PERFORMANCE ANALYSIS OF AIR FILTERS FOR DIESEL ENGINE: AN EXPERIMENTAL APPROACH

P.Ravi Chander*

Dr. Sudheer Prem Kumar**,

Dr. K. Vijaya Kumar Reddy***,

Dr. S. Chakradhar Goud ****

ABSTRACT

Air filters are the key components for automobiles, and evolves with developments in the automotive industry. Taking the automotive industry as a whole it must be observed that the air filtration applications around road vehicles have increased and are still increasing. Besides filters for the crankcase ventilation and transmission filters a whole new range of filter systems in the vehicle has developed. This is mainly due to the so-called On-board diagnostics (OBD) II-standard and driven by the trend to zero emission vehicles. A multitude of sensors on the cars, which can be very sensitive to contamination (with particles and gases) and in many cases have to be protected, require specific air filters. Today there are 30 to 40 different filter applications around the automobile to be found. The technological performance requirements of the majority of these products are usually more straightforward and are often but vaguely defined. The definition of performance profiles does not yet follow standardized filter tests but are negotiated. Further by proper maintenance can help vehicles perform as designed, positively affecting fuel economy, emissions, and overall drive ability. This paper addresses the issues of whether air filter replacement improves fuel economy. This paper describes the measured results with focus on changes in vehicle fuel economy but also including emissions and performance. Previous studies shows replacing clogged air filter can improve vehicle fuel economy and, conversely, that a clogged air filter can be significantly detrimental to fuel economy. An attempt made in this study by approaching experimentally by using different air filters for analyzing the performance of diesel engine. Also study focused on diesel emissions and other particulate matter (PM) contaminants lead to improvement in original manufactured air filter to re - design filtration system for diesel engine.

Key words*: air filters, diesel engine, fuel economy, pollutants.*

[1]Research Scholar, JNTU, Hyderabad.

[2]Professor & Head Of Department Of Mechanical Dept ,JNTU, Hyderabd , A.P

[3] Professor, JNT University, Hyderabad ,

[4]Associate Professor, MNR College Of Engineering, Sangareddy.

1.0 INTRODUCTION:

Innovative vehicle designs and increased environmental awareness call for new engineering solutions for on-road and off road vehicle components. Automotive air filters are classified into two categories-engine/intake air filter and cabin air filter. The intake air filter is used to prohibit the entry of foreign particles such as road dust, debris, etc. into the engine. This helps in the enhanced functionality of engines. It minimizes the emissions from vehicles and prevents the engine and its components from damages caused by foreign particles. Cabin air filters are the new types of air filters, which are specifically designed for the vehicle's cabin air filtration. The market for automotive air filter is influenced by production trends in the automotive industry, emission norms, health safety regulations, buyer's preferences, and lifestyle, whereas factors such as vehicle park, average miles driven, and the types of filters used influence the aftermarket demand for air filters. Diesel engine air intake suppliers are facing increasing challenges as vehicle manufacturers demand higher performance in a smaller volume while minimizing life-cycle costs. This paper focus changes on air filtration solutions that have worked in the past, and a new filter technology that promises to better meet these increasing challenges. Many factors are affecting the changing demands on diesel engine air intake systems. One of the most prominent changes in the market is the various emissions standards being adopted around the world. These new requirements not only increase the space consumed by advanced emission components, but also impact other vehicle parameters. Current and future diesel engine designs are placing more emphasis on lower restrictions in the air intake system, as higher restrictions can increase the emission levels being measured in the engine exhaust. [1-3]Air is a not only vital for any life form on earth but also important for today's state of the art diesel engines. An average Heavy Duty Diesel truck engine requires between 13,000 to 20,000 liters of air to burn just one liter of fuel. However - this air is polluted and contains all kinds of contaminants such as fumes, dust, smog and other particles. Like temperature and humidity these particles are not always visible to the eye, but they are harmful to the engine. They diminish the purity of the air and can lead to severe damage of all engine components. Under normal conditions the air consumed in a 16 liter engine contains almost 20 kilograms of dirt/ contaminants per 100,000 Kms .[4] There is no room for compromise. The air intake is a completely open system. Air Filters are essential for diesel engines and the air that these engines 'breathe' needs to be as clean as possible. The air quality will significantly impact the performance of a diesel engine. So, air filters are engineered to deliver optimized air quality, and provide the best overall performance and service life.

