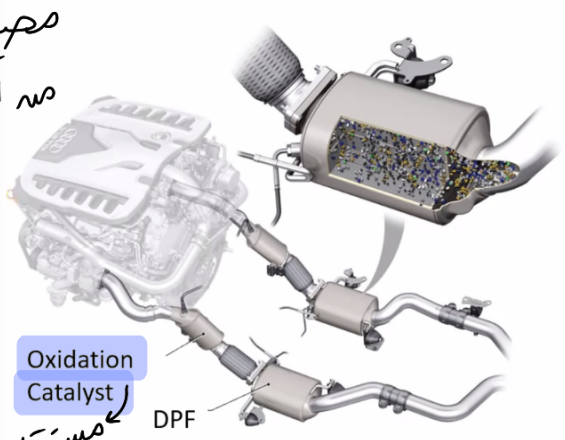
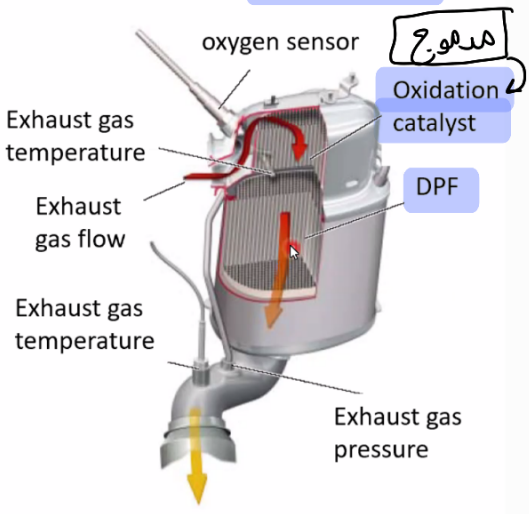
Diesel particulate filter system

BIRZEIT UNIVERSITY

Diesel particulate filter (**DPF**) is a device designed to remove diesel particulate soot from the exhaust gas of a diesel engine





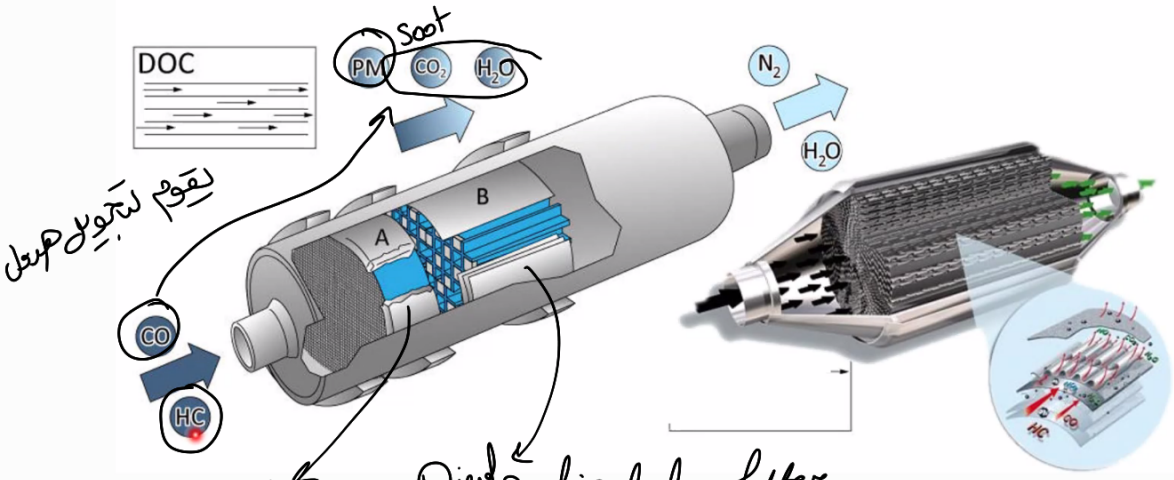
Set-Up: The diesel particulate filter and the oxidation catalytic converter are installed separately in a same housing. The oxidation catalytic converter is arranged in front of the particulate filter in the direction of the flow.

