International Journal of Advanced Technology in Engineering and Science www.ijates.com
Volume No 03, Special Issue No. 01, March 2015 ISSN (online): 2348 – 7550

# DOWNSIZING OF GASOLINE ENGINES

**Aditya Gavane[1], Dharini Chhajed[2]**

[1]*Department of Mechanical Sandwich Engineering,*

*All India Shri Shivaji Memorial Society's College of Engineering, Pune (India)*

[2]*Department of Electronics Engineering,*

*Padmashree Dr. D. Y. Patil Institute of Engineering and Technology, Pimpri, Pune (India)*

## ABSTRACT

*In order to meet commitments in terms of vehicle CO2 emission reduction for the whole fleet of cars for the year 2008, engine research and development is today exploring several fields. From CO2 point of view, Gasoline engines suffer from a handicap in comparison to Diesel engines. Reduction of size of gasoline Engine(downsizing) appears to be a promising way to improve engine efficiency and is subject toextensive research. Having a look to the long term, the aim should be to reduce by half the engine displacement volume. Calculating results from a vehicle simulation illustrates that even a so extensive downsizing will not be enough to bring the entire gasoline fleet to the requested CO2 levels. It would just be sufficient to reach the targeted levels for year 2008 for a mid-class vehicle powered by a downsized 0.8 litre engine instead of a current 1.6 litre gasoline engine. Reduction of CO2 emission is in that case about 18% in warm engine conditions. Then, further improvements have to be achieved in terms of engine specific fuel consumption, especially for bigger cars*

***Keywords: Gasoline, Downsizing***

## I. INTRODUCTION

Because it is a major cause of global warming, theconcentration of carbon dioxide (CO2) in the air is today of great concern. Transport represents 20 to 25% of the CO2 release in the atmosphere and this share tends to increase. A part of the automotive industry has taken into account the absolute necessity to reduce the CO2 emission of the vehicles.

The European Car Manufacturer Association (ACEA)has for example entered into a highly ambitious undertaking the commitment is that CO2 emission of the future vehicles:

- Averaged on the whole production of the signatories will reach: 140 g/km of CO2 in year 2008, and perhaps 120 g/km of CO2 in year 2012.

The reduction in the CO2 emissionof the vehicle will be essentially achieved thanks to an increase in efficiency of the engine and of gear. Of course, other features of the vehicle may be improved such as aerodynamic drag, mass, resistance of the tyre but to a lesser extent.

Several ways are today explored by the engine researchers for the reduction of the fuel consumption of the engines. As far as the gasoline engines are concerned, the tested technologies are for example:

- Stratified combustion thanks to the development of incylinder
- Direct injection technology;

- Variable valve process, from simple variable timing camshaftup to fully electronic control of the valves (*camless*engine);
- Variable compression ratio
- Reduction in the engine size (downsizing)

Downsizing is today considered as a promising way to increase fuel economy with a good cost to benefit ratio. The challenge is here to reduce the engine displacement volume while keeping the same performance in terms of torque and power than the initial larger engine, and simultaneously to ensure an improvement in engine efficiency. Downsizing of gasoline engine is already an industrial reality. During last years, several car makers have presented 1.8 l to 2.0 l turbocharged engines. The performances of these engines are typically the ones of naturally aspirated engines with 2.5 l displacement. The reduction of fuel consumption is typically about 10%. The second generation of downsized engines is today the object of extensive research. Target is to reduce by half the displacement of the engines and also to consider the downsizing of smaller engines than the upperclass engines with 2.5 l displacement or more. This paper explains the concept of downsizing using aturbocharger coupledwith gasoline direct injection and illustrates the potential of downsizing in the very near future.

## II. CONCEPT OF DOWNSIZING

Most of the time, and especially when the vehicle is driven at a constant speed, the engine is run under low load conditions.This leads to poor engine efficiency especially forconventional existing gasoline engine for which load is controlled by a throttle. Throttling generates pumping losses and reduces efficiency.

A larger engine with a smaller version, witha lower displacement. The downsized engines of tomorrow will have fewer, smaller cylinders, so the volume swept by pistons as they pump up and down inside is reduced.