2.0 CLEAN AIR PROVIDES SUPERIOR PERFORMANCE:

Air is necessary for successful combustion in the engine [5] In fact, for efficient combustion, a modern diesel engine requires several thousand times as much air as it does fuel. Clean air — air almost 100% pure — is critical to engine survival and vital to its performance. If a turbocharger engine added then, it may need to make changes to the intake ducting. Turbocharged engines require even more free-flowing clean air, 750 cubic feet per minute or more. Naturally aspirated engines demand about 20% less, but still these engines can require up to 15,000 gallons of air for every gallon of fuel. In either case the induction system (ducting, hoses and reducers) brings outside air to the engine. The system should have enough intake capacity to meet engine requirements for air flow, avoiding sharp bends or constrictive ducting. It should be installed in a clean location, away from exhaust flow, road grime and splash. It should be vented to remove airborne moisture. Air may flow into the engine through a series of components: and an air-inlet hood to eliminate moisture. So, a air filter that will typically remove 80% to 90% of all airborne contaminants. One air cleaner can be significantly more effective than another - even if the difference in efficiency appears to be marginal. An air filter @ 99.0% efficiency permits twice as much dust to pass into the engine compared to an air filter @ 99.5% efficiency. This means 10 times more dust than at 99.9% efficiency! So, the choice of the filter for the right application can make a substantial difference in wear rate, cost and performance of the diesel engine. In the search to improve the performance of the engine, one way of air intake system of the engine continue to be examined. This can often take the form of either increasing the air filter's life along with diesel engine. Size reductions in the system can allow for alternate configuration.[2] Although dust-holding capacity is the primary feature of engine air filters operating in dusty environments, efficiency becomes a major factor when selecting an engine air filter. Inertial separators and high porosity or fibrous pre filters are commonly used to decrease the dust load to the main filter while high efficiency is achieved by utilizing submicron or nano fibers in the main filter. The patented multi-stage filter was designed to achieve ultra-high particle removal efficiency and dust holding capacity, and long life in dusty and on highway environments. The main (final) filter is located downstream of the pre filter. The main filter is made of pleated filter media containing nano fibers with a diameter in the range of 40 – 800 nanometers. The upstream in-line pre cleaner utilizing flow-through mini cyclones has separation efficiency of 95%. A high dust capacity, high efficiency pre filter can be used instead of the pre cleaner. The pre filter is made of vertically lapped nonwoven filter media made from synthetic fibers of different materials to fully utilize the tribological effect. The volume of the pre filter is determined by the performance required and space allotted. This paper discusses the filter performance of high dust holding capacity engine air filters. Filter specifications, design and performance are discussed in detail. Performance characteristics of the media and full size filters were determined using on-line particle counters and the gravimetric test method. Initial and final efficiency, and dust loading performance characteristics, are provided.

3.0 AIR FILTERS – MEDIA:

Majority of the automotive AIF designs currently use fibrous media in various configurations and packages.[6-10] A short list of some popular fibrous media noted as:

- cellulose fiber media (most popular)
- phenolic resin
- non-phenolic resin
- cellulose and synthetic fiber (blend) media
- synthetic fiber media (spun-bonded etc.)
- multilayered cellulose/synthetic felt media
- Dual stage filters using reticulated foams or felts as pre-filters

Filter media effectively captures the contaminant on its fibers and within the inter-fiber spaces. There are various filtrations mechanisms that cohesively work to capture contaminants. Typically the filter media for AIF can be classified into three types;

1) Surface Loading (paper media etc.)

2) Depth Loading (multilayered felts, paper/felts etc.)

3) Deep Bed Loading (porous media etc.)

3.1 Surface Loading - Majority of the media used for Air filters exhibit surface loading behavior. Surface loading is characteristic for paper (single layer) type media where the ratio of surface area to caliper (media thickness) is very large. For media exhibiting surface filtration, the formation of a dust cake on the surface is critical. The porosity and dendrite structure of the dust cake affects the efficiency, capacity and pressure drop across the media. Cellulose/synthetic type paper media when treated with special surface coatings (wettants, tackifiers etc.) support a very porous dust cake development, consequently giving higher efficiencies and dust capacities. This is especially true at higher face velocities.

3.2 Depth Loading - Is characteristic of media having a multilayered construction. These media are more popularly known as synthetic non-wovens or felts. The various layers (generally 2-5 for engine Air filters) are structured to provide a gradient packing density to successively trap finer particles within the media. Depth type media are also characterized by a higher surface area to caliper ratio, but relatively smaller than surface type media. Under similar conditions depth loading media exhibit a higher unit mass loading compared to surface loading media. Most depth media also exhibit some surface loading behavior. Felt media are relatively more expensive than paper media.

3.3 Deep Bed Filters - Are characterized by a much smaller surface area to caliper ratio when compared to both, surface and depth loading filters. Deep bed filters generally exhibit the highest mass loading per unit volume or surface. Deep bed filters may also be called as porous filters with gradient packing densities. The residence time of the particles (contaminants) through deep bed filters may be an order of magnitude higher than surface or depth type media. Examples of deep bed filters are reticulated foams, granular packbeds etc.

3.4 Direct Flow(TM) filters have been recently introduced to the engine filtration market to extend the options of in-line reduced volume filters. The purpose of this design is to achieve high value of media utilization factor, smaller, more compact components while maintaining a long life. Direct Flow(TM) filters provide high filtration performance while occupying less space. Moreover, the contaminant will not clog the filter inlet because there are allowable contaminant passages around the individual filter cylinders or panels. The angled gaps between the individual filter elements form flow passages that make it possible for contaminant particles to enter the plated material through the filter front side between the alternately sealed pleats and through the space above or below the element. Therefore, the filter front side stays open to the flow and filter media surface is loaded with the particles. It was shown that nano fiber filter media provide high initial efficiency for small particles. However, a quality assessment of nano fiber filter media is even more critical than for the classical cellulose filter media since nano fiber filter media permeability is usually higher than of the standard cellulose media. The classical HD media have lower permeability and work at lower aerosol velocities; therefore, the probability of re-entraining the larger, most damaging particles is relatively low. [11-15] Further, Automotive

Air Induction Filtration Systems (AAIFS) should be designed to deliver superior performance levels for optimal engine protection. In addition, it must also meet packaging requirements, higher flow rates, lower system restriction, and serviceability and induction noise. The ingested contaminant size and concentration levels need to be controlled to reduce engine wear. Major air filtration technologies in AAIFS, currently available and used on passenger cars, light/medium duty trucks So, Criteria for selecting Air Induction Filters (AIF) is a difficult task along with engineering and design parameters required for developing robust AAIFS.