Diesel particulate filter system

BIRZEIT UNIVERSITY

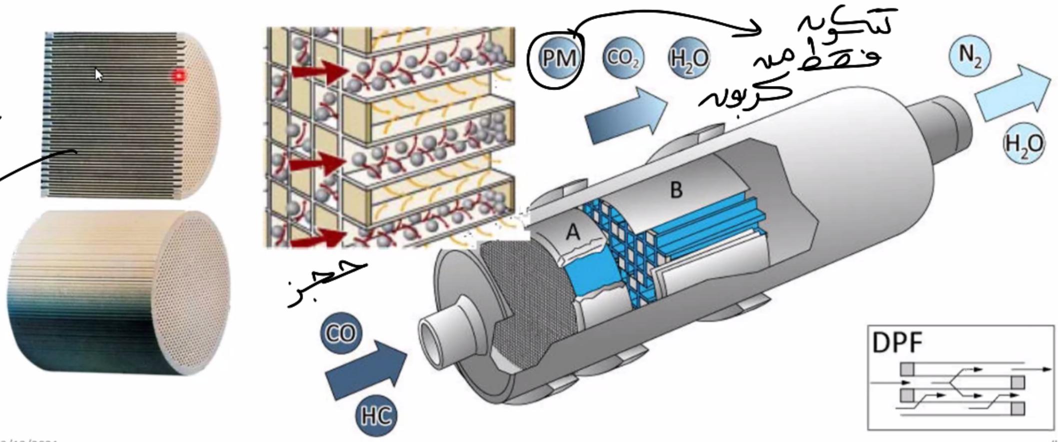
Oxidation Catalyst: The oxidation catalyst converts a large proportion of hydrocarbons (HC) and carbon monoxide (CO) into water vapour and carbon dioxide (CO2).

The carrier material of the oxidation catalyst is made of metal in order to quickly reach the starting temperature. On this metal body there is a carrier layer of aluminum oxide. Platinum is deposited on it as a catalyst for the hydrocarbons (HC) and the carbon monoxide (CO).



DPF: The sooty exhaust gas flows through the porous filter walls of the inlet channels. In contrast to the gaseous components of the exhaust gas, the soot particles are trapped in the entrance channels.

The diesel particulate filter consists of a honeycomb ceramic body made of silicon carbide. The ceramic body is divided into a number of small channels which are closed alternately. This results in inlet and outlet channels which are separated by filter walls. The filter walls are porous and coated with a carrier layer of aluminium oxide (and cerium oxide). The precious metal platinum, which serves as a catalyst, is evaporated onto this carrier layer.



فخار ceramic

تكوين قطع من كربون

حجز

انابيب صغيرة لاحتجاز الـ soot (PM)

لكن بعد فترة تتشكل طبقة عليها

Regeneration

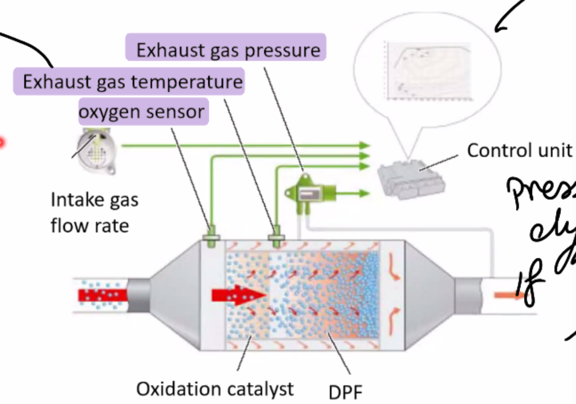
عملية تنظيف الـ ceramic Body عن طريق أنو اعمل Burning لذرات الكربون وتحولها لـ CO_2 (تعرضها لدرجة حرارة عالية مع توافر الأكسجين)

Regeneration

The particulate filter must be regenerated regularly so that it is not blocked by soot particles and its function is reduced. During the regeneration process, the soot particles collected in the particulate filter are burned (oxidised).

The regeneration of the particulate filter takes place in the following stages:

1. **Heating-up phase**
2. **Passive Regeneration**
3. **Active Regeneration**
4. **Regeneration drive-by customers**
5. **Service regeneration**



Sensors

pressure sensor

لمعرفة كمية الانسداد

اذا صار انسداد كامل بجيب اشي اعلى من الكربون

تحدد درجة الانسداد

Actuator: injector

pressure difference = 0 if DPF is is not here

ΔP high → higher torque needed → More fuel is needed

1. Heating-up phase
2. Passive Regeneration
3. Active Regeneration
4. Regeneration drive-by customers
5. Service regeneration

Driver does not Do them, the vehicle does.