This will reduce friction, thermal losses and the mass moved, boosting fuel economy and cutting carbon dioxide emissions. Diesel engines have already undergone aggressive downsizing – up to 40% – over the last decade and more stringent emissions legislations see this trend movingover to petrol engines.Consumers want to drive more fuel-efficient vehicles, but not at the expense of engine performance. Innovations from components suppliers have been crucial in ensuring that power is not lost in the process.

## III. AVOIDING POWER LOSS

Despite having a lower displacement, the performance of a downsized engine can be maintained by injecting more air into its combustion chamber to burn additional

fuel. This is made possible by turbocharging, which provides the engine with the mass of air needed to ensure highly efficient and clean combustion.

In 2008, Bosch teamed up with Germany based Mahle to form Bosch Mahle Turbo Systems to develop modern turbocharging systems for new petrol in passenger cars and commercial vehicles. Progress since then has been rapid. A turbocharger developed by the joint venture has recently been fitted into Mahle’s three-cylinder petrol engine. The engine can produce 160 horsepower and 286 Nm from a displacement of only 1.2 litres, matching the performance of a conventional engine twice its size.

## IV. TURBOCHARGING

In both, petrol and diesel vehicles, the turbocharger comprise two assemblies:

1. A centrifugal compressor powered by a turbine that is driven by the engine's exhaust gases (see Figures 1 and 2). Hot exhaust gases flow through the turbine's wheel blades,
2. Accelerating the turbine and driving the compressor.

These turbines are made from high temperature resistant nickel alloys, and can withstand temperatures in excess of 1000°C and accelerate to speeds upwards of 280,000 revolutions per minute .The compressor itself comprises an impeller and a diffuser, housed in the compressor casing. The precision-milledaluminium alloy impeller draws in air, accelerating it to a high velocity before forcing it towards the diffuser. The diffuser slows the fast-moving air, raising the pressure and temperature in the compressor housing, and compressing the air before it is directed to the engine. To prevent the turbocharger from overcharging at high engine speeds – and also to maintain torque at lower engine speeds – the flow of exhaust gases through the turbine and compressor is carefully controlled. In a petrol engine, at high engine speeds, a waste gate is opened to divert part of the exhaust gas flow away from the turbine. This decreases pressure in the compressor housing and preventsovercharging.Meanwhile at low engine speeds, the waste-gate will close so that the entire exhaust flow can drive the turbine and the compressor. These turbochargers arealso designed to provide 'over-boost,' a temporary, excessive increase in pressure for when, say, the driver is accelerating

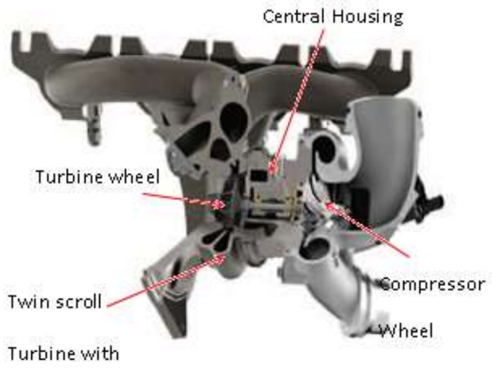


Figure 1

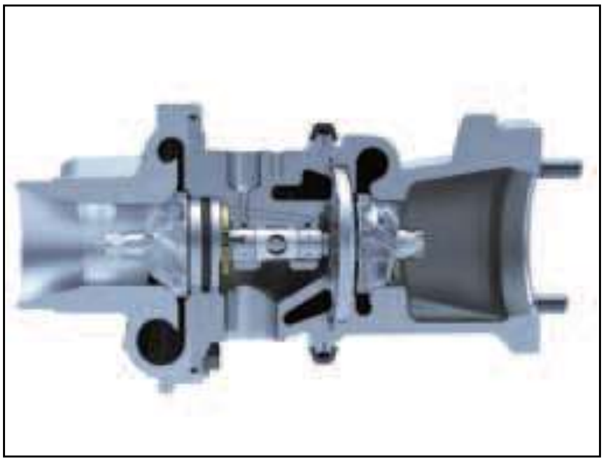

Figure 2

## V. GASOLINE DIRECT INJECTION

Gasoline direct injection often means stratified operations. This kind of engine operation allows fuel consumption gains at part load due to pumping and thermal loss reduction.Nevertheless, after-treatment of NOx emissions in an oxidising environment leads to a fuel penalty. It is alsodifficult to carry out this after-treatment especially because of the very low sulfur level required in fuel for NOx traps. Consequently, gasoline direct injections engines do not fully benefit from their high efficiency in running at stratified conditions and consumption gains on vehicles are limited to 10% or 12%.Homogeneous stoichiometric conditions present lots ofadvantages. After-treatment can be easily achieved without too expensive systems and applications of this combustion mode on current naturally aspirated engines shows high volumetric efficiency and compression ratio in comparison with intake port injection. Gasoline direct injection engine has a lower knocking sensitivity.

