Air injection and Catalytic converters

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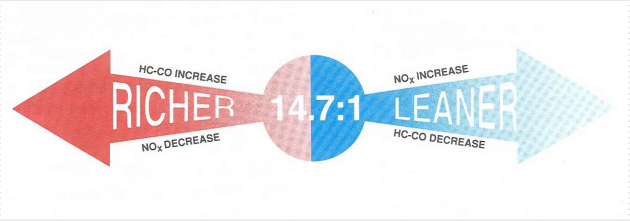
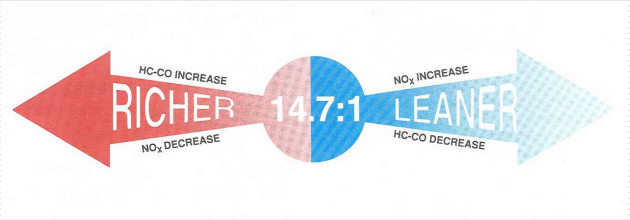
Relationships



- Richer A/F mixture:
  - lowers temp due to greater amount of fuel to quench burning process.
  - Increases the amount of CO and HC's due to the insufficient heat to burn HC and combine carbon with oxygen.

Relationships



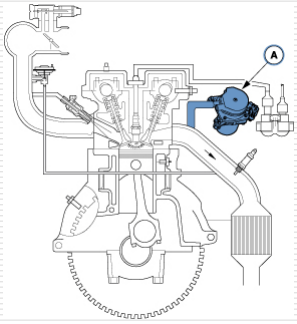
- Lower compression:
  - Lowering compression will also lower temperatures.
  - Increases HC and CO, with a loss of power and decreased fuel economy

Relationships

- Diluting the A/F mixture with Exhaust gases.
  - Exhaust gas contains very little oxygen to support combustion. If the A/F mixture is diluted with small amounts of exhaust gasses, combustion chamber temperatures drop. The side effects is the engine power and performance is reduced.
  - The PCM controls the EGR valve and allows EGR flow only during conditions when the reduced power does not adversely affect driveability.
  - EGR does not flow when:
    - Engine is starting
    - Engine is cold
    - Idling
    - WOT/Heavy load

Secondary Air Injection

- The secondary Air Injection Reaction (AIR) System (A) adds air to the exhaust gas stream either upstream or downstream of the catalyst.
- The fresh air is added to increase the temperature of the catalytic converter, which increases its ability to convert gasses.
- "AIR" = Air Injection Reaction

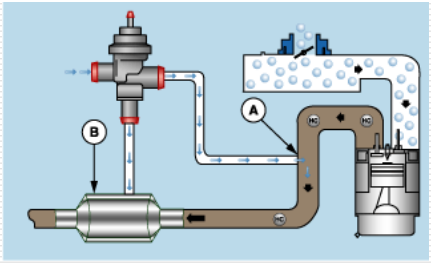


Secondary AIR Injection

- AIR injection can be upstream or downstream.

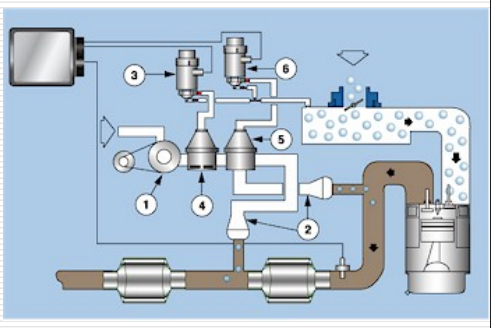
A. Upstream before the catalytic converter.

B. Into the catalytic converter.



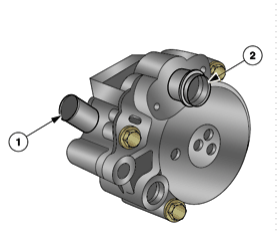
Secondary AIR Injection #1

- Components
  1. Mechanical AIR pump
  2. AIR check valves
  3. Normally closed AIR bypass solenoid
  4. Normally closed AIR bypass valve
  5. Diverter valve
  6. Normally closed AIR diverter solenoid



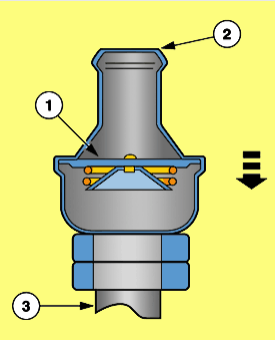
Mechanical AIR Pump

- Belt driven AIR pump.
  1. Air inlet
  2. Air outlet
- Provides a flow of fresh air to the AIR system



