Volume 1, 2021 ISSN 2769-2477

The influence of the gasoline octane number on a turbocharged engine performance

Dumitrascu Dorin Ion
Department of Automotive and Transport Engineering, “Transilvania” University of Brasov, Eroilor Street, No. 29, 500036, Brasov
ROMANIA

***Abstract:* - This paper aims to analyze the differences in power performance of a turbocharged engine in the case of fueling with two types of gasoline, regular and premium. Generally, on turbocharged gasoline engines higher octane fuels are typically recommended. A gasoline with higher octane number, typically, will boost performance in the case of supercharged or turbocharged engines, considering and adequate engine’s mapping, too. Nowadays, the oxygenated compounds are used to increase the octane number, ethanol being one of them, as a renewable source of energy.**
Thus, the gasoline characteristics are directly related to the power and environmental performance of the engine.

***Key-Words:* - gasoline type, octane number, power, turbocharging, ethanol, dynamometer.**

I Introduction

Fuel type and quality, in terms of physical and chemical properties became essential for engine’s power performances and emissions. These aspects were pushed forward by the EU regulations regarding emissions.

Thus, the internal combustion engines evolved, adopting a series of strategies in order to improve their efficiency and reduce the pollutant emissions. So, these solutions were: downsizing combined with supercharging or/and turbocharging, lean burn, higher compression ratios, variable compression ratios. All these technical solutions also involve the improvement of fuels properties in order to avoid abnormal, destructive operating regimes, such as knock, which consists in autoignition of portions of the unburned mixture ahead of the flame front. Then one or more specific regions in the end gas are compressed to a high pressure and temperature that generate spontaneously autoignition. This abnormal combustion – knock – limits engine’s compression ratio and boost pressure and therefore engine performance and efficiency.

The tendency to knock depends on:

- ✓ constructive and functional parameters such as engine design and operating values which influence end-gas temperature, pressure and duration, before flame front arrival;
- ✓ antiknock property of the gasoline is defined by the fuel’s octane number which is an indicator of a gasoline’s resistance to autoignition.

It became obvious the dependency between engine operating parameters, “compression level” and gasoline octane number. Considering this aspect, the higher the octane number, the better the resistance to autoignition and knock.

II Methodology

In this section are presented the aspects regarding the engine characteristics and test bench. For the test were used two types of gasoline: regular RON 95 and premium RON 100.

A. The vehicle & engine

The test was performed with a Ford Focus equipped with an EcoBoost gasoline direct-injection turbocharged 1.6-liter four-cylinder engine, power 134 kW, at 6000 rpm. The EcoBoost 1.6 L features double overhead belt-driven camshafts and variable intake and exhaust valve timing

B. The dynamometric MAHA LPS 3000 test bench

The research was carried out on the dynamometric MAHA LPS 3000 stand. The dynamometer consists of:

- ✓ communication desk with PC;
- ✓ a remote control;
- ✓ a roller set.

The LPS 3000 is available in various versions for performance testing of cars. Depending on the

