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OBD – II and Vehicle Evaporative System: Study on conversion of a fluid into vapour

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1.Abstract:- Evaporative system, it is a system meant to prevent the escape of petrol vapors from the fuel tank or carburetor float bowl to the atmosphere while the engine is off. The vapors are stored in a canister or in the crank-case until is started. OBD-II, systems were designed to maintain low emissions of in use vehicles, including light and medium duty vehicles. The OBD-II diagnostic system shall control the air flow of the complete evaporative system. In addition, the diagnostic system shall also monitor the complete evaporative system for the emission of Hydrocarbon vapor into the atmosphere by performing a pressure or vacuum check of the complete evaporate system. From time to time, manufactures may occasionally turn off the evaporative purge system in order to carry out a check.

Key Words: Anti-icing, Evaporative, ignition timing, reluctance sensor, shut purge valve, Vacuum Check, Venturi, Vapour.

2. INTRODUCTION:

2.1. Evaporative System Monitoring:

Hydrocarbon in the form of fuel vapors escaping from the vehicle, primarily from the fuel tank are required to be monitored to reduce emission. There are two principal cause of fuel vapor in the fuel tank, increasing ambient temperature and return of unused hot fuel from the engine. The evaporative control system consists of a vapor ventilation line that exits the fuel tank and enters fuel vapor canister. The canister consists of an active charcoal element which absorbs the vapour and allows only air to escape to the atmosphere. Only a certain volume of fuel vapor can be contained by the canister. The vapors in the canister must therefore be purged into the engine and burned by the engine so that the canister can continue to store vapors

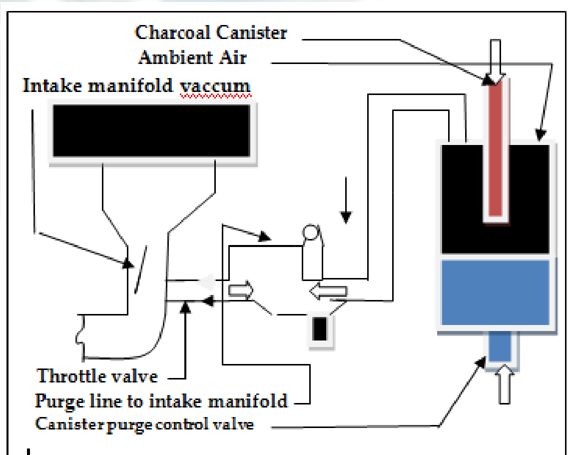


Figure: 1(a) Evaporative Emission Control System

that the canister can continue to store vapors when they are generated.

To accomplish another purge line leads from the char coal canister to the intake manifold. Included in this line is the canister purge solenoid valve.

During engine operation vacuum in the intake manifold causes flow through the charcoal canister because the canister vent opening at the charcoal filter end is at atmospheric pressure. The canister purge valve meters the amount of flow from the canister. The amount of fuel vapor in the canister and therefore, contained in the flow stream, is not known. Therefore, it is critical that the lambda control system is operating and adjusting the fuel requirement as the vapors are being purged. Purge vapors could otherwise result in up to 32% increase in Air Fuel mixture richness in the engine. Purge control valve is situated in the pipe line that connects is the intake manifold of the engine to the charcoal canister.

3. LITERATURE REVIEW:

3.1. Anti-Icing:

When fuel is sprayed into the air passing through the air horn, the fuel evaporates or turns to vapor. During evaporation, the fuel takes heat from the surrounding air and metal parts. This is the same effect you get if you put a few drops of water on your hand. Your hand feels cold. If you blow on your hand, causing the water to evaporate faster, your hand will feel even colder. The faster the evaporation takes heat from your hand, the cooler your hand feels. (From *Automotive Mechanics, 9th Edition)*

In the carburetor, spraying and evaporation of the fuel rob the surrounding air and carburetor of heat. Under certain conditions, the surrounding metal parts are so cooled that moisture in the air condenses and then freezes on the metal parts. The ice can build up sufficiently, if conditions are right, to cause the engine to stall. This is most apt to occur during the warm-up period following the first start-up of the day. It happens more with air temperatures in the range of 45 to 65° F and fairly humid air.

We know that carburetor process consists by Vaporizing petrol, mixing it thoroughly with air, and distributing this air fuel mixture evenly into the cylinder. However, the factors affecting performance carburetor is depending:

3.1.1. Temperature:

The vaporization of fuel is better with higher in take ambient temperature. These results in better mixing of fuel air mixture and even distribution into the cylinder, achieved good engine efficiency.

