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Charging the auotomobile engine using air resistance during vehicle motion for combustion

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ABSTRACT: *This paper describes the work done on Compression Ignition Engine downsizing and charging the engine using air resistance during vehicle motion substantial downsizing and improvement in performance in terms of power up rating, improvement in efficiency and improvement in fuel economy and noticed. Laboratory experiment to confirm utilization of air resistance is carried out. The field trails on TATA SUMO passenger vehicle shown improvement in fuel economy. The reduction in exhaust pollutants is also noticed during experimentation. This paper discusses about power up rating.*

Keywords: *Compression Ignition, air resistance, charging,fuel economy.*

I. INTRODUCTION

The consumption of diesel fuels in India was 28.30 million tones which was 43.2% of the consumption of petroleum products. This requirement was met by importing crude petroleum as well as petroleum products. The import bill on these items was 17,838 crores. With the expected growth rate of diesel consumption of more than 14% per annum, shrinking crude oil reserves and limited refining capacity, India will be heavily dependent on imports of crude petroleum and petroleum products. The demand of compression ignition or diesel will be twice than the gasoline engine. The conventional efforts to improve the engine performance is to operate the engine under lean mixture zone. The additional air is charged using supercharging or Turbocharging. The turbocharging improved dramatically on pollution emission levels but have not gained much in fuel economy especially at part load conditions.

The most promising approaches are:

Quality load control engines in combination with Exhaust Gas Recirculation(EGR).

Variable valve timing where engine is operated stoichiometrically or lean.

Reduced displacement and increased speed.

Increased intake air pressure to increase the air intake.

The quality load control engine in combination with EGR has reduced loss and has thermodynamic benefits, but does not substantially reduce friction. The thermodynamically lean engine cannot meet very low pollution emission standards.

Variable valve timing with lean operating condition reduces only pumping losses and is hampered by power demands and durability problems of the electromagnetic valve actuators. These engines can be operate stoichiometrically which allows to employ proven technologies.Approach three reduces both pumping and friction losses but requires a sophisticated transmission system. Moreover, there are some concerns regarding customs acceptance of the unusual acoustics behavior of such systems. There engines can have very low pollutants emission and achieve interesting fuel consumption levels, especially when combined with automated manual gear boxes.

Approach four is one present in the paper. A substantial reduction of the displaced volume in combination with fast and boosting device called as Sangmo Charger are the key ideas to reduce both pumping and friction losses and achieve part load efficiencies. The concept of increase in boost pressure is discussed in next section.

II. CONCEPT OF INCREASE IN BOOST PRESSURE USING VEHICLE AIR RESISTANCE

The aerodynamic drag of the vehicle is proportional to the speed. The frontal portion of the car which is normal to air flow will experience the kinetic head. Minimizing this area and providing proper shape can minimize this kinetic head to some extent. However some area due to practical constraints remains is position where fully kinetic head is experienced. The air resistance is given by:

$R_a = \rho A V^2 K_a$ ---------------Equation 1

Where ρ- Air density
Frontal area of vehicle
V- Speed of the vehicle in Km/hr
K_a- Co efficient of air resistance

The air drag of air resistance causes the major part of the Automobile power is consumed in over coming air resistance. In the present work , the wind resistance is used to increase the intake manifold pressure for the improvement of engine performance.

In Supercharging of the engines, compressor used for supercharging consumes part of engine power. The suction manifold also requires modifications. Supercharger adds up additional weight to the engine due to step up gearing required to increased the speed to 10000 to 30000.Superchaeger is effective at lower speed and part load.

Turbocharger installation has drawback due to high cost involved in installation. Engine suction manifolds and exhaust manifolds are required to be modified. Turbo charging acts as an obstruction in exhaust, which influences engine performance. Fuel injection system also requires modification to inject the fuel.

In present work , effect of boost pressure is obtained as in case of Turbocharger or Super charger. The alteration to be carried out for installation of additional components called Sangmo Charger is minimum or minor. Charger is of retrofitting type and can be installed on existing automobiles. This utilization of air drag gives performance at par with Turbocharging or Supercharging at nominal cost without any drawbacks at part load conditions.