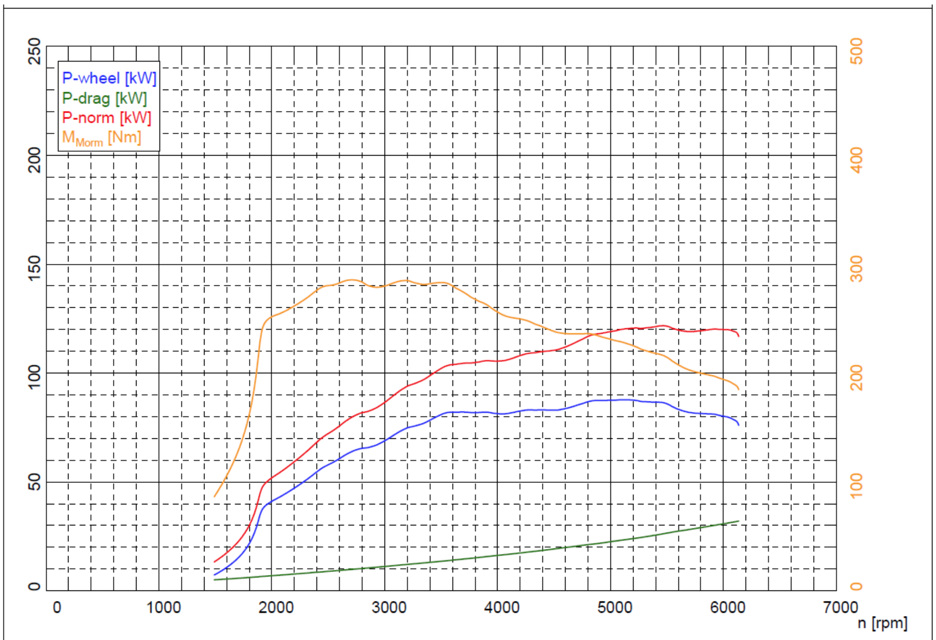
ISSN 2769-2477

version, wheel power from 260 kW to 520 kW with a max. test speed of 260km/h can be tested. The dyno load simulation is done with an eddy-current brake.

The LPS 3000 enables engine power measurements to be made on cars with Otto and diesel engines. Testing of four-wheel drive vehicles is possible if the LPS 3000 is equipped with the appropriate roller set and the corresponding control electronics. A cooling air fan which is connected to the communication desk and is operated via the radio remote control.

Fig.1 The dynamometric MAHA LPS 3000 test bench

III THE RESULTS OBTAINED WITH THE TWO TYPES OF GASOLINE



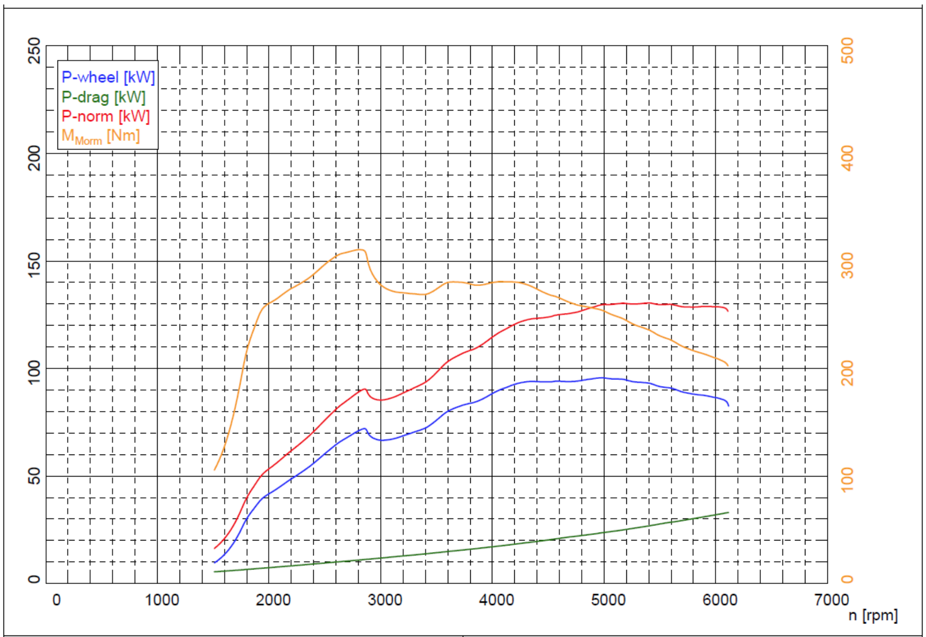
Power data						
Corrected power 1)	P_{Norm}	121,7 kW	/	165,5 BHP		
Engine power	P_{Eng}	112,6 kW	/	153,0 BHP		
Wheel power	P_{Wheel}	86,4 kW	/	117,5 BHP		
Drag power	P_{Drag}	26,1 kW	/	35,5 BHP		
Max. power at		5380 rpm	/	172,3 km/h		
Torque 1)	M_{Morm}	285,5 Nm				
Max. Torque at		2670 rpm	/	85,4 km/h		
Max. attained RPM		6135 rpm	/	193,6 km/h		