## VI. OPERATION OF THE TURBO SYSTEM

The hot exhaust gases drive the turbine wheel of the turbocharger which is connected to the compressor wheel of the turbocharger by a cast steel shaft. The turbine wheel drives the compressor wheel which thereby compresses the air which is allowed to pass through the charge air cooler. This high density air is then passed in the engine thereby improving the volumetric efficiency of the engine.

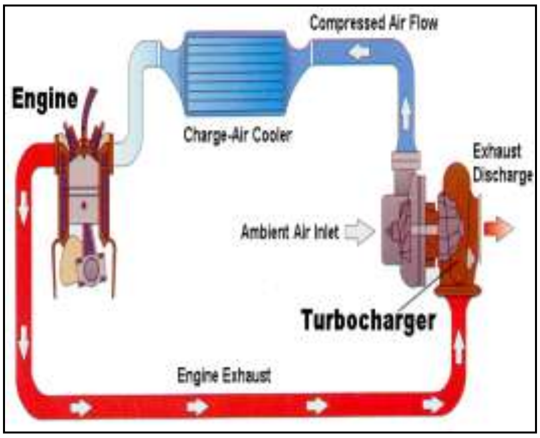


**Figure 3.**

## VII. TURBOCHARGING CONFIGURATIONS

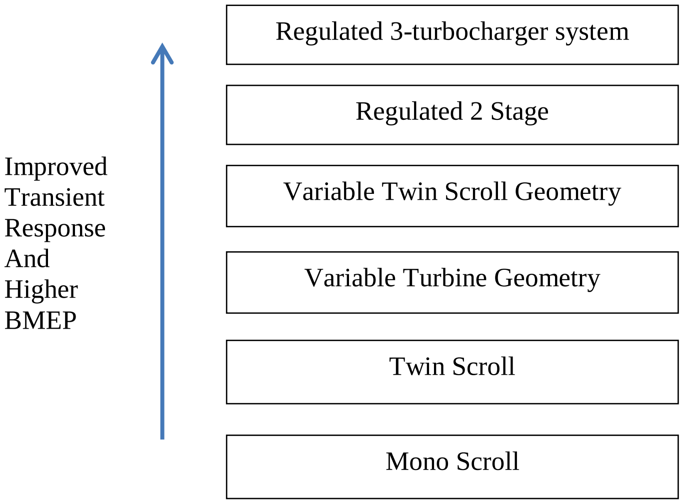


**Figure 4**

## VIII. ADVANTAGES

- Turbocharger improves the volumetric efficiency of naturally aspirated engine.
- The power/displacement ratio is increased considerably with implementation of turbocharger.
- More power can be drawn from the existing naturally aspirated engine
- Reduction in the $CO_2$ emissions thereby reducing the harmful effects of global warming.

## IX. LIMITATIONS

- Turbo lag: Turbochargers especially large turbochargers take time to spool up and provide useful boost.
- Power Surge: In some applications, reaching the boost threshold can provide almost instantaneous power surge causing instability of cars.
- Oil Requirement: Turbochargers get very hot and often tap into engine's oil supply. This causes additional plumbing and demands more oil.

## X. CONCLUSION

This paper illustrates that the use of turbocharger can bring effective improvement in fuel economy. The downsizing of an engine can be brought into the effect by installation of a turbocharger along with direct injection technology thereby reducing the CO2 and NOx emissions.

## REFERENCES

[1]. Towards a New Generation of Engines(2000) Ingénieurs de l'Automobile, 738, 82-88

[2] Guzzella, L.; Onder, C.: Introduction to Modeling and Control of Internal Combustion Engine Systems. Berlin: Springer, 2004

[3] Turbocharging for improved engine performance and reducing $CO_2$emissions: BorgWarner Inc,2013

[4] Birch, S. (1999) Direct Gasoline Injection from Renault.
Automotive Engineering International, **107**, 7, 28-30.