Outlook

Fw: Confirmation of participation in the CI3 2023

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Enviado: lunes, 14 de agosto de 2023 0:45
Para: Vicente Manopanta <ingenieriatecnicamc@hotmail.com>
Asunto: Confirmation of participation in the CI3 2023

Dear Vicente Manopanta,

Let me congratulate you on the acceptance of your scientific paper for oral presentation and publication at the Fourth International Conference on Research and Innovation CI3 2023.

Although the registration and the final version of your work can be delivered until August 27, to facilitate the organization and agenda of the event, confirmation of your participation in CI3 2023 is requested during this week, through an email to info@ci3.tech, with a copy to ci3@ister.edu.ec.

Thank you very much in advance for your collaboration.

See you at the opening of the conference on August 30 !!!

Ph.D. Marcelo Zambrano V.
GENERAL CHAIR
CI3 2023

Optimization of the b10s1 engine for Corsa with adaptation of the cylinder head of a spark-ignition engine and validation on a chassis dynamometer to verify its power

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Abstract: In the automotive fleet, the improvement of performance and power have a significant growth, these parameters are evidenced in high-end vehicles with high costs. In common vehicles, these improvements can be obtained with adaptations to the combustion engine. The objective of this research is to improve the performance of the engine by adapting a cylinder head. A Chevrolet Corsa B10S vehicle is selected. The engine power without modification is determined using a chassis dynamometer. The impact on the mechanical performance of the vehicle is given by the adaptation and modification of the cylinder head of an Aveo Activo 16 valves with independent ITBs for the intake manifold, modifications in the exhaust manifold with independent outputs (header), improving the intake and exhaust of gases in the spark-ignition engine. The method used will be the experimental one, making adjustments in the distribution with two camshafts and timing belt, optimizing the maintenance. It is also concluded that as the percentage of air-fuel increases, a better torque and power performance will be obtained in relation to the standard engine.

Keywords: Tuning, Adaptation, Power, Performance

1 Introduction

This theoretical and practical research will take into consideration that motor racing competitions in Ecuador have been practiced since 1930 in cities such as Quito, Guayaquil, Riobamba, Cuenca and Ambato. In 1985 the Tungurahua Automóvil Club (Tungurahua Automobile Club) (TAC) was created and new divisions were formed. One of the categories characterized by the high competitive level in the province, is the 0 to 1150 cc category, dominated by the presence of Suzuki Forsa 1 vehicles [1].Engine tuning is possible because all manufacturers have over-dimensioned them to obtain safety and reliability margins that ensure their operation in adverse conditions. It is possible to reduce these safety margins to acceptable minimums in order to considerably increase engine performance without jeopardizing the engine service life [2]. In conventional spark-ignition engines, efficient combustion requires the use of fuels that ensure fast and safe starting of the engine regardless of the outside temperature, guarantee a carbon-free combustion process, reduce the formation of pollutants, and produce minimum deterioration of the main engine parts [3]. The physical-chemical properties of the fuel used must allow the fuel to evaporate to form a very homogeneous fuel-air mixture in the combustion chamber. In spark-ignition engines (SIE) the above process depends on factors such as: the type of fuel, the proper design of the intake system, heat transfer conditions, the presence of waste gases, engine speed, leakage in the chamber due to compression losses and the effects of mixture agitation [4]. The addition of bridges and bores in the cylinder head proves to be very effective as it considerably reduces emissions. In addition, a slight change in the configuration of the bridges and bores can change the flow directions and patterns and vary the way the gases react, which can further reduce emissions [5]. Sha et al. (2015) [6] experimentally investigated the effects of pre-chamber volume and nozzle diameter on the resultant ignition characteristics. It was found that a larger pre-chamber provides higher ignition energy, which results in shortened flame development angle and combustion duration. At a given pre-chamber volume, nozzle diameter mainly affects the combustion duration [7]. The research begins with the aforementioned background, and due to contamination and lack of performance in spark-ignition and compression-ignition engines, the low level of energy consumption of organic materials as energy sources that guarantee an optimal performance in internal combustion engines. The main purpose of this project is the adaptation of the cylinder head of a spark-ignition engine and validation on a chassis dynamometer for the verification of its developed power after the respective modifications of the cylinder head with its respective elements that involve a better performance in the engine.

2 Method

2.1 Applied test vehicle

The research will be experimental and a Chevrolet Corsa 1.3 Standard 4-cylinder 1,300 cm^3 gasoline engine, with an indirect injection in the intake manifold, equipped with a three-way catalytic converter of the year 1997 will be used; the vehicle with the lowest fuel consumption and most sold in Ecuador in those years. Table 1 describes the technical specifications of the vehicle.