3.1.2. *Time:*

While the engine speed is high, the intake charge per stroke greatly reduces lowering the volumetric efficiency of the engine. The time available is not adequate for complete vaporization and proper mixture formation.

3.1.3. *Quality:*

Various grades of petrol are available in the market and have different Octane number. High octane rating fuels are used in engines having higher compression ratios. Hence the correct quality of fuel should be used for better burning and even distribution.

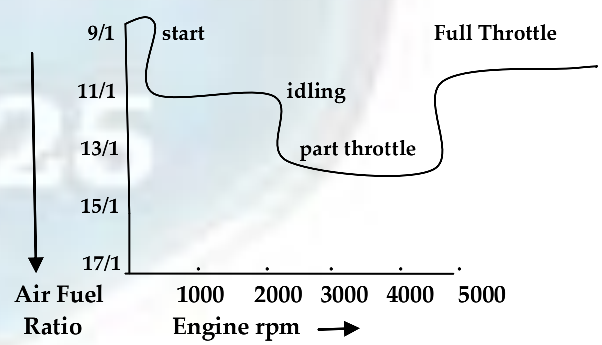


Fig: 3(a) Graph/- Air Fuel Ratio/Engine rpm

From the above graph, the most economical Air-Fuel mixture is 16:1 and maximum power is obtained with air fuel ratios between 12:1 and 14:1. The carburetor is designed to give the necessary air fuel ratio as desired by the engine operating conditions.

To prevent such icing, many carburetors have special anti-icing systems. During the warm up period, the manifold heat-control valve sends hot exhaust gases from one exhaust manifold to the other. Part of this hot gas circulates around the carburetor idle port is and near the throttle valve shaft. This adds enough heat to prevent icing. Another system has coolant passes through a special manifold in the carburetor throttle body. This adds enough heat to the carburetor to prevent icing.

The air fuel ratios at the various operating conditions are below:

[a] Starting (from cold) : 1:1
[b] Starting (normal ambient temperature): 9:1,
[c] Idling: 12: 1,
[d] Acceleration: 13:1
[e] Maximum Power: 12:1,
[f] Economical condition: 16:1,
(While cruising)

4. METHODOLOGY:

4.1. Evaporative Leak Monitoring & Diagnostics:

The advances Enhanced evaporative diagnostic subsystem are that:

4.1.1. Monitor Enabling Conditions,
4.1.2. Update Cold Test Timer,
4.1.3.Perform Tank Pressure Sensor Diagnostic,
4.1.4. Perform system High Tank Vacuum Tests, P0446.
4.1.5. Perform Systems Weak Tank Vacuum Tests (stage 1 and 2) P0440.
4.1.6. Perform Systems Small Leak Diagnostics P0442,
4.1.7. Perform Purge Leak Diagnostics P0444,
4.1.8. Report Results,
4.1.9. Monitor Fuel Level Sender,
4.1.10. Power down Logic.

4.1.1. Monitor Enabling Conditions:

The Evaporation monitors the engine and the purge systems to ensure that the diagnostic is run only once per engine start from cold state. The enabling criteria are that the fuel temperature is less than 33° C to run the large leak, small leak and the blocked canister vent tests. In addition, the difference between the start up coolant temperature and MAT temperature must be less than or equal to 4.5° C. The other enabling conditions are that no malfunctions should be already present before running this diagnostics.

The fuel level should be below 80% level in the fuel tank, the engine speed should be within a calibrated window, throttle position should be within a calibrated window and fuel tank pressure should not be low and barometric pressure should not be low.

4.1.2. Update Cold Test Timer:

This timer keeps the time of the cold test runs at the end of the cold tests it indicates that cold is completed. It also checks that engine is running before incrementing the timer.

For example:

A single acting four stroke petrol engine has size cylinders, diameter 6 cm, stroke 8 cm. The fuel uses in the engine contains 84% carbon, and 16% hydrogen. The diameter at the throat of the choke tube is 35 mm. At 3000 rpm the volumetric efficiency is 75% (refereed to 0° C and 1.027 kg/cm²) the pressure at the throat of the choke tube 0.92kg/cm² and the temperature there is 15.5 ° C. If the fuel air mixture is chemically "correct" for combustion estimate: (a) the fuel air consumption in kg per hour, (b) the speed of the air through the choke. Give n R = 29.27 kg. m /kg°K for air and 9.9 kg. m /Kg°K for fuel.

