

## ***Review on Air Filter Cleaning Machine for Automobile***

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### ***Abstract***

*The performance of internal combustion engines is strongly influenced by dust particles from the atmosphere by that passes through air filter and reaches inside the kinematic couplings of the engine. Air filters have relatively low efficiency as they are used, air filters are impregnated with a layer of fine dust and their filtering efficiency is increasing. Proper maintenance can help vehicles perform & thereby positively affecting fuel economy, emissions, and overall drivability. Previous studies shows that, replacing clogged air filter can improve vehicle fuel economy and can be significantly detrimental to fuel economy. But, a recent study showed that the fuel economy of modern gasoline vehicles is unaffected by filter clogging due to the closed loop control and throttled operation of these engines. This paper describes the various air filter cleaning methods for engines & the measured results with focus on changes in vehicle fuel economy.*

***Keywords:*** *Air filter, Maintenance*

### **INTRODUCTION**

Air cleaners are used in a wide range of automotive applications. From passenger cars to heavy duty trucks, there is always an air cleaner to keep inlet air free of impurities

and air flow passage obstruction in low levels. The air filters in an air intake system permanently remove foreign particles such as dust, dirt and soot from the intake air, thereby maintaining the performance of the

engine and protecting it from damage. A clean air filter results in improved gas mileage, better acceleration, increased engine life, lower emissions and overall improved engine performance. Not only does an air filter clean the air entering the engine but it also prevents debris from entering the engine and causing damage. As an air filter becomes dirty, the capacity for it to filter the air going into the engine is reduced [1]. Because of this, the engine is not able to function properly, which may cause numerous drivability issues.

Symptoms of a dirty air filter vary but often times include a noticeable decrease in gas mileage. A dirty air filter prevents the necessary volume of clean air from reaching the engine which affects the emission control systems of the car; reducing air flow and causing a too rich air-fuel mixture which can foul the spark plugs. Fouled spark plugs can create an engine miss, rough idle and even starting problems. In addition, a too rich fuel mixture increases engine deposits which may even cause the Service Engine Soon light to come on. Over the past decade, numerous emission standards and engineering achievements have come together to create advanced, clean, and flexible engines. These diesel engines and

the vehicles they power are demanding for smaller air cleaner system package sizes, increased contaminant loading performance, improved contaminant separation efficiency, and higher temperature performance, all the while maintaining low initial restriction to airflow.

Emissions compliant engines, extended oil drains and oils and tighter component tolerances all contribute to the need for increased air filtration system performance. Proper maintenance can help vehicles perform as designed, positively affecting fuel economy, emissions, and overall drivability. The issue of air filter replacement improves fuel economy.

The automobile air cleaner element is a part that needs to be replaced periodically, and making this part last longer is essential. Generally, to achieve longer life, it has been necessary to raise the space ratio of the material making up the filter element, but it is difficult to do this and maintain cleaning efficiency at the same time. For this particular reason, it has been necessary to select filter elements to suit the properties of impurities as well as the usage environment, and to replace these elements or remove impurities on a frequent basis.

The air induction system of the engine contains the air filter, air filter housing and the intake air duct; all these parts generates pressure restrictions that at high levels, would lead to lower engine power. Acceptable relative decrease of the engine's power due to restriction of the engine air induction system is usually 2-3 %, according to [3,5]. The study developed in paper [6] showed that using used filters, replaced according to the maintenance scheme recommended by the vehicles manufacturer, the maximum engine's power is not affected. In [4] it is shown that the normal service life of an air filter may be considered the period when the filter protects the engine without affecting its performances.

The service life of an air filter for internal combustion engines that equip the vehicles is determined according to the following criteria: □ distance travelled by the vehicle with an air filter expressed in thousands km the operation period expressed in years reaching a limit value of restriction for used filters compared to the value generated by the new filters, this value being emphasized by an "air filter indicator".

The first two criteria are most frequently used. Establishing these maintenance intervals is made, in engineering terms, by measuring the pressure restriction generated by the clogged filter. Usually, for determining the moment when to replace the air filter, the total restriction of the clogged filter is measured or the restriction rises compared to the initial restriction of the new filter. The restriction limits set by the engine manufacturer that recommends the total restrictions values depending on the type of the engine, according to paper [7]. For large diesel engines, these values range between  $3.7 \div 7.5$  kPa. Similar values of total restrictions are mentioned in paper [4]. Also in [4] shows that the values of total restriction for gasoline engines range between  $3.8 \div 5$  kPa, while paper [3] states that the maximum air intake system restriction is generally  $5 \div 7.6$  kPa for turbocharger diesel engines.

There are only few engines in operation equipped with "air filter indicator", that is a device that detects the pressure restriction and indicates, usually by colours, air filter condition and the moment when the air filter should be replaced. Such a device that equip a 6.7 l diesel engine indicates the replacement moment when the restriction

value is 3.6 kPa [8]. Papers [9] and [5] states that the air filter should be changed when restriction rise reaches values of 1 ÷ 2.5 kPa for light and medium vehicles engines.

For heavy-duty vehicles, paper [9] recommends changing the air filter when restriction reaches 6.25÷7.5 kPa.

In paper [10] for a 6.7 l diesel engine, the value of total restriction is 3.5 kPa for new filters and 6.5 kPa for used filters that need replacement. The severe clogged air filters generate a slight decrease of the acceleration performances of the vehicles and pickup vehicles equipped with modern diesel engines [8].