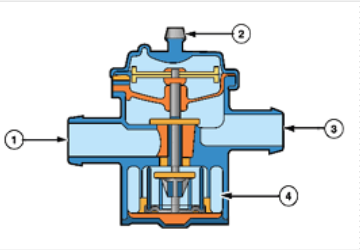
One-way Check Valve

- The one-way check valve is used to prevent exhaust gases from backing up in the AIR system and melting components with hot exhaust gases.
- Components:
  1. Rubber disc
  2. In from air
  3. Out to exhaust



AIR Bypass Valve

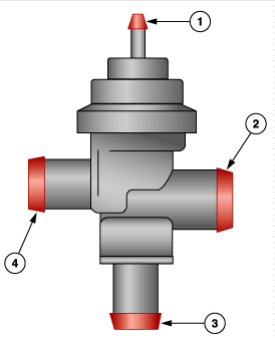
- The bypass valve is used only on the mechanical AIR pump system. This valve directs airflow to the exhaust stream, the diverter valve or to the atmosphere.
- Components:
  1. Inlet from AIR pump
  2. To AIR bypass solenoid
  3. Outlet to check valve
  4. AIR bypass/relief exhaust ports



Diverter Valve

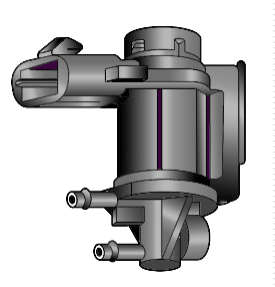
- The diverter valve receives air from the bypass valve, on mechanical systems, or directly from the electric pump. The diverter valve directs airflow "upstream" or "downstream".

- Components:
  1. To AIR diverter solenoid
  2. Outlet to check valve downstream
  3. Outlet to check valve upstream
  4. From AIR bypass valve



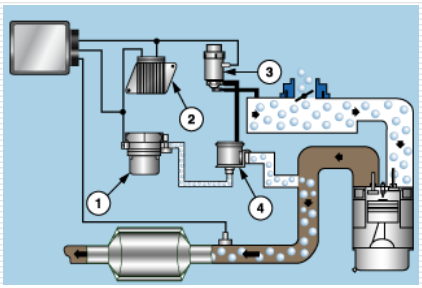
N/C AIR Solenoid solenoid.

- Used to control the operation of AIR system flow bypass valves.



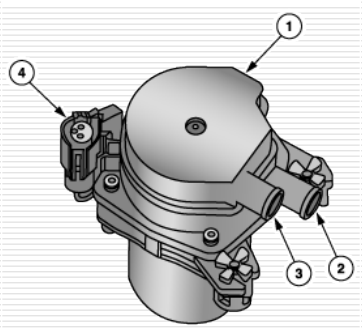
Secondary AIR Injection #2

- Components:
  1. Electrical AIR pump
  2. Solid state relay (SSR)
  3. Secondary AIR injection diverter solenoid
  4. Air injection diverter (AIR diverter) valve



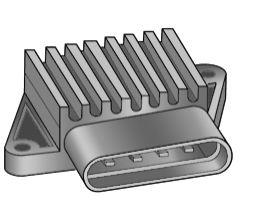
Electrical AIR Injection Pump

- Electrical motor driven used to provide fresh air pressure for AIR Injection system.
- Components:
  1. Filter cover
  2. Outlet
  3. Inlet
  4. Electrical connector



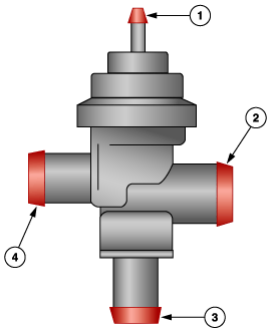
Solid State Relay

- Provides power to electrical air pump, and is controlled by the PCM.