1) Correction acc. to ISO 1585
Correction factors: Q_V = 0,00 %

Ambient data		
Ambient temperature	$T_{Ambient}$	21,6 °C
Intake air temperature	$T_{Intake\ air}$	19,8 °C
Relative humidity	H_{Air}	80,0 %
Air pressure	p_{Air}	939,9 hPa
Steam pressure	p_{Steam}	20,6 hPa
Oil temperature	T_{Oil}	109,0 °C
Fuel temperature	T_{Fuel}	----,- °C

Fig. 2 Tests results for 95 RON gasoline.

ISSN 2769-2477



Power data

Corrected power 1)	P_{Norm}	130,4	kW	/	177,3	BHP
Engine power	P_{Eng}	119,9	kW	/	163,1	BHP
Wheel power	P_{Wheel}	93,1	kW	/	126,6	BHP
Drag power	P_{Drag}	26,8	kW	/	36,4	BHP
Max. power at		5285	rpm	/	171,6	km/h
Torque 1)	M_{Morm}	310,4	Nm			
Max. Torque at		2755	rpm	/	89,4	km/h
Max. attained RPM		6115	rpm	/	194,3	km/h

1) Correction acc. to ISO 1585
Correction factors: Q_V = 0,00 %

Ambient data

Ambient temperature	$T_{Ambient}$	22,6	°C
Intake air temperature	$T_{Intake\ air}$	21,4	°C
Relative humidity	H_{Air}	71,1	%
Air pressure	p_{Air}	937,3	hPa
Steam pressure	p_{Steam}	19,5	hPa
Oil temperature	T_{Oil}	101,0	°C
Fuel temperature	T_{Fuel}	----,-	°C

Fig. 3 Tests results for 100 RON gasoline.