The vehicle in motion experiences air drag. A convergent-divergent nozzle which acts as charger is fitted in frontal area of vehicle. Air is allowed to pass through convergent nozzle, increases incoming velocity of the air in proportion to the dimensions of the nozzle. This velocity of the air is allowed to ascertain the stagnation conditions in a chamber connected to intake manifold, inlet pressure of the engine increases.

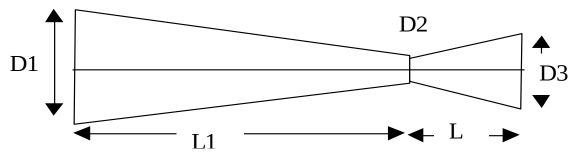

Fig 3: Shows the details of nozzle

The Divergent portion of the Nozzle is connected to intake manifold. Increased velocity of air at throat is brought toi stagnation condition in the chamber. The pressure in the chamber increases in proportion to the kinetic enerty in the air.

Divergent part of the nozzle normalizes variation in the pressure.Increased pressure in chamber increases inlet pressure for the engine. The increase in pressure of air is utilized for induction during suction stroke. The increased Pressure is likely to have following effects.

Rate of Chemical reaction inside cylinder accelerates.
Increases flame speed and decreases concentration of exhaust pollutants.
Increase in power
Fuel economy

Selection of nozzles

The nozzles are designed to satisfy output requirement in terms of pressure gradient and mass flow rate. In the present requirement nozzles are operated under variable speeds. The performance evaluation is carried out for known inlet velocity. The experimentation is carried out for nozzles performance.

Table 1 : Dimension of Convergent-Divergent Nozzles.

D_1 In mm	D_2 In mm	D_3 In mm	L_1 In mm	L_2 In mm
100	20	36	350	75
100	30	46	350	75
100	40	58	400	75
100	40	55	400	75
100	40	55	450	75
100	40	55	500	75
100	50	65	450	75

The relative velocity of air with respect to stationary nozzles is considered . The flowintg air stream is utilized for experimentation. Wind tunnel is used to get flowing air of required velocity. Velocity of air is controlled by the means of Dimmersted. The wind tunnel consist of axial flow blower coupled with three phase motor. Flow of air is passed through circular duct of 500mm diameter. The air is further deffused to rectangular section of 480mm x 245mm. The flow is further passed in a rectangular sectionof 420mmx420mm. And finally to contraction cone of 500mm length with diameter of 175mm.Nozzle performance is evaluated over operating range of inlet velocity of 40km/hr to 80km/hr.

Seven Nozzles are selected are giving similar trends in terms of Stagnation pressure. The experiment are conducted on the stand alone nozzles. This increase in stagnation pressure is expected to improve the performance of an engine. The improvement in performance of an engine due to Sangmo Charging is verified on engine. The verification is conducted stationary engine and effect of vehicle motion is obtained by wind tunnel to give equivalent wind velocity at the nozzles. The selected test to evaluate performance of an engine is as per IS code 13116:1991 for power up rating. The standard procedure is adapted for measurement of power with brake rope drum dynamometer and speed by digital tachometer.

Parameters controlled

The experimental set up is retained for all experimentation. No modification are done other than changing of the nozzle in the set up. The existing design parameters of an engine such as suction manifolds, injection timing, fuel charging and geometry of the components such as piston are not changed. The fuel used is high speed diesel available commercially. The diesel is procured in a bulk from one stock and same fuel is used for all experimentation.Environmental conditions cannot be controlled due to resource limitations, hence all experimentation are conducted during 11:00 a.m. to 6:00 p.m. There is no large atmospheric temperature variations in the month of February and March in this region.Two throttle condition are used i.e. idle and throttle. Sufficient time is provided after starting of measurement of parameters.