4.0 AN APPROACH TOWARDS EXPERIMENTAL TESTING:

Design of diesel engine air intake systems requires the integration of many technologies and the balancing of many factors. Figure [1] is a simple graphic illustrating how the primary value measurements of a system can be affected by design changes in other system properties.

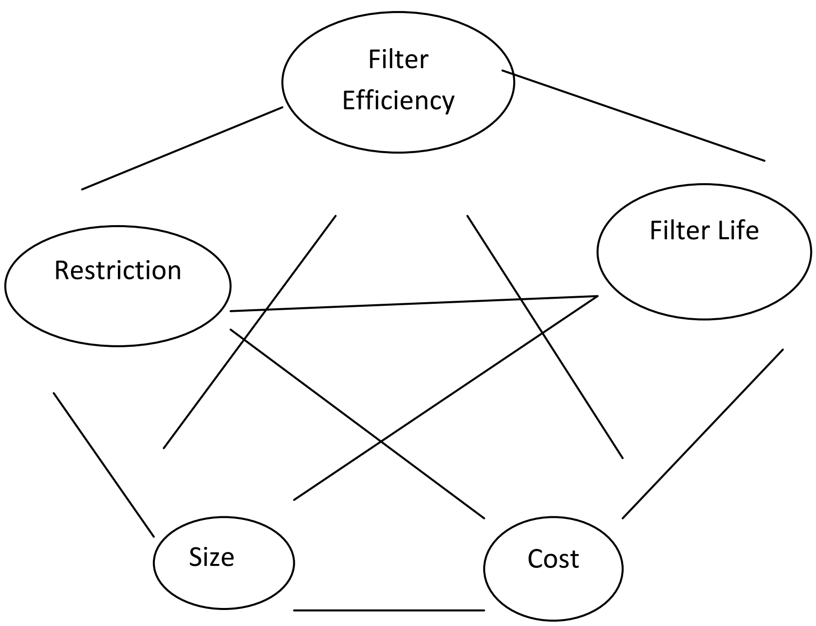


Figure 1. Air Filter Primary Design Tradeoff Relationships

At a given technology level, each property can be improved through compromises in another property. Size can be reduced by reducing filter efficiency, reducing filter life, or increasing filter pressure loss. Advancements in technology are required to achieve simultaneous improvement in multiple parameters. These technology advancements can take several forms, from simply improving via design and materials expertise, therefore the engine testing was performed only with the specified air filters available in the market which were arranged and plugged for kirloskar AV-1 engine and considered as constant speed @ 1500 rpm with different load conditions to analyze performance and emission pollutants. The following air filters considered for the experiment.



Fig(2) Maruthi 800– NF -560 Fig(3)Tata Indica-NF 615 Fig (4) Tata Sumo – NF 1004

4.1 Engine specifications:

1	Make	Kirloskar AV-1
2	Engine type	4- stroke single cylinder diesel engine (water cooled)
3	Rated Power	3.7KW
4	Speed	**1500 rpm**
5	Bore & stroke	80mmx110mm
6	Compression rate	16.5:1 (Variable From 14.3to20)
7	Cylinder Capacity	553cc
8	Dynamometer	Electrical-AC alternator
9	Cylinder sensor	Piezo sensor
10	Starting	Auto type
11	Orifice Dia	15mm
12	Exhaust gas Calorimeter	Ind lab Engineers
13	Software	Lab view Software

4.2 Air Flow Calculations:

Metric: Air flow in m^3/min = $\frac{\text{Swept Volume}^1 \text{ (liters)} \times \text{Speed2} \times VE^3 \times \text{PF4}}{1000 \times CF}$

[1] engine displacement in liters; [2] maximum engine RPM; [3] Volumetric Efficiency; [4] Pulsation factor

Imperial: Air flow in CFM = $\frac{\text{Swept Volume}^5 \text{ (CID)} \times \text{Speed2} \times VE^3 \times \text{PF4}}{1728 \times CF}$

[5] engine displacement in cubic inches; [2] maximum engine RPM; [3] Volumetric Efficiency; [4] Pulsation factor.

Volumetric Efficiency (VE)

- VE = can be greater than >2 for very new engine designs
- VE = 1.3 to 1.8 for 4 stroke engine with turbocharger
- VE = 0.85 for 4 stroke engine that is naturally aspirated
- VE = 1.4 for 2 stroke (cycle) engine with Roots-Compressor (blower)
- VE = 1.9 for 2 stroke (cycle) engine with Turbocharger

Cycle Factor (CF)

- CF = 2 for a four stroke (cycle) engine
- CF = 1 for a 2 stroke (cycle) engine

Pulsation Factor (PF) - only applies to engines that are both naturally aspirated and having 3 cylinders or less

- PF = 2-2.1 if only 1 cylinder
- PF = 1.4-1 for two cylinders
- PF = 1.33 for three cylinders

4.3 CALCULATION OF PERFORMANCE PARAMETERS:

For the evaluation of an engine performance few more parameters are chosen and the effect of various operating conditions, design concepts and modifications on these parameters is studied.

