ABSTRACT

This project aimed at developing an indicating device to monitor the clogging level in Air filters. A manifold absolute pressure sensor is used to continuously check the quality of the intake air just at the inlet manifold, and send a signal to a processor. The processor will be calibrated against the voltage differences produced by the sensor, and will be displayed on a digital display unit kept on the dashboard. As the clogging increases over a period of time, the instrument will display the clogging level and the percentage of clogging.

Whenever the air filter reaches warning levels, the driver will get a clue to clean or replace the air filter through this instrument, avoiding sudden stoppages and lower performance levels.

Air filter in cars, filters dust particles, pollen, and any such materials to ensure the supply of clean air to engine, due to residue collection air filter clogs and it has to be monitored. Present day cars do not have an indicator to monitor the clogging level of air filters; it becomes the responsibility of the driver to check the filters often manually by opening the hood. This is an extra exercise, and if not carried out periodically, there is the danger of the engine stalling on a highway, making the driver stranded; hence development of a device which indicates the level of clogging in the air filters and displays it on the driver dashboard has to be developed.

Quality of air entering through the inlet manifold of an IC engine, determines the efficient combustion of the fuel, and hence the power output. The role of air filter is undeniably very important in ensuring the quality of intake air. However, because of atmospheric pollution, dust,

moisture and fumes, air filters progressively get clogged, affecting the performance of the engine.

If the air filter is unchanged for a long time, the car may stop running altogether. A permanent damage is unlikely,. If an air filter were sufficiently dirty and broken, it could allow harmful contaminants into the combustion chamber. It is an important part of a car's intake system, because it allows the car to "breathe." An engine needs an exact mixture of fuel and air in order to run, and the air enters the system primarily through the air filter.

Car air filters have a simple construction. They are paper-like or fibrous material, and arranged on a plastic or metal frame. Some are made out of a cotton or fabric, which is then oiled to increase airflow. Vehicles generally have a dedicated holder for this filter, which is usually a plastic or metal box. Generally, the holder is connected to the intake manifold by a plastic tube through which the air flows.

Having a clean air filter is important. This means that filters should be changed regularly, or the vehicle's mileage will drop. A dirty filter can also cause other systems to malfunction, such as the emissions control system, which regulates the car's air-fuel ratio. It can also cause the spark plugs, which ignite the fuel in the combustion chambers, to foul, as there will be too much fuel without sufficient air; if the spark plugs foul, it may have problems preventing the car running. Hence such an indicating device for clogging level could be an essential addition in future automobiles.

1.5 Defining a Clogged Air Filter

Air filters reach a condition where they cannot take in or filter any more dust, forming a dense and dusty thick black layer, preventing it from efficient filtration these are clogged filters. The channels which send air get jammed and stick together allowing only little air to pass through them .A clogged air filter will restrict air intake making the engine use a mixture having more fuel and lesser air. This ratio is not good for the engine and will cause a burning of an improper mixture, which will affect the engine and other vital components. A clogged air filter will make way for an engine to work in a strained manner which in due course, if unattended ruins the general smoothness and feel rough to drive and eventually leads to component failures

1.6 Specification of the Air Filter considered for this project

The specifications of the air filters that we used were

Weight	150 grams
Type	Paper filter element
Make	Purolator

Table 1: Air filter specification

The above Table shows the basic specification of the air filters considered for testing. The fully clogged filter was clogged to simulate the real time clogging condition of a fully clogged filter, so that the vacuum pressure in the air intake of that filter could be calculated .Then a half clogged filter was used to simulate the clogging levels similar to a used filter, to measure the vacuum pressure difference. Finally a fully clean filter was used to take readings to simulate the condition when a brand new filter was used

CHAPTER-2: DESIGN METHODOLOGY

2.1 Design requirement

The design requirement was to design a structure which could house the air filters, a hose which could hold the sensor and the clamping positions.

2.2 Pro-E model showing the Air Filter & sensor position

The design was a structure which could indicate the size and shape of the air filters; a box like structure was designed in PRO –E, showing the intake section open to the atmospheric air and other side to the engine. We also included the point of placement of the sensor and the direction flow of air during suction and the points of locking made the understanding easier. Figure 2 shows the PRO E design shows the position of the sensor and air direction. The design gave a possible idea of the box to be fabricated

Figure 2: PRO–E design representing air flow and mounting

3.2 Trial-1(Using a new air filter)

The first trial was made by installing a new filter and taking the reading

- In this trial the inlet pressure recorded was around 30 KPa
- The voltage the sensor produced was greater than 4.30 volt
- 5volt Ref. provided by ECM it is Regulate output source.
- In this procedure the MAP sensor gave the reference voltage output which was checked by the voltmeter
- The new air filter showed a unstrained engine operation when accelerator pedal was depressed