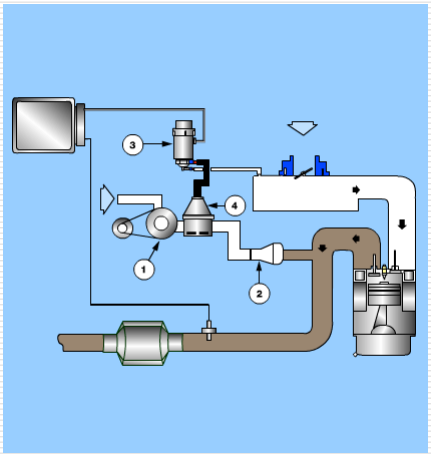
Diverter Valve

- The diverter valve receives air directly from the electric pump. The diverter valve directs airflow "upstream" when needed.
- Ports
  1. From AIR Dirverter solenoid
  2. Outlet to exhaust upstream
  3. Check valve
  4. From AIR Pump



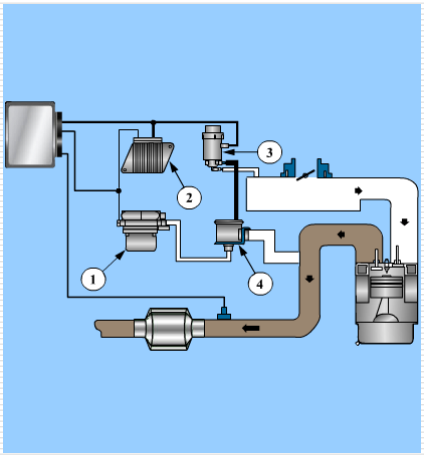
Mechanical TWC

1. PCM grounds signal to bypass valve solenoid.
2. Bypass valve solenoid sends vacuum to bypass valve
3. Bypass valve opens port to allow air to be pumped into exhaust upstream.



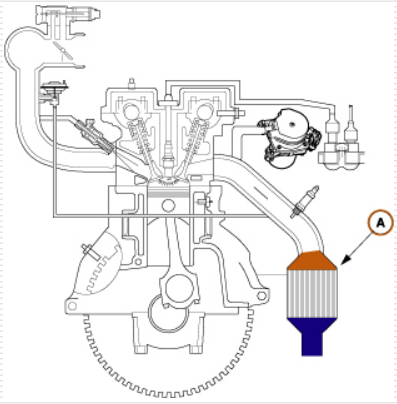
Electrical TWC

1. PCM commands SSR to turn on air pump.
2. PCM grounds Bypass Solenoid which applies vacuum to Bypass Valve.
3. Bypass Valve opens port for airflow to TWC



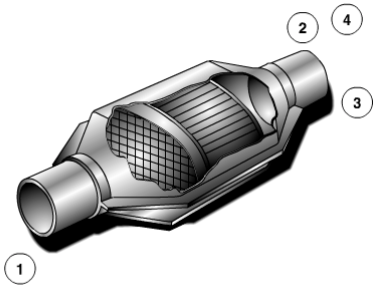
Catalytic converter.

- With increasing exhaust emissions, a catalytic converter (A) was added to the exhaust system in the mid-1970s. Catalytic converter technology has steadily improved, and as a result, the modern day catalyst has become the cornerstone of emission control devices.



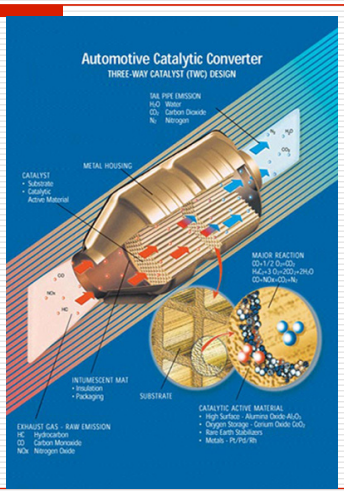
Catalytic Converter

- The catalytic converter is an after treatment device used to reduce exhaust emissions.
- Emissions:
  1. HC, CO, NOx
  2. HC + O2 => CO2 + H2O
  3. CO + O2 => CO2
  4. NOx + H2 => N2 + H2O



Catalytic converter construction

- Ceramic monolith catalytic converter.
- Components
  - Ceramic monolithic brick with parallel holes to allow for flow.
  - Washcoat made of a porous aluminum material for a rough surface
  - Catalytic material applied to washcoat. (platinum, rhodium, and palladium)
  - Intumescent mat to stabilize the brick
  - Stainless steel metal housing.



Catalyst

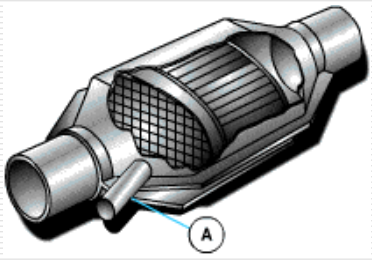
- The catalyst is an element that starts the chemical reaction without becoming a part of, or being consumed in the process.

