Compersion Data For Efficiency of Different Types of Air Cleaner Assemblies

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Abstract- The air intake assembly provides the internal combustion engine with fresh air and it has a major effect on engine performance and emissions. Therefore great attention has to be focused on the design of the intake system and its efficiency for clean air supply. Many investigations are related to the improvement of the breathing capacity of the engine, to the minimization of pressure losses along the pipes and to the distribution uniformity of air among the cylinders of the engine. A good air intake system allows for clean and continuous air into the engine, thereby achieving more power and better mileage for your vehicle.

Keywords: Air cleaner assembly, CFD, Dust holding capacity, Restriction to the flow, Fuel economy

I. INTRODUCTION

Now a day in the era of better performing engine and based norms for EURO ratings, the demand for great fuel efficiency is always treating like a boost to progress in market. The air cleaner assembly for an engine playing a major role to get a better fuel economy from a particular vehicle's powertrain. To achieve this air cleaner assembly need to be get validated in mentioned points;

- Air Flow
- Initial Efficiency
- Full Life Efficiency
- Initial Pressure Drop(Across Filter)
- Dust Hold Capacity
- Sealing (Radial or Axial)
- Air Inlet \Air Outlet
- Mounting Type (Horizontal vertical)
- Metallic \ Plastic Air Cleaner
- Water Wadding Height

II. METHOD OF EXPERIMENT

In order to determine the best air cleaner system for a particular engine and vehicle application the intake airflow and restriction limit of the engine to be identify based on power rating required for the vehicle. Also the level of dust or contaminants in the environment in which the vehicle is used must be defined with respect to desired service interval for the air cleaner system. In order to determine the best air cleaner system for a particular engine and vehicle application, following factors should be considered as method of experiment:

(A) Intake airflow and restriction limit of the engine model
(B) Power rating to be used in the vehicle.
(C) Level of dust or contaminants in the environment in which the vehicle is to be used.
(D) Desired service interval for the air cleaner system.

III. DESIGN RECOMMENDATION AND STANDARDS

The general recommendations for air intake system design are based on mentioned guidelines;

1. The air cleaner must be at least 99.9% effective at removing airborne dirt particles when tested according to SAE STD.
2. The air cleaner design must provide adequate filter element service life in the environment in which the vehicle will be operated.
3. The restriction of the installed intake system with a clean filter element must not exceed the Maximum Inlet Restriction with Clean Filter on the Engine Data Sheet.
4. The system must include a restriction indication device, connected to the intake system with a filtered fitting, set to indicate when the Maximum Inlet Restriction with Dirty Filter on the Engine Data Sheet is reached.
5. The air inlet location on the vehicle must prevent the ingestion of hot engine compartment air, Prevent the direct ingestion of rain and road spray, Prevent the ingestion of exhaust soot.

In a very dusty environment, a longer service interval can be obtained by using a pre-cleaning system to separate out contaminants before they reach the filter element. When designing an air cleaner system on a new vehicle model which will be used in a known application, the dirt holding capacity which has proven successful in that application should be specified. If there is no appropriate field experience available, the following guidelines should be used.

- For On-Highway Trucks and Busses operating exclusively on paved roads, Light or Normal Duty air cleaners with a dirt holding capacity of at least 1.5 gm/cfm of fine dust (tested per SAE J726) are acceptable.
- For On-Highway Trucks, which also operate off highway or in dusty environments, Light or Normal Duty air cleaners with a dirt holding capacity of at least 1.5 gm/cfm of fine dust (tested per SAE J726) are acceptable.

For vehicles which operate predominantly on unpaved roads, in very dusty environments, or in environments containing abrasive materials such as rock dust, cement or sand, Light or Normal Duty air cleaners with a dirt holding capacity of at least 3.0 gm/cfm of fine dust (tested per SAE J726) are acceptable.

IV. MODELING AND SIMULATION OF "AIR INTAKE ASSEMBLY" BY USING PRO-E/ANSYS

In consideration of requirement some of the basic CAD data for air intake system prepared by using CAD tool Pro-Engineer and Simulation boundaries with ANSYS CFD. The system consists of Primary and secondary ducts, snorkel assembly, air cleaner assembly, route hose, turbocharger pipe assembly. Here the flow resistance (1500 Pa) as a factor of safety consider for air cleaner assembly only. As the other parts are belongs to the route path the iteration wise data prepared for the flow path restriction verification by using CFD analysis. Also here with the resistance factor for the air cleaner assembly consider to verify the pressure drop during the air flow within the air intake system

V. POST PROCESSING BY USING ANSYS

The air flow counters are the fluid simulation code on finite volume method for simulating the performance of air intake system with requires air flow as per engine's rated power. Tools using this three dimensional approach accurately predict all engine breathing characteristics. This enables engineers to Consider air system and air intake effects during analysis. The post processing for fluid simulation (CFD) has to be use following boundary conditions to finding out the require results: (elaborate the figure 1 and 2 and explain it in all places)
1. Air flow; 650Kg/Hr.
2. Filtration restriction boundary; 1500 MPA.
3. Maximum pressure drop; 381 mmH_2O (15" of H_2O).