Figure 16 shows the voltmeter indicating a value of 4.73 volts when a new filter was being tested

Figure 16: **Voltmeter indicating the sensor voltage**

3.3 Trial 2(Using a Half clogged filter)

The second trial was performed using a half clogged filter for testing

- In this trial the inlet pressure recorded was around 35 KPa
- The voltage the sensor produced was in the range of 4.26-4.30 volt

- The half clogged air filter showed a rise in pressure when compared to a new air filter
- The half clogged filter showed a slightly strained engine operation when accelerator pedal was depressed
- In this procedure the MAP sensor gave the reference voltage output which was checked by voltmeter

Figure 17: Voltmeter indicating the sensor voltage when a half clogged filter was being tested

Figure 17 shows the voltmeter indicated a voltage of 4.57 volts which we inferred as the voltage given when a half clogged filter was tested

3.4 Trial 3(Using a clogged filter)

The third trial was performed using a fully clogged filter for testing

- In this trial the inlet pressure recorded was around 40 KPa
- The voltage the sensor produced was less than 4.26 volt
- The half clogged air filter showed a rise in pressure when compared to a new air filter
- The half clogged filter showed a slightly strained engine operation when the accelerator pedal was depressed

CHAPTER-5: ASSEMBLY

This was the final phase of the system. This phase included using all the design, data and programmed value. The pressure drop due to the clogging of air filters of the vehicle. This phase show the mounting of MAP sensor hoses and the display, assembled on the carburetor intake. Figure 22 shows the assembly of the intake hose and the casing over the inlet manifold

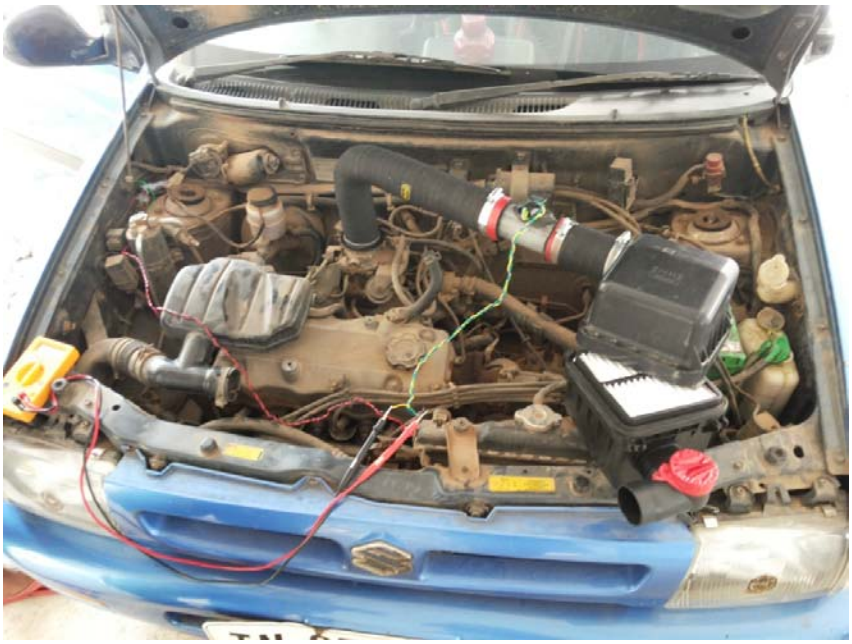

Fig 22: Assembly of the setup over the inlet manifold

5.1 Carburetor Intake Assembly

It is clamped tightly to prevent air leak and pressure drops, the hoses that we had made were made to as per the measurements of the intake over the carburetor .We housed the sensor on a PVC pipe, which was cut as per the measurement and the sensor was sealed with silicone sealant to prevent air escape. The vehicle tried to shut down if the air supply was cut off. Figure 23 shows the assembly of the setup on the carburetor intake being tightly sealed

CHAPTER 6: RESULTS AND CONCLUSION

6.1 Results

When a new filter was used and the results were recorded, it was found that the MAP sensor voltage is always greater than 4.4 V with a maximum voltage of 4.8 V An air filter with a clogging level of up to 30% is considered to be a new and healthy. .Accordingly the device was calibrated to give the output (% of clogging) in the digital display along with an advisory note to the driver that the filter is clean and healthy. Figure 24 shows the screen shot of the result screen showing that there is no dust