Element	Parameter	Value
1.Engine	Make	Kirloskar four stroke Naturally Aspirated
	Cylinder	Single Cylinder
	Bore	80mm
	Stroke	110mm
	BHP	5 HP at 1500 rpm
2.Rope Brake dynamometer	Brake drum diameter	300
	Rope Diameter	15
3.Control and indicator panel	Fuel Measurement	Glass Burette with capacity of 50ml with three way cock
4.Air Tank	Air Tank Capacity with U tube manometer	Volumetric capacity of 1 m^3

Engine specifications on which the trails were conducted are as follows

Parameters varied

Experimentations are conducted for different nozzles , at different brake loads. The experiments are conducted for various wind velocities (equivalent to wind velocities) All the trails are conducted for two throttle conditions. They are

Idle and ii) throttle

The idle condition is set to 770 rpm at no load conditions.

The idle condition is set to 770rpm at no load condition. Full throttle condition is set to 1500rpm at no load condition. The original equipment manufacturer recommends the speed of 1500rpm as maximum speed.

All seven nozzles are tested for performance improvement. The figure 5 shows the details of nozzle fitments. Initially trials are conducted at Naturally Aspirated conditions for comparison.

The brake load is applied from 1 kg to 6 kg in the steps of 1 kg on the brake drum. This gives brake torque of 1.575 N-m to 9.45 N-m in the stages of 1.575 N-m. Table 2 shows the average reading at idle condition and Table 3 shows the average of reading at throttle condition.

To analyze effect of brake power, graphs are plotted for brake power obtained at various wind velocities for all nozzles. The graphs are superimposed for comparison of a nozzle under specific condition. Figure 5 shows the percentage improvement in brake power as compared to naturally aspirated condition at idle condition. Figure 6 shows percentage improvement in brake power at throttle condition.

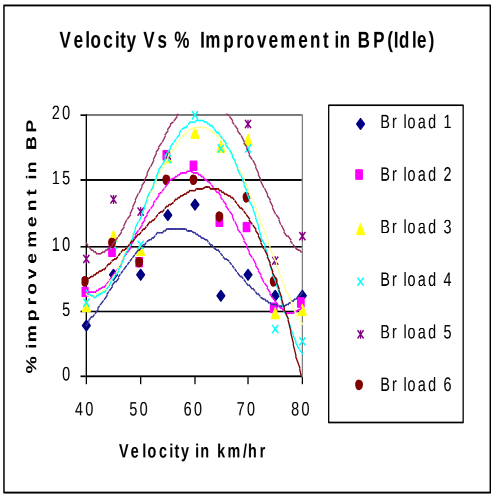

Figure 5. Graph of Inlet Velocity V/S Brake Power for Nozzle No. 3 under Idle Condition

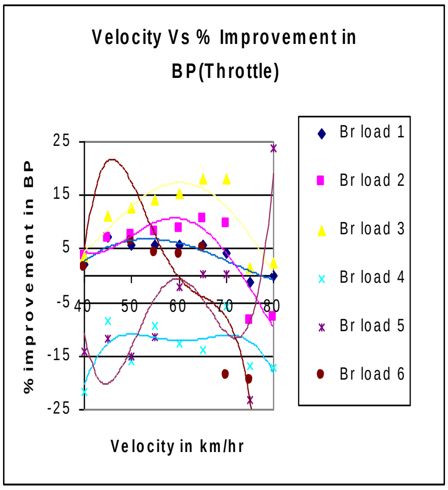

Figure 6. Graph of Inlet Velocity V/S Brake Power for Nozzle No. 3 under throttle Condition

TABLE 3.Average reading at Thrittle condition

Load in kg	RPM	Manometer reading in mm
1	1430	30
2	1365	30
3	1045	30

III. CONCLUSION

Brake power is consistently higher because of Sangmo Charging as compared to naturally aspirated condition at least by 5 %

The increase in Brake power is consistently higher in the speed range of inlet velocity equivalent to vehicle speed of 50 km/hr to 70 km/hr.

The increase in power drops beyond 75 km/hr.

Increase in brake power drops down beyond 75 km/hr.

For lower brake loads, improvement is to the tune of 10 %

Over entire speed range the brake power develop is higher than naturally aspirated condition.

At throttle condition improvement drops suddenly at 54 km/hr for all the nozzles

at throttle condition the increase in power is higher in the speed range of 60 km/ hr to 70 km/hr.

Sangmo Charging is effective at low and moderate loads.

At higher wind velocities deterioration of power is observed

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