The basic performance parameters are (a) Power and Mechanical Efficiency. (b) Mean Effective Pressure and Torque. (c) Specific Output. (d) Volumetric Efficiency. (e) Fuel-air Ratio. (f) Specific Fuel Consumption. (g) Thermal Efficiency (h) Exhaust Smoke and Other Emissions. (i) Specific Weight. The formulae as follows:

1	Fuel consumption in kg/min	$M_f = \frac{\text{Fuel consumed for ml X Density of DIesel X 60}}{\text{1000 X time taken in seconds}}$; [Density of diesel = 0.85grm/ml]
2	Total fuel consumption in kg/hr	TFC= M_f X 60(sec)
3	Air consumption in kg/min	$M_a = 0.6 \times A_o \times V_a \times 1.29 \times 60$; where A_o is the area of orifice in(m^2) = $\pi/4 \times d^2$; ρ_{water}= 1000kg/m^3 ,ρ_{air} = 1.29kg/m^3,$V_a = \frac{\sqrt{hm}}{1000} \times 123.24$;
4	Air fuel ratio	$A/f = M_a/M_f$;
5	Break Power	B.P = V×I/0.70 Kw ; V= voltmeter reading in volts, I= Ammeter reading in amps; (70%efficiency of the alternator)
6	Specific fuel consumption	SFC = TFC/BP kg/kw-hr ;
7	Indicated Power	IP= BP+FP ; [FP value obtained from graph by using Williams line method]
8	Heat input	$H.I = \frac{TFC \times Cv}{60 \times 60} C_v$;
9	Break power Efficiency	η_{BP}= BP/HI× 100 ;
10	Mechanical Efficiency	η_{mech} = BP/IP * 100;
11	Overall Efficiency	η_{ith}= IP/HI*100 ;

5.0 ANALYSIS OF AIR FILTERS:

5.1 Case – 1 (a) Marathi filter NF 560(used)

S.No	load	T.F.C (Kg/hr)	S.F.C (Kg/KW.hr)	A/F	(η_{mech})	(η_{Btherm})	(η_{therm})
1	0.5 Kw	0.501	0.8016	18.66	32.98	10.44	31.66
2	1.0Kw	0.642	0.467	15.23	51.97	24.64	32.7
3	1.5Kw	0.78	0.363	12.7	62.97	23.08	35.62
4	2.0Kw	1.02	0.333	9.77	70.64	25.08	35.5
5	2.5Kw	1.11	0.318	8.97	73.3	26.31	35.8

S.No	HC (ppm)	CO (%)	CO_2 (%)	O_2 (%)	NO_X (ppm)
1	27	0.186	3.78	15.04	48
2	14	0.091	3.19	16.11	84
3	18	0.135	2.87	16.65	150
4	13	0.202	3.45	15.48	205
5	18	0.231	2.3	17.1	144

5.2 Case – 1 (a) Maruthi filter NF 560(New)

S.No	load	T.F.C (Kg/hr)	S.F.C (Kg/KW.hr)	A/F	(η_{mech})	(η_{Btherm})	(η_{therm})
1	0.5 Kw	0.49	0.75	19.5	36.62	11.11	30.34
2	1.0Kw	0.6	0.43	16.2	55.09	19.27	34.98
3	1.5Kw	0.6	0.27	16.2	65.64	30.02	45.32
4	2.0Kw	0.96	0.31	10.12	72.98	26.52	36.34
5	2.5Kw	1.08	0.3	9	75.78	27.28	36

S.No	HC	CO	CO_2	O_2	NO_X
	(ppm)	(%)	(%)	(%)	(ppm)
1	18	0.143	3.05	16.08	34
2	12	0.1	3.24	16.22	96
3	14	0.124	4.22	14.63	196
4	14	0.144	3.1	15.84	174
5	34	0.32	3.9	14.87	194

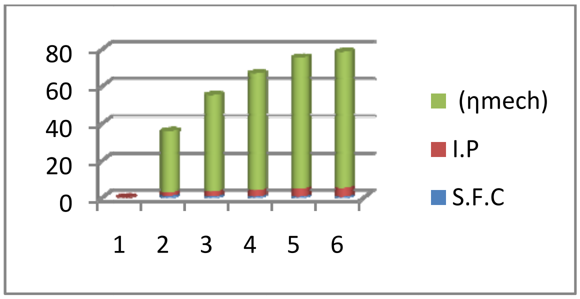


Figure 5: S.FC V/s η_{mech} (NF 560-used)

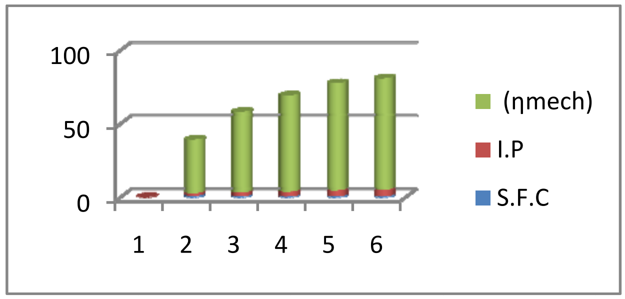


Figure 6: S.FC V/s η_{mech} (NF 560-New)