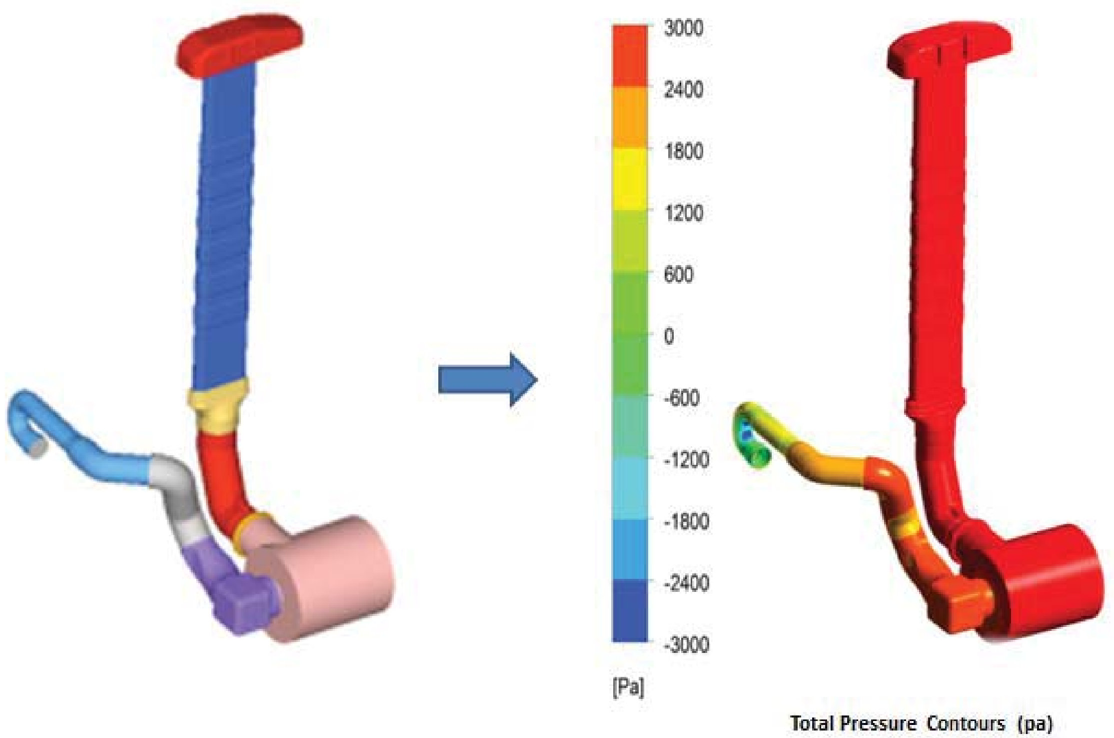

Figure 1 Pressure drop contours for Air intake system

As per the post processing result shown (Refer figure 1) both the figures are highlighted the pressure drop zone from snorkel top to turbo inlet end. Based on color rating scale the effects on air flow within the system showing the restriction in Pascal as shown. It shows the change in routing of air flow area will leads for increment or decrement of restriction.

VI. RESULTS AND DISCUSSION

This research work shows that the requirement based on virtual data and optimization for design, the physical air intake assembly with its subcomponents and assembled on physical vehicle for validation and test. As we have taken observation for total 4 no. of iteration in air cleaner assemblies, the restriction values are varying as per the requirement of engine intake for combustion. These iterations are belongs to the requirement of an engine having power rating of 180hp and referring the engine intake requirement data we have calculated the maximum pressure drop & restriction zones for desired air intake systems too. As found the result for all iterations are different in manner of measurement as CFD based or manual based systems.

The iterative process follows up and monitoring of test procedure has generated result for all setup as mentioned;

Comparison of Different Air cleaner						
	RESTRICTION (INCH H2O)	AIR FLOW (m3/min)		Dust Holding capacity(kg)	Air cleaner weight (Approx.) (kg)	Cleaning Efficiency (Min.)
Air cleaner Plastic) (Opt 1)	6	10.84	1.84	9.6	5	99.90%
	8	12.54	1.7			
	10	14.04	1.5			
Air cleaner (Plastic) (Opt 2)	6	8.18	-	7.2	4.2	99.90%
	8	9.51	1.33			
	10	10.65	1.14			
Air cleaner (Metal) (Opt 1)	6	8.78	-	6.2	13.6	99.82%
	8	10.19	1.41			
	10	11.6	1.41			
Air cleaner (Metal) (Opt 2)	6	6.08	-	4.3	9.4	98.95%
	8	7.5	1.42			
	10	8.63	1.13			

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