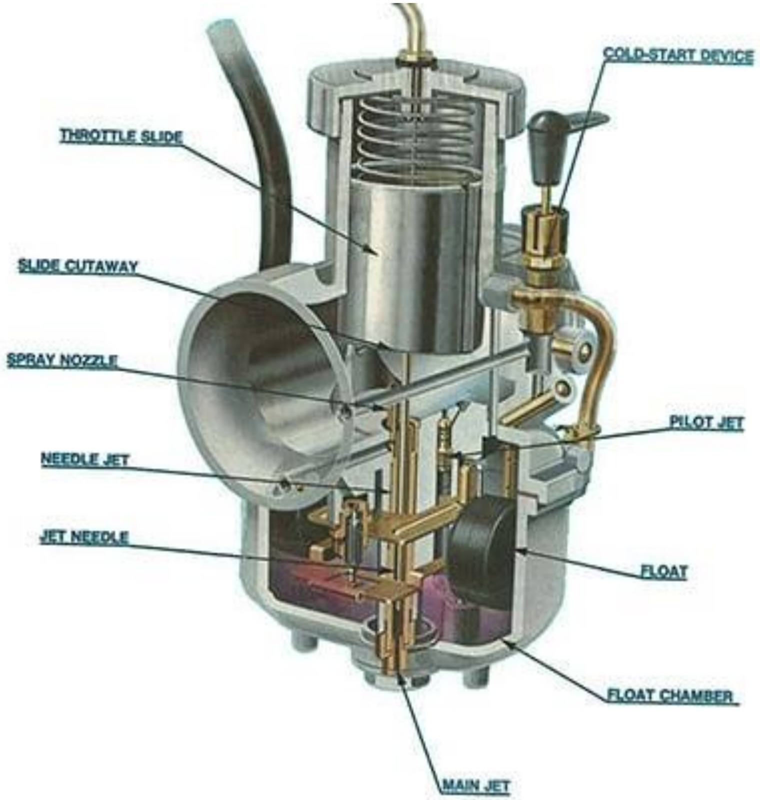


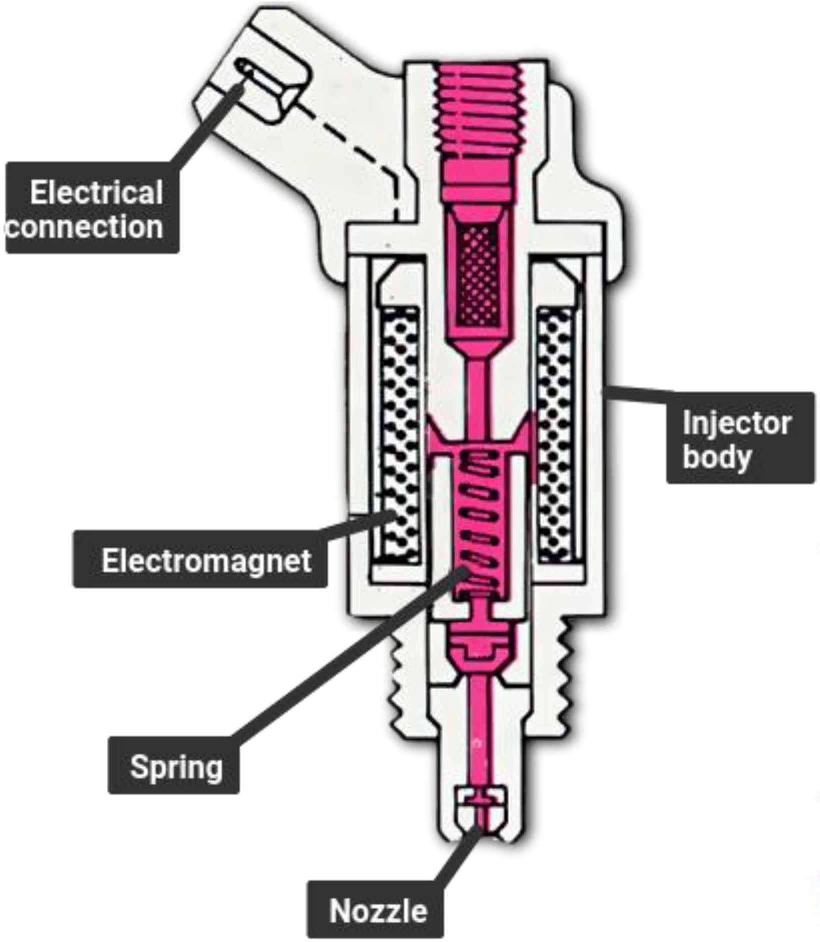
Figure 1. Systems of fuel injection [1]:a) Single Point Injection, b) Multipoint Injection, c) Direct Injection; 1 – Fuel supply, 2 – Air intake, 3 – Throttle, 4 – Intake manifold, 5 – Fuel injector (or injectors), 6 – Engine

Carburetor


Float Carburetor
Throttle valve
Idle system
Air/fuel mixture
Fuel inlet
Mixture needle
Atomized fuel
Float chamber
Fuel filter
Venturi
Float
Fuel dischar nozzle
Float needle valve
© AeroToolbox
Metering jet
Air inlet


COLD-START DEVICE
THROTTLE SLIDE
SLIDE CUTAWAY
SPRAY NOZZLE
PILOT JET
NEEDLE JET
JET NEEDLE
FLOAT
FLOAT CHAMBER
MAIN JET

Injectors


Electrical connection
Injector body
Electromagnet
Spring
Nozzle


MECHANICAL INJECTION
INJ-044
MAINLY EUROPEAN
SIDE FEED
INJ-084
CFI OR MULTI POINT
EFI – PORT INJECTION
INJ-035
VERY COMMON
DIRECT INJECTION
INJ-271
CURRENT
EARLY TYPE
CURRENT TYPE