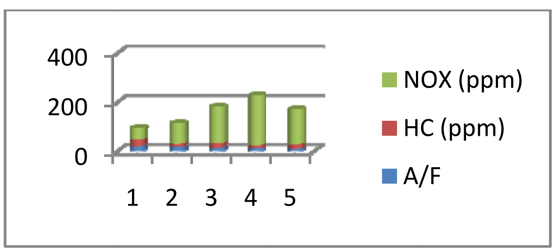


Figure 7: A/F v/s No_x (NF 560-used)

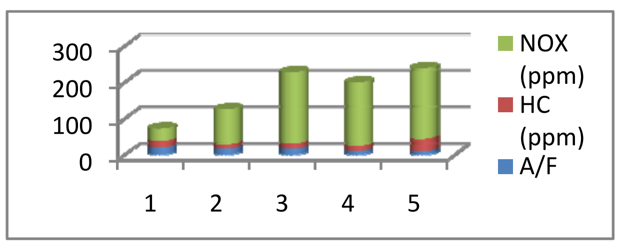
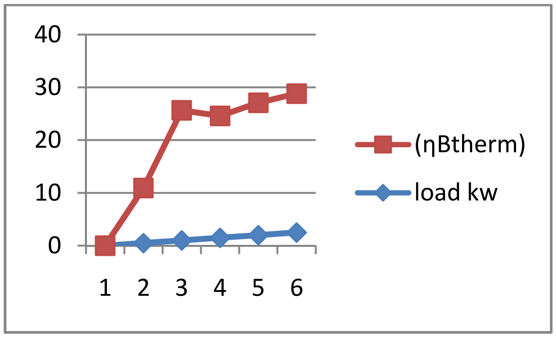


Figure 8: A/F v/s No_x (NF 560-New)



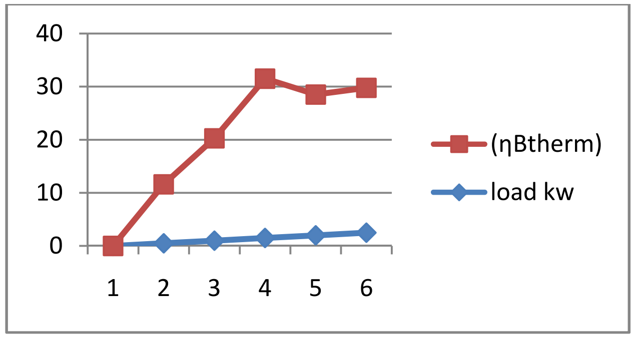


Figure 9: Load V/s η_{Bth} (NF 560-used) Figure 10:Load V/s η_{Bth} (NF 560 -New)

5.2 Case – 2 (a) Tata Indica NF 615(used)

S.No	load	T.F.C (Kg/hr)	S.F.C (Kg/KW.hr)	A/F	(η_{mech})	(η_{Btherm})	(η_{therm})
1	0.5 Kw	0.5142	0.845	20.42	28.57	9.9	34.24
2	1.0Kw	0.618	0.458	17.28	47.18	18.26	38.48
3	1.5Kw	0.755	0.354	13.89	58.67	23.62	40.24
4	2.0Kw	0.984	0.32	10.12	67.17	26.15	38.89
5	2.5Kw	1.1094	0.321	8.97	69.63	26	37.28

S.No	HC	CO	CO_2	O_2	NO_X
	(ppm)	(%)	(%)	(%)	(ppm)
1	13	0.161	2.94	16.21	30
2	15	0.137	2.9	16.3	87
3	9	0.131	4.69	13.8	175
4	15	0.191	4.46	13.99	226
5	10	0.186	2.95	16.46	110

5.2 Case – 2 (b) Tata Indicca NF 615(New)

S.No	load	T.F.C (Kg/hr)	S.F.C (Kg/KW.hr)	A/F	(η_{mech})	(η_{Btherm})	(η_{therm})
1	0.5 Kw	0.51	0.822	15.8	29.24	10.18	34.81
2	1.0Kw	0.6	0.44	13.5	47.55	18.99	39.94
3	1.5Kw	0.6	0.27	13.5	58.9	30.02	50.97
4	2.0Kw	0.96	0.31	8.43	67.1	26.7	39.79
5	2.5Kw	1.08	0.3	7.5	70	27.13	38.75

S.No	HC	CO	CO_2	O_2	NO_X
	(ppm)	(%)	(%)	(%)	(ppm)
1	2	0.141	3.09	16.2	26
2	10	0.147	4.11	14.58	97
3	5	0.144	4.99	13.28	208
4	9	0.122	2.59	17.1	133
5	32	0.48	6.97	10.48	324

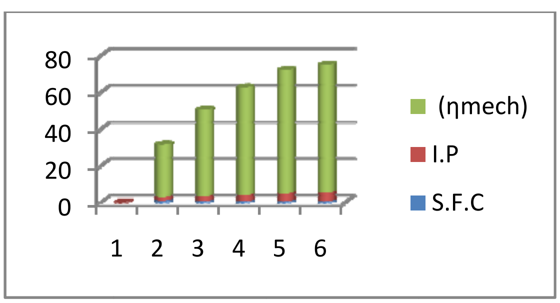


Figure 11: S.FC V/s η_{mech} (NF 615-used)