Today continuous research on automotive air intake systems are developing to deliver maximum filtration efficiency, maximum dust holding capacity and maximum service interval range based on engine performance and reliability requirements [3]. The primary purpose of automotive air induction systems (AIS) is to reduce the airborne contaminant level ingested by engines, especially abrasive contaminants which can cause engine wear. [4] A superior air filter performance is necessary for automotive AIS to protect the engine from wear and to

provide the engine with required amount of air. The buildup of dust on the filter surface increases the resistance of the filter medium to flow, which in turn increases the pressure drop across the filter. The problem is so severe in high dust environments like off highway application. In this study, numerical techniques like commercial CFD code, Fluent used to calculate flow through a filter and predict average pressure loss of the flow knowing the initial properties of the filter medium.

In this work an attempt has been made to consider the deposition of dust on the filter and the resulting changes in the filter medium properties, which lead to increasing pressure loss across air filter. Dust distribution and pressure drop are predicted for a constant flow rate of air. Further investigating the performance of air filter development. The stratified concepts offer a reduction of the scavenging losses in 2-stroke engines. The results of the engine optimization process including flow simulation, concept evaluation and combustion process development are presented and further focused on the design specifications of the air head carburetor and the specific layout of the reed valve scavenging process.

A proposal is presented by [5] the three-dimensional CFD analysis of flow inside an automotive air filter conducted by SMARTech Fluidos for SOGEFI Filtration do Brasil Ltda., in order to determine the pressure drop over AIS (Air Intake System). Two geometries have been analyzed in seven operation conditions, each. The flow was considered steady-state, incompressible, turbulent and isothermal. The region occupied by the filter element was treated as a porous medium and the porosity coefficients were extracted from experimental results.

The contribution given by each component to the total pressure drop was determined. When using a new filter, dust particles, first settle on the fibers of the filter. [6] As contamination increases, the thickness of this dust layer increases and causes a decrease in the pore volume. This leads to the increase in pressure difference. This increase in pressure difference is a typical phenomenon in depth filtration. The pressure difference rapidly increases when the volume gets exhausted. When it reaches a specified value by the manufacturer, the filter should be replaced. While studying this process it is found that there is a new

parameter that affects the performance of engine pleated air filter, which is the efficiency of the effective filtration area.

The efficiency of the effective filtration area ( $\eta_{eff}$ ) is defined as the ratio between the effective filtration area and the total geometric filtration area. The effective filtration area is found to decrease with the increase in temperature, specific dust and flow rate. A numerical study presented [7] on air filters used for an off-highway vehicle by using commercial CFD code FLUENT v 6.1. For the primary filter, the flow is obtained by the use of Reynolds stress model and stochastic

Lagrangian model is used to study the gas solid flow. The separation efficiency for dust particles of sizes 50 and 100 microns is found to be 94.4 %. Engine intake filters have an expected and recommended service life (by OEMs) of approximately 45K to 75K kilometers under normal driving conditions. Majority of air filter element manufacturers do not recommend any type of cleaning to be performed on their OEM products. Vehicle owners in some regions would like to service and clean their own air filter elements in an effort to reduce vehicle operating costs. As a result, [8] a number of

OEMs selling passenger vehicles in these regions are requesting their suppliers explore solutions and the effects of whether cleaning air filter elements is appropriate for proper engine operation.

In contrast a number of heavy duty and motorcycle air filter manufacturers do include a recommended cleaning schedule and procedure to maintain optimal operating performance. On the other hand, filter cleaning is more popular in the aftermarket industry. An attempt tried [9] to address the issue using a multi-disciplinary approach that employs failure analysis, laboratory experimentation, predictive correlation, and concurrent engineering with an emphasis on contaminant characterization and filtration strategies.

Practical contamination analysis methodologies are discussed on Excessive wear and malfunctions in fluid power handling systems are often caused by contaminants or small particles that may be built-in, self-generated, or ingested from the environment. Filtration subsystems in such systems are designed to prevent these problems from happening. The influence of multi cyclones application study done [10] on a harvester air cleaner system. Its

compact size summed to high contaminant retention capacity improves usual air cleaner systems performance to longer service intervals with reduced pressure drop. Improvements on technology performance were demonstrated through numerical simulations and laboratory tests that simulate the actual application. Virtual Prototyping (VP) is an important method to assess the sound performance of possible designs in earlier stages of development.

The common noise simulation with simple level determination can now be combined with subjective assessments that can be particularly interesting for noise content judgment. Engine Air Induction System inlet orifice noise field reviewed and illustrated the main advantages and difficulties in the implementation of VP. In a research, a new filter element was investigated in order to achieve longer life without reducing cleaning efficiency. Choosing a wet type, nonwoven filter made of hollow fibers and impregnated with oil enables not just the filter element's mesh, but also the fiber surface, to trap dust, unlike a nonwoven filter made of ordinary fiber which produces a filter with not only higher cleaning efficiency but also a smaller decline in

pressure and no loss of efficiency, even at high flow rates.

## CONCLUSION

The life of an engine is determined by the rate at which it ingests abrasive contaminants. Approximately 1 gram of dust per HP is sufficient to destroy an engine. Unlike the human body, which has different filtration systems and sensors to warn of bad air, the Air Filter is the only protection on an engine against potential damage. It has one chance and one chance only, to remove the dust. The engine will find it difficult to breathe due to high restriction reducing power output and increasing fuel consumption. So we clean the air filter in correct manner for increase the air flow into the engine for the combustion. This will increase output and reduce the fuel consumption.

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