Solution:

Volume of mixture supplied at 0°C and 1.027 kg/cm² per minute,

$$= \frac{\pi}{4} d^2 \times l \times 6 \times \frac{N}{2} \times n_v$$

$$= \frac{\pi}{4} \times (6)^2 \times \frac{8 \times 6 \times 3000 \times 0.75}{(10)6 \times 2}$$

$$= 1.52 \text{ m}^3$$

Amount of air required for chemically, correct combustion of 1 kg of fuel.

$$\frac{3.52}{0.23} = 15.3 \text{ kg}$$

$$\therefore \quad \frac{Wa}{wf} = \frac{15.3}{1}$$

Specific volume of air at 0° C and 1.027 kg/cm²,

$$V_a = \frac{RaT}{P}$$

$$= \frac{29.27 \times 273}{1.027 \times (10)4} = 0.78 \text{ m}^3/\text{kg}$$

Specific volume of volatile fuel at 0°C and 1.027 kg/cm²,

$$V_f = \frac{RfT}{p}$$

$= \frac{9.9 \times 273}{1.027 \times (10)4} = 0.236\ m^3/kg$

$\therefore\ W_a V_a + W_f V_f = 1.52$

Or, $15.3\ W_f W_a + W_f V_f = 1.52$

$\therefore\ W_f = \frac{1.52}{15.3\ V_a + V_f}$

$= \frac{1.52}{15.3 \times 0.78 + 0.263}$

$= 0.125$ kg/min.

(a) Fuel consumption $= 0.125 \times 60$

$= 7.5$ kg/min

(b) Density of air at the throat of choke,

$P_a = \frac{P^2}{Ra\ T^2}$

$= \frac{0.92 \times (10)4}{29.27 \times 288.5}$

$= 1.09\ kg/m^3$

$\therefore$ Speed of at air the throat,

$U_2 = \frac{15.3\ Wf}{(A)2Pa}$

$= \frac{15.3 \times 4 \times 0.125}{\pi (d2)^2 \times 1.09 \times 60}$

$= \frac{15.3 \times 4 \times 0.125 \times (10)4}{\pi \times (3.5)^2 \times 1.09 \times 60}$

$= 30.4$ m/sec

4.1.3. Perform Tank Pressure Diagnostic:

The Tank pressure sender is monitored and verified that it is not stuck at very low reading indicating a stuck at zero fault or stuck at very high reading a stuck at one fault. The expected pressure consistently and accurately.

4.1.4. Perform System High Tank Vacuum (Pretest and Post test) P0446.

Perform Cold FMO pretest:

This test determines a possible canister vent blockage. The tank vacuum is monitored while the vent solenoid is commanded open. This test begins after enabling the purge and continuous until the saturated canister condition is checked. If tank vacuum is greater than a calibrated value, the FMO test is failed. Otherwise the test passes.

5. RESULT AND DISCUSSION:

The objectives of the Enhanced Evaporative Systems are:

5.1.1. Detect large leaks in the enhanced evaporative emission systems. A large leak is a 0.040 " diameter or greater leak in the evaporative emission systems at 20% to 80% fuel fill levels detected under diagnostic enabling conditions.

5.1.2. Detect small leaks in the evaporative emission system under the same conditions.

5.1.3. Detect blocked canister vent condition.

5.1.4. Detect blocked or shut purge valve.

5.1.5. Detect an open purge valve.

5.1.6. Detect the presence of a fully saturated charcoal canister on the FTP test etc.

However, the saturated canister detection is conducted by using the intrusive loop integrator monitor method. The test monitors the state of the closed loop integration at the start of the cold start condition. The purge is enabled with a quick ramp to a constant calibrate duty cycle. The canister is considered to be loaded with fuel vapor if both closed loop integrators drop below a threshold value before a calibrated timer expire.

Perform Cold FMO post-test, this is done after the system small leak test also passes. The vent solenoid is opened and the purge solenoid is commanded to a duty cycle depending on the fuel level in the fuel tank. If the proper driving conditions are met (all windows and thresholds in proper values and the tank vacuum is less than a calibrated value, FMO post-test passes. If the tank vacuum is greater than the threshold calibration for a calibratable length of time, then FMO post-test is failed.

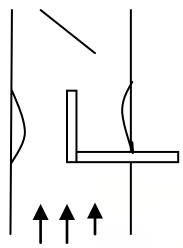
Perform throttle position tracking, this system high tank vacuum post-test the throttle is within a prescribed window of opening. The TPS (Throttle Position Sender) should not be too closed that it has high intake airflow with low vacuum. At the same time the TPS should not be too open that it has low intake airflow with high vacuum. TPS must be above the throttle angle at which the purge is uncovered.

6. TYPE OF DATA:

The various position of a simple carburetor, it is does not matter, if the carburetor vertical tube is vertical or horizontal, but the float chamber have to remain in the vertical direction. The direction of air flow from carburetor to manifold, determines the class of draft and there are three basic type carburetors:

6.1. Up-Draft:

These types of carburetors have the air-fuel mixture moves upward through them.