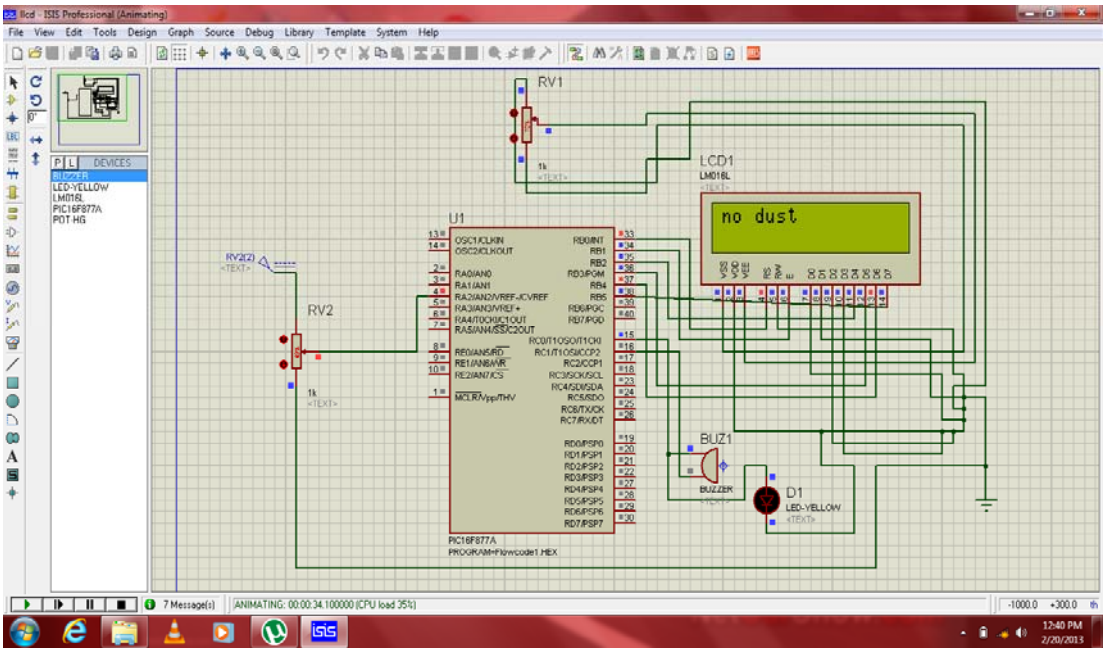

Figure 24: Result Screen shot showing no dust

New filter made way for more filtration and healthier engine, air fuel proportion was proper and there were reduced chances of stalling. The mileage also increased. Figure 25 shows the LCD display unit indicating low dust condition when a new filter was used.

A Clogged filter makes way for lesser filtration and unhealthier engine; air fuel proportion will be improper and increases the chances of stalling. The mileage will also decrease, Figure 27 shows the LCD display unit indicating dust condition when a fully clogged filter was used

Figure27: Display showing full dust

6.2 Conclusion

Based on the trials made on the air filters, using MAP (Manifold Absolute Pressure) we inferred that there was a pressure increase when the dust level increased .The pressure difference was measured with a vacuum pressure gauge, this was done to form a relation with the sensor voltage and the pressure that was measured, Voltage was measured on a higher sensitivity voltmeter could which could measure current up to 20A for 30 seconds and 10A continuously. The sensor was mounted on in the inlet manifold, on a rubber hose. The sensor had three wires connected to it and one was connected to a Controller board.

During the first trial, when we used a fully clean filter; we observed that there was a pressure of approximately 30 KPa and the sensor voltage reduced by 0.25V.The engine

was able to run without strain and showed no symptoms of trying to shut down .The sensor showed a voltage of 4.5V-4.30V, and we were able to come to a conclusion that the if the filter tested showed a voltage difference above 4.30V it was considered to be a healthy filter. We used this value for programming to show the percentage level which was calibrated by assigning 0-50% for a clean filter.

During the second trial, when we used a half clogged filter; we observed that there was a pressure of approximately 35 KPa and the sensor voltage reduced by 0.02V.The engine was able to run without strain and showed no symptoms of trying to shut down .The sensor showed a voltage of 4.30V-4.27V, and we were able to come to a conclusion that the if the filter tested showed a voltage difference below 4.30V it was considered to be a half clogged filter. We used this value for programming to show the percentage level which was calibrated by assigning 50%-55% for a half clogged filter.

During the final trial, when we used a fully clogged filter; we observed that there was a pressure of approximately 40 KPa. The engine felt strained and showed symptoms of shutting down .The sensor showed a voltage below 4.26V which was considered to be an unhealthy filter. We used this value for programming to show the percentage level which was calibrated by assigning 56-79% for a clean filter.

A Program was used for process the voltage change shown by the sensors when the pressure reduced. It showed a lowering voltage when there was a drop in pressure, The PIC controller was used to program the voltage input and to assign values. It was used to synthesize the signals at the different modes of operation. The LCD displayed the results, which was connected to the controller The Proteus software was very helpful in programming the micro controller to display output. Every trial was documented separately and the values were processed by the proteus software. The wires were soldered and the unit was mounted