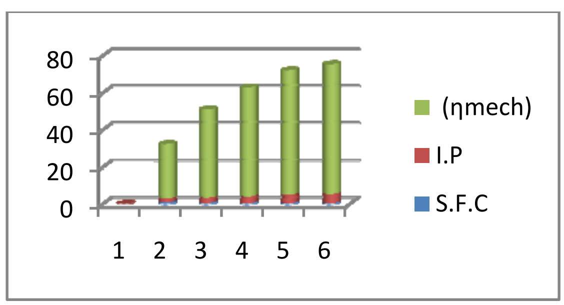
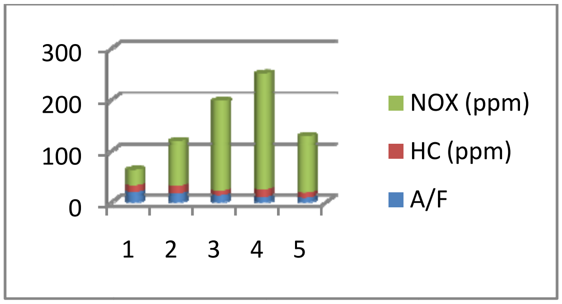


Figure 12: S.FC V/s η_{mech} (NF 615-New)



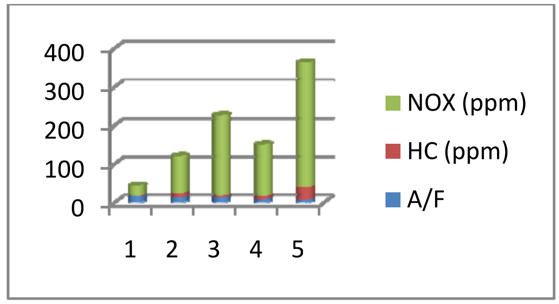
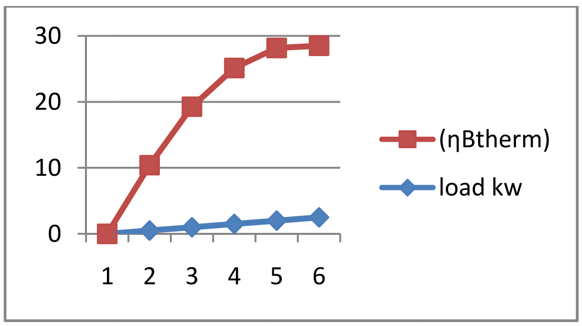


Figure 13: S.FC V/s η_{mech} (NF 615-used)

Figure 14: S.FC V/s η_{mech} (NF 615-New)



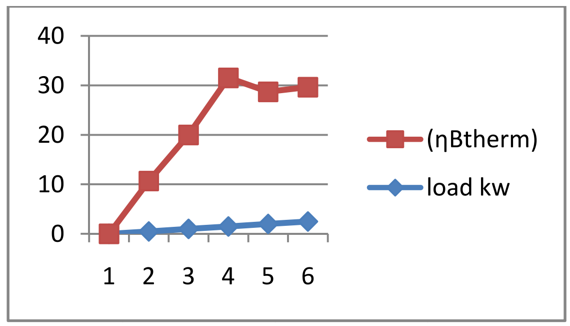


Figure 15:Load V/s η_{Bth} (NF 615-used)

Figure 16:Load V/s η_{Bth} (NF 615 -New)

5.3 Case – 1 (a) Tata Sumo – NF 1004 (used)

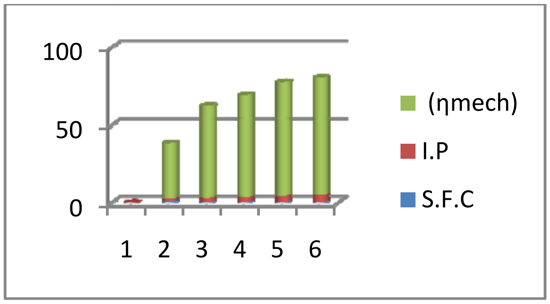
S.No	load	T.F.C (Kg/hr)	S.F.C (Kg/KW.hr)	A/F	(η_{mech})	(η_{Btherm})	(η_{therm})
1	0.5 Kw	0.5	0.79	23.29	35.89	10.55	29.39
2	1.0Kw	0.6	0.36	20	59.45	23.04	38.75
3	1.5Kw	0.72	0.33	16.6	65.85	25.23	38.31
4	2.0Kw	0.96	0.31	12.5	73.3	26.96	36.78
5	2.5Kw	1.08	0.3	11.11	75.78	27.28	36

slno	HC	CO	CO_2	O_2	NO_X
	(ppm)	(%)	(%)	(%)	(ppm)
1	39	0.086	2.37	17.07	36
2	31	0.08	1.87	18.22	91
3	19	0.084	3.82	15.69	182
4	15	0.127	2.7	17.57	164
5	20	2.22	2.22	18.7	180

5.3 Case – 2 (a) Tata Sumo – NF 1004 (New)

S.No	load	T.F.C (Kg/hr)	S.F.C (Kg/KW.hr)	A/F	(η_{mech})	(η_{Btherm})	(η_{therm})
1	0.5 Kw	0.707	1.05	17.18	43.94	7.9	18
2	1.0Kw	0.69	0.48	17.13	62.28	17.23	27.06
3	1.5Kw	0.79	0.36	15	71.7	23.11	32.23
4	2.0Kw	0.98	0.31	12.19	78.22	26.41	33.76
5	2.5Kw	1.04	0.42	11.32	80.22	28.09	35