This type of carburetor is fitted under the manifold and it is mostly fitted for Industrial engines.

Fig:6(a) Up-Draft

6.2. Down Draft:

Down Draft carburetor that has the air-fuel mixture downward through them. This type of carburetor is fitted on the manifold and mostly used in automobiles. The main advantages are:

6.2.1. These give better volumetric efficiency as the air-fuel mixture flows down assisted by gravity.
6.2.2. Used for high speed engines.
6.2.3. The carburetor can be fixed at the top of the engine.

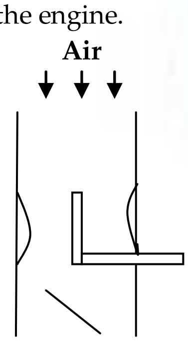


Fig: 6(b)Down-Draft

6.3. Side or Natural Draft:

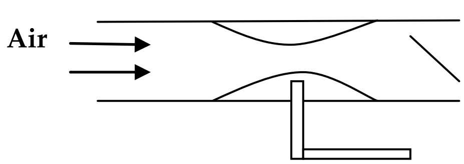


Fig: 6(c): Natural Draft

This type of carburetor is fitted in line with the manifold and theses are used for small stationary engine.

From the above, the critical air velocity, the minimum velocity of air at the throat of venturi at which the fuel just begins to flow is termed as the critical velocity.

The pressure difference which causes the fuel flow is $(\Delta Pa - X.Pf)$.
If $\Delta P_a = X.P_f$, the fuel will be raised to the top of the jet orifice , but there will be no flow of fuel.
Fuel flow will start when $\Delta P_a > X.P_f$

Now, $\therefore U_2 = K_a \sqrt{\frac{2g.\Delta Pa}{pa}}$

And, $U_f = K_f \sqrt{\frac{2g\,(\Delta Pa - x.pf)}{Pf}}$

$$\therefore \frac{Va^2\,Pa}{Ka^2} = \frac{Vf^2\,pf}{Kf^2} + 2g.x.p_f.$$

If, $V_f = 0$,

$$V_a = K_a \sqrt{\frac{2g.x.Pf}{Pa}}$$

This is the critical air velocity at which the fuel just begins to flow.

7. CONCLUSION:

Ignition timing sensor, the magnetic reluctance sensor is mounted on the engine block near a harmonic damper at the end opposite the flywheel. The damper has a notch cut in its outer surface. As a notch in the rotating damper passes by a variable reluctance sensor, the decrease in magnetic flux generates a voltage pulse in the sensor circuit. This voltage pulse is used to set ignition timing.

The ignition system, which spark is provided in the petrol engine to ignite the compressed fuel air mixture and produced a high voltage spark (8000 – 30,000 volts) for a small duration at correct intervals of time, between the electrodes of the spark plug.

In terms of Diagnostics approaches, the electrical characteristics of the ignition timing sensor may deteriorate resulting in incorrect output, out of range/performance values, stuck at low signal, stuck at high signal and intermittent failure.

8. REFERENCES:

[1] Seminar On Board Diagnostics – II, by Prof. S. Ganeshan, Oakland University, USA/2000.
[2] Automotive Service Business, Volume I, a Book by Dr. Porag Kalita.
[3] Automotive Design problem by K M Agrawal, reprint edition 1995.

9. Definition/Acronyms/Abbreviation

Definition:

Compression Ratio: It is the ratio of the volumes of the combustion chamber: When the piston is at the bottom of its travel and when the piston is at the top of its travel.

$$\textit{Compression Ratio} = \frac{\textbf{Sweapt Volume+Clerance Volume}}{\textbf{Clerance Volume}}$$

Throttle valve: The butterfly valve of a petrol Engine.
Timing: Ignition timing the correct timing of the spark relative to the engine rotation or valve timing, the opening and closing of the valves relative to the engine rotation.
Idle: Engine running without a load at the lowest speed possible.
Volumetric Efficiency: Ratio of the volume discharged from a pump to the piston displacement of the pump, called Volumetric Efficiency.

Acronymss

Throttle: A valve in the carburetor that permits the driver to vary the amount of air-fuel mixture entering the engine, thus controlling the engine speed.

Abbreviation

CARB = California Air Resource Board.
CCR = California Code of Regulations.
DTC = Diagnostic Trouble Code,
FTP = Federal test Procedure.
TPS: Throttle Position Sender
I.C. ENGINE = Internal Combustion Engine.
MIL = Malfunction Indicator Light.
MAP = Manifold Air Pressure