Table 1. Chevrolet Corsa 1.3L Standard Technical Data Sheet

Characteristics	Units
Make	Chevrolet
Model	Corsa Wind
Year	1997
Compression Ratio	9.4 / 1
Torque	111 Nm

Horsepower	60 CV
Bore	77.6 mm
Top Speed	164 km/h
Acceleration, 0-100 km/h	14.8 s
Max Power	60 CV DIN AT 5800 rpm
Displacement	1389 cmˆ3
Max Torque	111 Nm DIN AT 3400 rpm
Valves	2 valves per cylinder
Fuel	Gasoline
Engine	Inline four
Firing order	1-3-4-2

2.2 Combustion Chamber (Cylinder Head) Features

It is made of aluminum, which helps to dissipate heat. The design of the cylinder head is simple, easy to reproduce and install; given the intake stroke, the mixture reaches the cylinder with little speed, the turbulence is almost null, the combustion is slow and prone to detonation due to the long length of the flame [8]. The measurement of the volume of the combustion chamber can be seen in Figure 1 with the help of a graduated burette in ml and an acrylic piece.

Fig. 1. Measurement of the combustion chamber volume

The mathematical models are generated from the following equations

Piston volume measurement [9]

$$Compressed\ Vol. = \text{Piston}\ Vol. + Chamber\ Vol. + \text{Gasket Vol.} \quad (1)$$

$$Compressed\ Vol. = 14{,}4 + 22{,}2 + 4{,}65 = 41.25cm^3$$

Calculation of the compression ratio of the engine

$$Rc = \frac{Compressed\ Vol. + Displacement\ Vol.}{Compressed\ Vol.} \quad (2)$$

$$Rc = \frac{41{,}25 + 343.67}{41.25} = 9.33{:}\,1$$

With the help of the mathematical models [9] and the corresponding adaptation, calculations are made to obtain the tuned or modified compression ratio that will allow observing the changes in the displacement values, comparing the results of this experiment where a burette is used to have a great accuracy in the liquid measurements and precision instruments to avoid errors in this experiment, as shown in Table 2.

Table 2. Compression Ratio Technical Data

	ENGINE WITHOUT MODIFICATION	ENGINE WITH MODIFICATION
Displacement Vol.	343.67 cm^3	343.67 cm^3
Gasket Vol.	4.65 cm^3	3.66 cm^3
Chamber Vol.	22.2 cm^3	22 cm^3
Piston Vol.	14.4 cm^3	14.4 cm^3
Compressed Vol.	41.25 cm^3	40.06 cm^3
Compression Ratio	9.33:1	9.57:1

2.3 Valve mechanism system

The project involves a traditional OHV type distribution system and a DOHC type system with the variation of two camshafts, improving the engine performance and gas intake and exhaust [10]. The adaptation is based on the use of a cylinder head from a Chevrolet Aveo vehicle in the monoblock of the Corsa vehicle. The DOHV valve system performs an exhaustive work in the gas recirculation. Figure 2 shows several characteristics of the valves both in standard and modified or tuned form, applying an inclination of 30 degrees to the valve seat [11].

Fig. 2. Camshaft and valve configuration

Table 3 shows the characteristics of the intake and exhaust valves with their standard and modified values for the experimentation with a Corsa Wind vehicle with the engine tuned.

Table 3. Valve System

	STANDARD CONDITION	MODIFIED CONDITION
Intake Valve Measurement		
Retainer Diameter	39.2 mm	28.58 mm
Valve Length	105.1 mm	101.58 mm
Valve Stem	7.1 mm	5.86 mm
Valve Seat	45°	30°
Exhaust Valve Measurement		
Retainer Diameter	31 mm	26 mm
Valve Length	112.5 mm	101.34 mm
Valve Stem	105.1 mm	5.85 mm
Valve Seat	45°	30°

2.4 Intake and exhaust system of the spark-ignition engine

The cylinder head has the gas intake mainly by means of ITB ducts which are used for the recirculation of gases and managing a proper combustion. Figure 3 shows the ITBs that allow greater air intake. Table 4 details the characteristics and values for standard and tuned measures proposed in this research. In addition, Figures 2, 3 and 4 show the measurement processes established to obtain the data in the cylinder head [12]. The engines are fed with ethanol-gasoline blends and the users are responsible for performing the tuning, without following a recommended instruction and carrying out the tests in any chassis dynamometer. The service technicians, with their experience rather than formal training, are the ones that perform the engine tunings when operating with fuel not provided by the manufacturer [13].