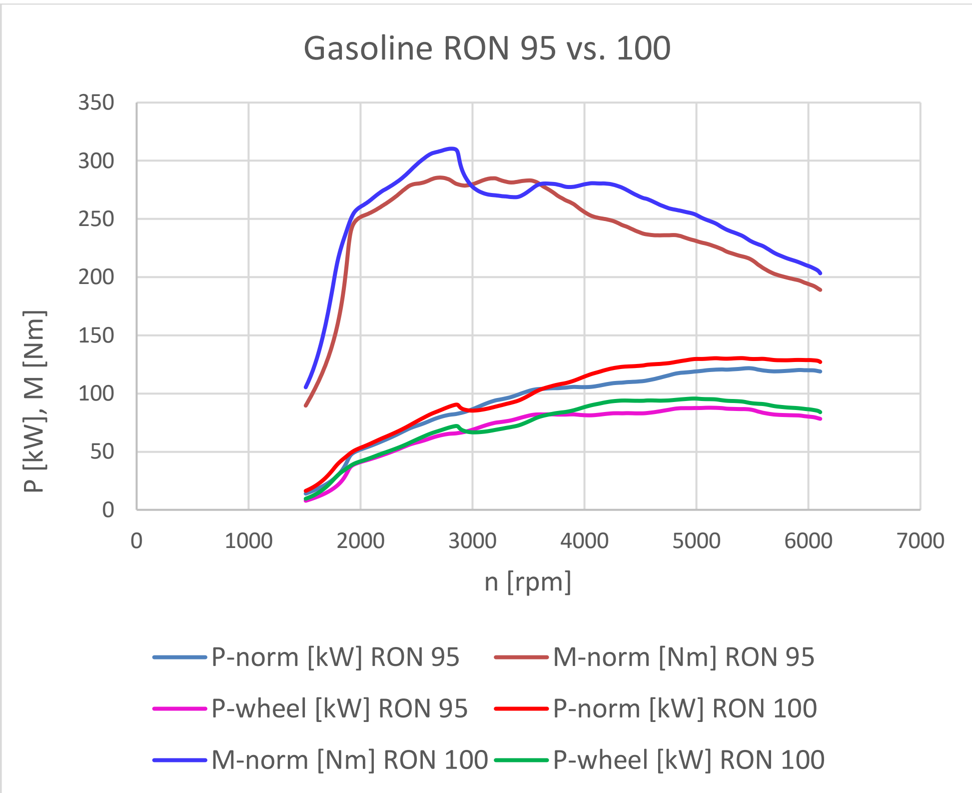


Fig. 4 Comparative analyses for 95 and 100 RON gasoline.

ISSN 2769-2477

During the test all the characteristic parameters, such as the power and torque curves, have to be recorded and comparatively assessed.

In figure 2 and 3 are presented the results obtained for the for the two types of gasoline (RON 95 and 100) and in figure 4 is represented the comparative analyses between them.

The tests were performed in the fourth gear of the gearbox where the power and torque are maximum.

IV CONCLUSIONS

As it can be seen from diagrams the maximum engine power was 112,6 kW for 95 RON gasoline and 119,9 kW for 100 RON gasoline, an increase of about 6%, and this above 5000 rpm.

In the speed range between 2000 and 3000 rpm the differences between the registered power values for the two types of gasoline are insignificant, the curves overlapping almost the entire interval. In this case a higher-octane level doesn't increase the vehicle performance.

In the speed range between 3000 and 3500 rpm the power values for 95 RON gasoline are superior compared to 100 RON gasoline, the usage of a superior octane number decreased the engine energetical performance.

Only after the speed of 3600 rpm the power values become superior in the case of the 100 RON gasoline, in other words after this speed, the 100 RON gasoline makes its presence felt. Between 3600 rpm and 6000 rpm the engine power level become superior, compared with the case of 95 RON gasoline.

Maximum torque and maximum speed were obtained at about the same points for both types of gasoline, these aspects can be seen on the related diagrams.

In the case of this type of turbocharged engine, higher octanes can improve performance and can reduce emissions during some average to severe duty operations, above 3600 rpm. However, under normal driving conditions, it will do little to nothing for the vehicle performance.

Extrapolating the research results, it can be concluded that in a large number of cases a higher-octane level may not necessarily increase the vehicle's performance, but only paying extra for premium gasoline. This is especially true for naturally aspirated engines, which clearly do not have a mapping that can capitalize the benefits of a higher-octane number.

This can be contradicted, for example, by the corresponding increase of the compression ratio value for the naturally aspirated engines, in order to increase their performance and efficiency.

REFERENCES:

[1] John B. Heywood, *Internal Combustion Engine Fundamentals*, Second edition, McGraw-Hill Education, 2018, 978-1-26-011611-3.

[2] Hua Zhao, *Advanced Direct Injection Combustion Engine Technologies and Development: Gasoline and Gas Engines*, Woodhead Publishing in Mechanical Engineering, 2014.

[3] Konrad Reif, *Gasoline Engine Management Systems and Components*, Springer Vieweg, 2015, ISBN 978-3-658-03964-6.

[4] George E. Totten, *Fuels and Lubricants Handbook: technology, properties, performance and testing*, ASTM International, 2003.

[5] Rolf Isermann, *Combustion Engine Diagnosis, Model-based Condition Monitoring of Gasoline and Diesel Engines and their Components,* Springer Vieweg, 2017, ISBN 978-3-662-49467-7.

[6] A. J. Martyr, M. A. Plint, *Engine Testing, The Design, Building, Modification and Use of Powertrain Test Facilities,* Butterworth-Heinemann is an imprint of Elsevier, 2012, ISBN–13: 978-0-08-096949-7.