Converter types

- COC
- TWC
- COC + TWC

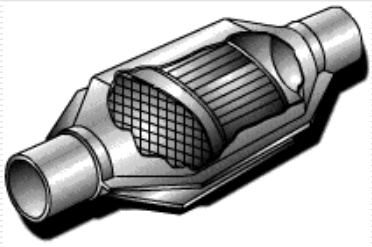
COC

- Conventional Oxidation Catalyst
- Used to convert only HC and CO to CO_2 and H_2O
- First design used on motor vehicles.
- Due to its inability to convert NOx the engines where run rich to control NOx



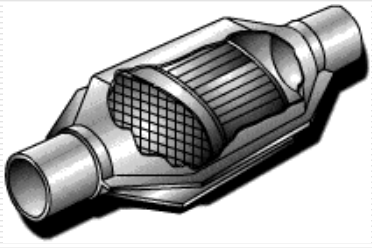
TWC

- Three-Way Catalyst
- TWC's combine an oxidation function to control HCs and CO and a reduction function to convert NOx.
- The reduction function is done by adding ceria (CeO_2)
- Ceria has the ability to store and release oxygen, thus eliminating the need for pumped in air.



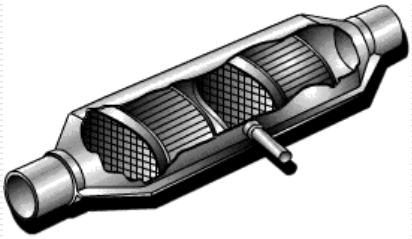
TWC (cont.)

- Three-Way Catalyst
- The front section of the catalytic converter reduces the oxides of Nitrogen, this reduction strips the Oxygen from the Nitrogen and the two elements travel to the COC element.
- The COC element combines the Oxygen with Carbon and Hydrogen to produce Carbon Dioxide and Water.



COC + TWC

- For some vehicle applications, both the COC and the TWCs were used. Some used separate catalysts and some combined both catalysts into one housing.
- Secondary air was injected upstream into the exhaust manifold during startup and injected downstream into the middle of the catalyst system.
- The downstream air provided the extra oxygen required by the COC while allowing the TWC to operate using a stoichiometric air/fuel ratio (14.7:1)



Operation

- A Catalytic converter requires the Rich-to-lean exhaust for proper operation.
  - A rich exhaust is required for reduction of the Oxides of Nitrogen.
  - A lean exhaust is required to provide the oxygen that is necessary to oxidize HC and CO. (Combining Oxygen with HC and CO produces Carbon Dioxide and Water.

Operation (cont.)

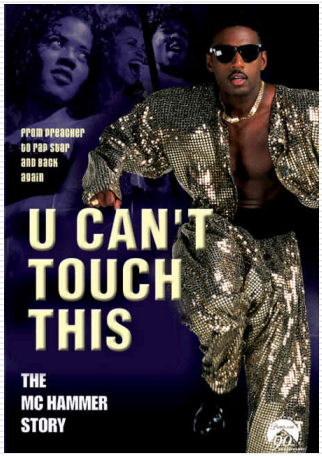
- Catalytic Converter "light-off"
  - The catalytic converter does not work when cold and must be heated to its light-off temperature of close to 500 F before it starts working at 50% effectiveness.
  - When fully effective, the converter reaches a temperature range of 900 F to 1600 F.
  - Some vehicles have LOC (light-off converters), which are mounted directly to the exhaust manifold or very close. The LOC are quick heating

Converter Diagnosis

- Tap Test
- Back pressure with vacuum gauge
- Back pressure with pressure gauge

Tap Test

- Using a hammer tap lightly on the catalyst casing and listen. If possible compare to known good cat. If the catalytic converter rattles enough to be loud replace the cat.



Overview
Ford Motor Company

Restriction Test w/ vacuum gauge

- Run the engine at 2000 to 2500rpm and monitor the vacuum gauge readings. If the engine manifold vacuum drops closer to zero while at 2k 2.5k rpm the exhaust is restricted.

AUMT 2317 Emission Systems
Overview

Restriction Test w/ pressure gauge

- At idle the pressure should be less than 1.5 psi. at 2500 rpm the pressure should be lower than 2.5 psi.

Catalytic converter damage