Fig. 3. Measurement of the intake manifold nozzle diameter

Table 4. Gas recirculation cylinder head ducts and valve springs

	ENGINE WITHOUT MODIFICATION			ENGINE WITH MODIFICATION		
Cylinder head intake nozzles						
	Diameter (mm)	Length (cm)	Volume (cm^3)	Diame-ter (mm)	Length (cm)	Volume (cm^3)
CYLINDER 1	33.0	35	500	40.73	18.5	238.7
CYLINDER 2	33.0	35	500	40.73	18.5	238.7
CYLINDER 3	33.0	35	500	40.73	18.5	238.7
CYLINDER 4	33.0	35	500	40.73	18.5	238.7
Cylinder head exhaust nozzles						
	Diameter (mm)	Length (cm)	Volume (cm^3)	Diame-ter (mm)	Length (cm)	Volume (cm^3)
CYLINDER 1	30.0	22	530	33	26	530
CYLINDER 2	30.0	22	530	33	26	530
CYLINDER 3	30.0	22	530	33	26	530
CYLINDER 4	30.0	22	530	33	26	530
Cylinder head springs						
	Diameter (mm)	Length (mm)	Thick-ness (mm)	Diame-ter (mm)	Length (mm)	Thick-ness (mm)
CYLINDER 1	29.50	30.50	3.05	27.1	40.42	3.48
CYLINDER 2	29.50	30.50	3.05	27.1	40.42	3.48
CYLINDER 3	29.50	30.50	3.05	27.1	40.42	3.48
CYLINDER 4	29.50	30.50	3.05	27.1	40.42	3.48

Intake valve timing has a significant effect on the engine air exchange process. During engine start conditions, the engine valve strategy is to delay the intake valve timing and speed up the exhaust valve timing to ensure the lowest residual exhaust gas and maximum fresh air [14]. The sizing of the manifold nozzles is relevant to appreciate the modification as a consequence of the new performance desired from the vehicle engine, according to Table 5.

Fig. 4. Measurement of the ITB diameter

Table 5. Manifold nozzles and cylinder head height

	ENGINE WITHOUT MODIFICATION	ENGINE WITH MODIFICATION
Measurement of the cylinder head height		
	mm	mm
Height	96	130.4
Measurement of the exhaust manifold nozzle diameter		
	Diameter (mm)	Diameter (mm)
CYLINDER 1	30	33
CYLINDER 2	30	33
CYLINDER 3	30	33
CYLINDER 4	30	33
Measurement of the intake manifold nozzle diameter		
	Diameter (mm)	Diameter (mm)
CYLINDER 1	33	40.73
CYLINDER 2	33	40.73
CYLINDER 3	33	40.73
CYLINDER 4	33	40.73

2.5 Determination of the developed power

For the measurement process, the drive wheels or front wheels of the car rest on four rollers. The rollers rotate with a known moment of inertia. There is a sensor that registers the rotational speed of the rollers and systematically sends the speed information to the computer. [15] (For this chassis dynamometer, only computerized measurement is admissible). The main test in this study is in the chassis dynamometer, where the SAENZ PERFORMANCE INERTIAL CHASSIS DYNOS-N 08-19 was used, which allows simulating a speed profile as a function of time to perform dynamic tests on diesel and gasoline vehicles. It allows to load several test cycles of the different legislations for which they were designed, determining in an exact way the values of power and torque of the vehicle.

Fig. 5. Dynamometer characteristics

Figure 5 shows a sequential representation of the process and the model of tests performed on the vehicles. This is a chassis dynamometer.

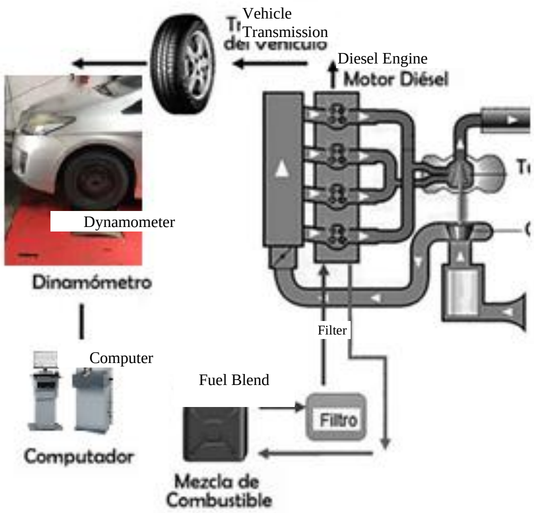

Fig. 6. Chassis dynamometer structure

The power and torque test protocols were performed under the ISO 1585 and ISO 3173 standards; following the test protocol: verify that the diameter of the wheels is equal to or greater than 13-inch rim (Wheels of the Corsa vehicle are 175/70/13). Verify the cleanliness of the test site both in the tire tread and in the dynamometer.