S.No	HC (ppm)	CO (%)	CO_2 (%)	O_2 (%)	NO_X (ppm)
1	31	0.187	3.51	15.64	29
2	29	0.165	4.01	14.84	115
3	13	0.147	4.85	13.86	333
4	16	0.185	4.03	14.98	346
5	14	0.214	3.12	15.71	343



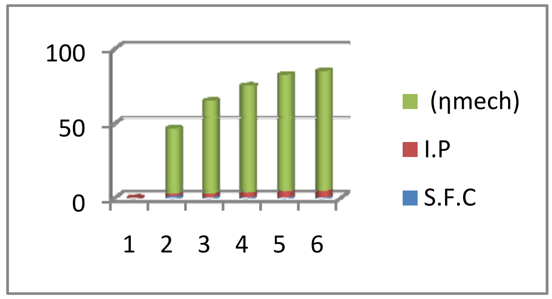
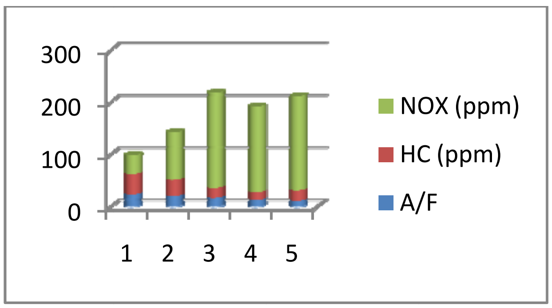


Figure17: S.FC V/s η_{mech} (NF 1004-used) Figure 18: S.FC V/s η_{mech} (NF 1004New)



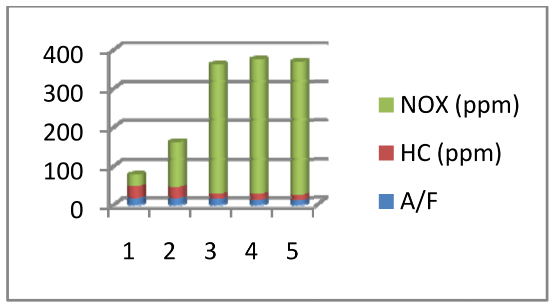
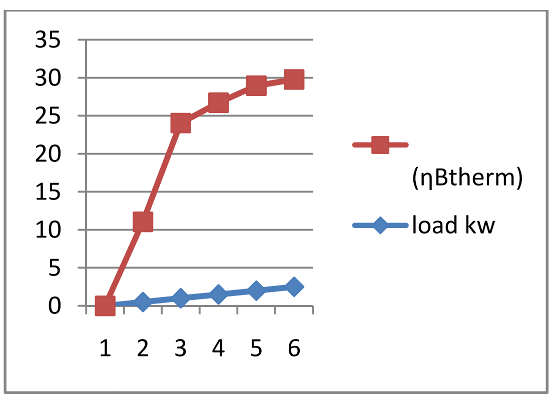


Figure 19: S.FC V/s η_{mech} (NF 1004-used) Figure 20: S.FC V/s η_{mech} (NF 1004-New)



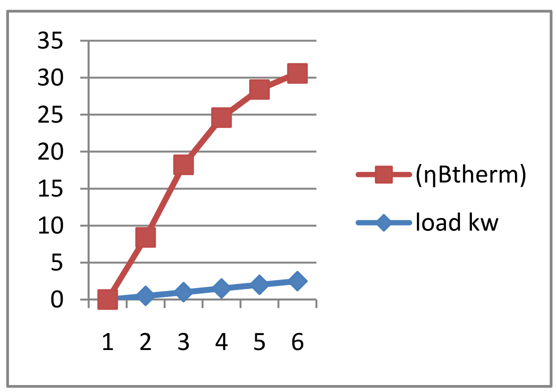


Figure 21:Load V/s η_{Bth} (NF 1004-used) Figure 22:Load V/s η_{Bth} (NF 1004-New)