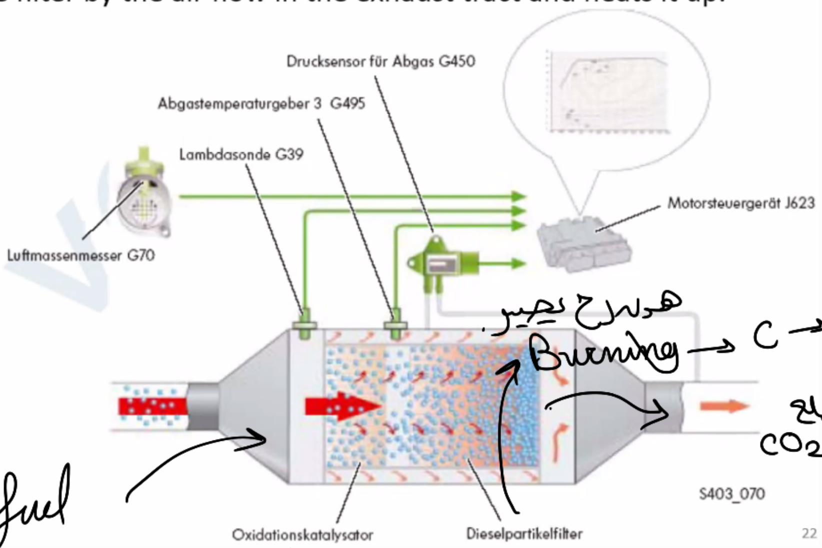
Diesel particulate filter system

Regeneration

1. Heating-up phase

- In order to heat up a cold particulate filter as quickly as possible and thus bring it to operating temperature, after-injection is initiated by the engine management system after the main injection. This fuel does not burn in the cylinder but evaporates in the combustion chamber and is oxidized in the oxidation catalyst. The resulting heat is transferred to the particulate filter by the air flow in the exhaust tract and heats it up.

- The heating-up phase is completed as once the exhaust gas temperature after the oxidation catalytic converter has reached approx. 250 °C for at least 90 seconds.



unburned fuel

Burning → C → CO_2

oxidies the vapor and so high temp exhaust gasses

DPF

Diesel particulate filter system

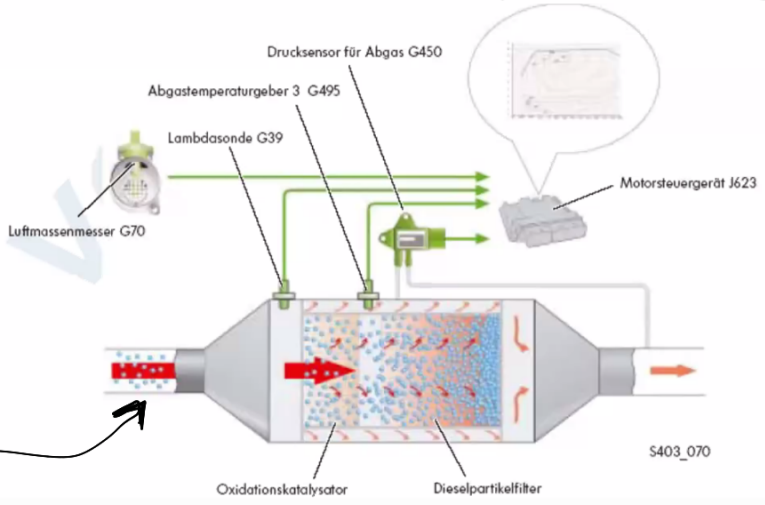
BIRZEIT UNIVERSITY

Regeneration

2. Passive Regeneration

- During passive regeneration, the soot particles are continuously burned without the help of the engine control system. This occurs mainly at high engine loads, for example on highways, with exhaust gas temperatures of 350°C - 500°C.

- The soot particles are converted into carbon dioxide by a reaction with nitrogen dioxide.



Diesel particulate filter system

BIRZEIT UNIVERSITY

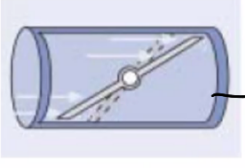
3. Active Regeneration

- In city traffic, i.e. with low engine load, the exhaust gas temperatures are too low for passive regeneration. Since no more soot particles can be broken down, there is an accumulation of soot in the filter.

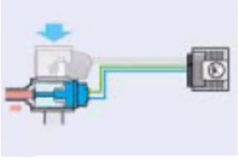
- As soon as a certain soot load is reached in the filter, active regeneration is started via the engine control system. The soot particles are burned to carbon dioxide at an exhaust gas temperature of 600 -650 °C.