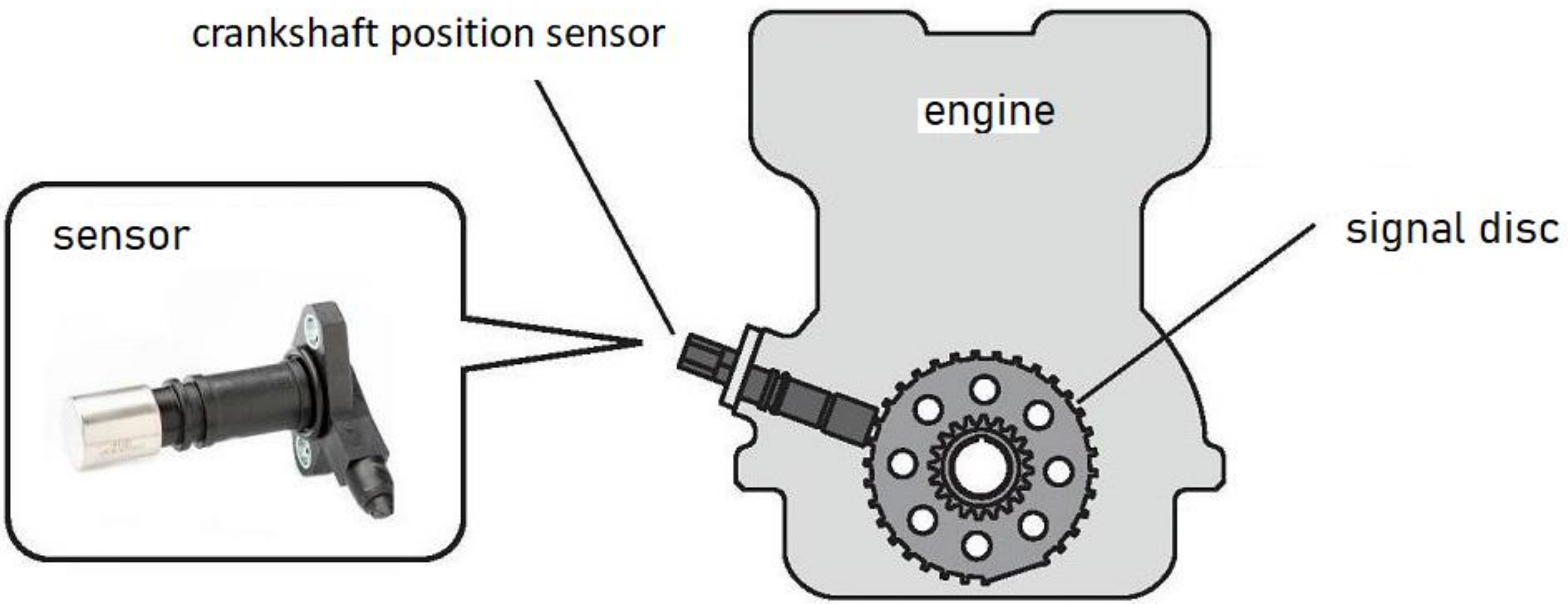
Engine control

Vehicle sensors collect information from individual components and send it to the control unit. This unit, based on the received data, selects the best "work path" and sends out commands about the selection made.

The crankshaft position sensor is responsible for:

- collects information about the current, instantaneous position of the crankshaft and its rotational speed,
- determines which cylinder is performing the power stroke,
- measurement of engine speed,
- determination of the ignition advance angle,
- angular regulation of fuel injection time

Some may confuse a failure of the crankshaft position sensor with a failure of the fuel pump, as in both cases the fuel supply to the engine is cut off.

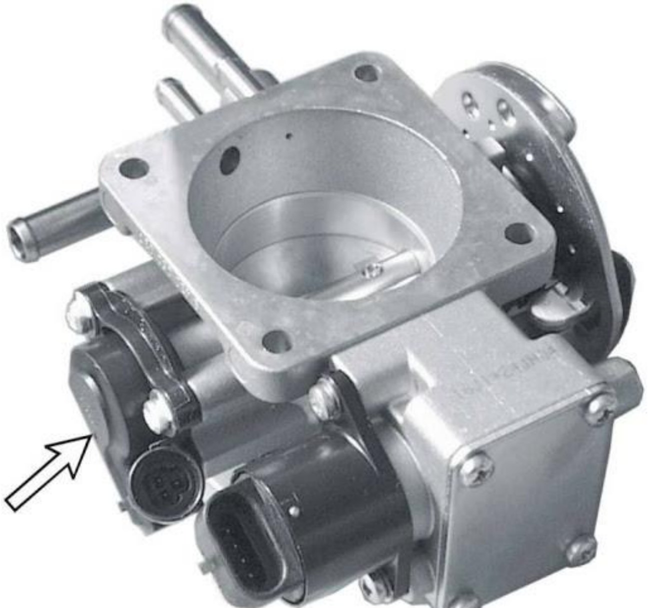

crankshaft position sensor
engine
sensor
signal disc

Air flow meter

- measurement of the intake air mass (or volume with temperature),
- determining the basic fuel dose

Throttle position regulator

- controls the electric motor so that the throttle is opened or closed depending on the measured rotational speed (reaching the intended speed)



Lambda sensor/ oxygen sensor:

- measurement of the amount of oxygen in the exhaust gas at the cylinder outlet,
- regulates the composition of the fuel-air mixture by sending information about the mixture (rich / lean) to the controller