6.0 CONCLUSION:

Studies of clogged air filter results shows that has no significant effect on the fuel economy of the engine. The engine control systems were able to maintain the of intake restrictions, and therefore fuel consumption was not increased. By considering the of Case 1 study filter the initial change in Specific fuel consumption decreased in clogged type air filter as resulted in higher in efficiency of the engine , as with introduction of new air filter of same model with same specific fuel consumption the efficiency of the engine validated and difference observed as 2.4 % increase of efficiency . By observing the data obtained of emission and pollutants with comparison of air fuel ratio with different parameters like HC and NOx , as decreases in air fuel ratio then rise in HC and NOx as 144ppm. At constant speed of 1500 rpm with different same load conditions in both filters the efficiency of break thermal is increased with .97 % , but as load increases after 1.5 kw the efficiency slightly decrease , this is due to observation of in sufficient air supply / proper fuel burning .With the same air fuel ratio in new filter also rise in HC and Nox as 194 ppm. Fuel economy decreased more than 5% from the initial clogged air filter test results and about 7.5% from the results for the new air filter. Further study of case 2 filter the initial change in Specific fuel consumption decreased in clogged type air filter as resulted in higher in efficiency of the engine, as with introduction of new air filter of same model with same specific fuel consumption the efficiency of the engine validated, where there 0.7 % increase of efficiency . By observing the data obtained of emission and pollutants with comparison of air fuel ratio with different parameters like HC and NOx , as decreases in air fuel ratio then rise in HC and NOx as 110ppm. With the same air fuel ratio in new filter also rise in HC and Nox as 324 ppm. Fuel economy decreased more than 10% from the initial clogged air filter test results and about 18% from the results for the new air filter. At constant speed of 1500 rpm with different same load conditions in both filters the efficiency of break thermal is increased with 1.13 % , but as load increases after 1.5 kw the efficiency slightly decrease , this is due to observation of in sufficient air supply / proper fuel burning .Comparing the case 1 and case 2 of new filters resulted good in efficiency and controlling of air pollutants with their own advantage. As comparing with case 3 with case 1 and case 2 it is observed as break thermal efficiency is increased 0.81 % with same load conditions and with constant speed. But where as load increase after 1.5kw the break efficiency not decreasing after 1.5 kw load ,so it is observed that case 3 filter has more advantage. Even study continuing for model NF 1004 with clogged and new air filters resulting good as compared with previous models. However, only by changing the air filter can keep engine running at its best. Studies have consistently shown that vehicles with clean air filters perform better than dirty old air filters. A dirty and clogged air filter reduces the amount of air flow available to engine. A limited amount of air causing a drop in performance as well as other problems. Additionally, damaged air filters can allow small particles to enter your car's engine, causing additional problems. As comparing with results with other studies the improvement with a new filter ranged from 2 to 6%. Optimum filtration performance of Air Filters is important to provide the minimum level of air cleanliness required to the engine. Continued demand for further reductions in air intake system size and restriction has resulted in innovative solutions. For dusty conditions these efficiency levels may have to be orders of magnitude higher. The overall/final efficiencies should be higher than the initial efficiencies. Lower overall/final efficiencies would indicate re-entrainment problems. Efficiency measurements using standard test dusts may not represent field conditions. Contaminant/dust holding capacity of Air Filters depends on the particle size distribution and concentration. The air passages are far more efficient with (mostly) radiuses corner between the air filter housing and the intake manifold. However, that’s not to say that this design can’t be improved upon. These new filter designs are made of a filter media that is inherently high in mass air flow handling capacity and in many cases come with an optional ducting and housing assembly that completes the package. Other cool thing about these filters is that most of them are cleanable. the ability to remove the filter and clean it with spirits and re-install in the housing, saving the cost of purchasing a new filter while keeping the old filter out of the landfill. In view of the automotive air filters market studies, it is poised to witness an annualized growth of over 7.47% from 2013 to 2018. Considering the filter type, the intake air filter is the leading market for automotive air filters when compared to cabin air filters. Cabin air filters have been growing for the past few years and is growing at a promising CAGR.

REFERENCES:

1.Dan Adamek, (2008), “Methods for Diesel Engine -Air Intake and Filtration System Size Reductions “Donaldson Company, Inc.

2.Barris, Marty A., (1995) , “Total Filtration™: The Influence of Filter Selection on Engine Wear, Emissions, and Performance”, SAE 952557, SAE Fuels and Lubricants Meeting & Exposition.

3. Deierlein, Bob, (2001) “Managing Fuel Consumption”, Fleet Equipment,

4. 2011,Air Filtration Products and Systems, Cummins Filtration Inc.

5. 2009 Baldwin Filters, Inc.

6. Neville J. Bugli, (1995), “Performance and design of engine air induction filters”, Visteon Automotive Systems.

7.Bugli N. J, Puckett R., and Lanier V., “ Filtration Challenges and Conical Filter Development for Engine Air Induction Systems, ” SAE technical paper 950941, Detroit, February 27 - March 2, 1995.

8. Bugli N. J, 1997, "Filter Performance Requirements for Engine Air Induction Systems", SAE technical paper 970556, SAE special pub. SP-1252 pp. 55-69, presented at the SAE International Congress and Expo. Detroit, Feb.-Mar 1997.

9.Jaroszczyk T., Wake J. and Connor M. J. ,"Factors Affecting the Performance of Engine Air Filters," Journal of Engineering for Gas Turbines and Power, Vol. 115, pp. 693 - 699, October 1993.

10. Alexander W. R., Murphy L. T. , and Shank G. L. , "Improving Engine Durability via Filters and Lubricants," SAE Technical Paper 852125, 1985.

11. Tadeusz Jaroszczyk, Stephen L. Fallon, Scott W. Schwartz, “Development of high dust capacity, high efficiency engine air filter with nano fibers”, Cummins Filtration Inc.

12. Baldwin brochure - form 346.

13. Cheng, Y. S., Allen, M. D., Gallegos, D. P., and Yeh, H.C., Drag Force and Slip Correction of Aggregate Aerosols, Aerosol Science and Technology, 8, 1988, pp. 199-214.

14. Donaldson Brochure, 2002.

15.Jaroszczyk, T., Fallon, S. L., Pardue, B. A., Liu, Z. G., Schmitz, K, New Generation Direct Flow Engine Air Filters – Performance Analysis, Proceedings of World Filtration Congress, New Orleans, Louisiana, USA, April 18 – 23, 2004.