Action taken by the engine control unit during active regeneration to increase the exhaust gas temperature:

A. The intake air is controlled by the throttle valve control unit.



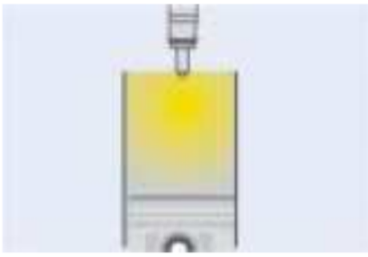
B. The exhaust gas recirculation is switched off to increase the combustion temperature and the oxygen content in the combustion chamber.



control units will open the throttle more than intended to let more air enter → (Driver has no control)
→ EGR switched off → higher engine temperature → so higher Exhast gasses temperature → post_injection

Action taken by the engine control unit during active regeneration to increase the exhaust gas temperature:

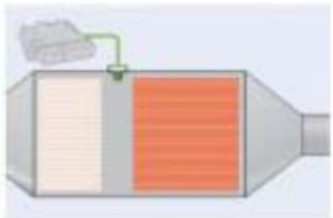
C. Late after the main injection a further post injection is initiated. This fuel does not burn in the cylinder, but evaporates in the combustion chamber.



D. The unburned hydrocarbons of this fuel vapor are oxidized in the oxidation catalyst. The resulting heat causes the exhaust gas temperature upstream of the particulate filter to rise to around 620°C.

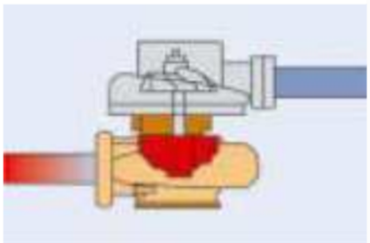
Action taken by the engine control unit during active regeneration to increase the exhaust gas temperature:

F. To calculate the injection quantity for late after-injection, the engine control unit uses the signal from the exhaust gas temperature sensor upstream of the particulate filter.



يعني زيادة الهوا لغرض ما توثر على السرعة

G. The charge pressure is adjusted so that the torque does not change noticeably for the driver during the regeneration process.



Diesel particulate filter system

4. Regeneration drive-by customers

- If the load condition of the diesel particulate filter reaches a limit value of certain grams, the indicator light for the diesel particulate filter lights up in the control panel insert.
- With this signal the driver is requested to carry out a regeneration drive. The vehicle must be driven at increased speed for a short period of time in order to achieve a sufficiently high exhaust gas temperature and to maintain the operating conditions for successful regeneration over a period of time.

- Possible causes for the indicator light for diesel particulate filters lighting up:
  - In extreme short-distance traffic, no sufficiently high exhaust gas temperature is reached to regenerate the filter.
  - During long full throttle runs, a larger number of particles is produced than can be removed by the filter.
  - A digital driving mode (throttle, brake, accelerator, brake) leads to uneven operating conditions for successful regeneration of the filter and thus prevents the reduction of the load condition.

لما تكون السيارة تمشي في مدينة او مسافات قصيرة

حد عشان بسرعات عالية

شبيه فيه

Brake gas Brake gas

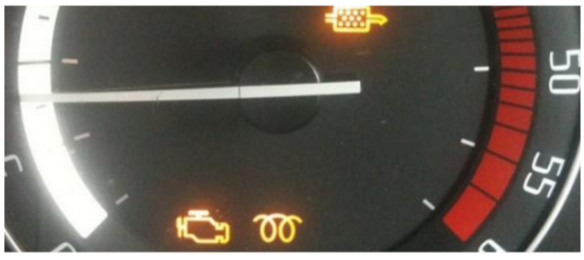
5. Service regeneration

- If the regeneration run has not been successful and the load condition of the diesel particulate filter has reached 40 grams, the indicator lamp for glowplug indicator lights up in addition to the indicator lamp for diesel particulate filter.

Diesel particulate filter indicator lamp

Engine malfunction

Glowplug indicator



- The display of the control panel insert shows the text "Engine malfunction workshop".
- This prompts the driver to go to the nearest workshop. In this case, active regeneration of the diesel particulate filter in the engine control unit is blocked in order to prevent damage to the particulate filter.

3 Signs together

Regeneration phases of the 2.0l TDI CR engine in the Tiguan