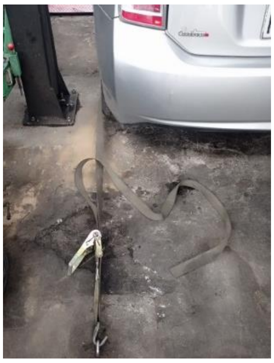

Fig. 7. Security straps and anchoring of the vehicle.

Secure the vehicle with straps to prevent it from slipping off the rollers; enter the technical data concerning the vehicle to be tested into the software; check the gear and transmission ratio of the unit, which must be 1:1; make sure that the engine temperature is in the range of 85°-90°, otherwise it must pass an engine warm-up period to reach such temperature; start the cooling fan of the dynamometer; start the measurement test; accelerate the vehicle with the pedal fully depressed in the test gear until reaching the desired speed called "rpm cut" (4500 - 6000 rpm); when the "rpm cut" has been reached, depress the clutch, leaving the gear engaged. The dynamometer decelerates to a stop [16][3].

Fig. 8. Dynamometer tests

3 Results

3.1 Vehicle power without modification of the cylinder head

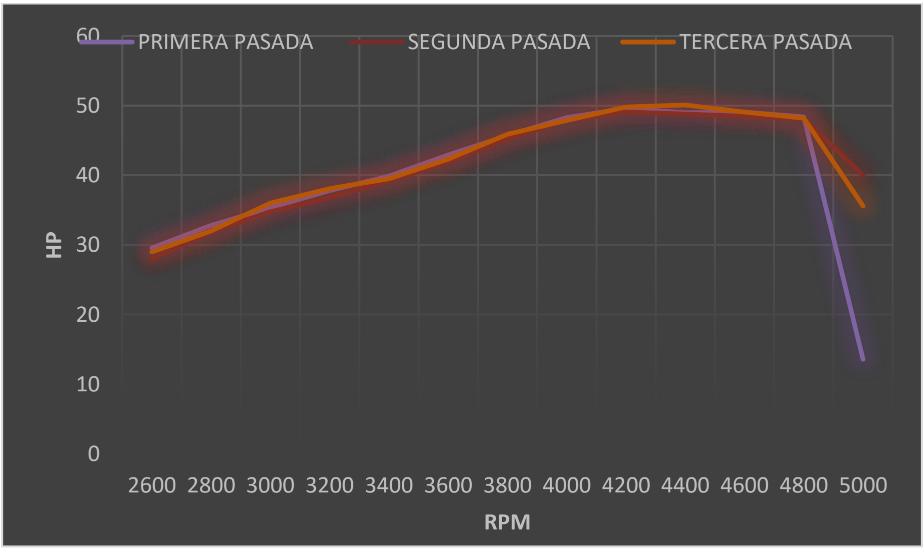

Fig. 9. Vehicle power without the cylinder head modification during three runs

The power values generated by the engine of the Corsa 1.3 vehicle are obtained with tests. The static test with load was carried out, using the chassis dynamometer, under the ISO 1585 Standard, performing three tests for each case and obtaining the result to be evaluated. Figure 9 shows the results of the tests on the equipment. The results of the power values obtained for the vehicle with the dynamometer are as follows. The test was run three times in a row using premium gasoline. In this test, it can be observed that the curves generated do not show a major difference according to the values.

3.2 Vehicle power with the cylinder head modification

Next, the power parameters generated by the engine of the Corsa 1.3L vehicle are presented. The static test with load was carried out using the chassis dynamometer, under the ISO 1585 Standard. Three consecutive tests were performed obtaining the result shown in Figure 10, which indicates the power curves obtained with the dynamometer, using premium gasoline. In addition, it is shown that there is no great difference between the values obtained.

Fig. 10. Vehicle power with the cylinder head modification during three runs

Table 6 shows the results obtained in the dynamometer with a power increase of 8 hp, where it is confirmed that the adaptation of the cylinder head of the Aveo vehicle to the engine of the Corsa vehicle has been efficient.

Table 6. Test results of the tuned engine

DYNAMOMETER	POWER	RPM
First test	68.58 hp	5500 rpm
Second test	69.58 hp	5500 rpm
Third test	68.58 hp	5500 rpm

3.3 Discussion of the results on the obtained power

The engine could be fueled by gasoline, ethanol or a blend of both in any proportion. The fuel injection system was controlled by an electronic module for engine development, which allowed optimizing the blend ratio and ignition timing for the whole speed range tested [18].

In Figure 10, an irregular line representing the torque curve as a function of revolutions per minute of the Corsa Wind 1.3L engine can be seen. The graph starts at 2200 RPM with a torque of 50 hp, when approaching 2300 RPM there is an abrupt change, a rise in the graph curve up to 68 hp and at 5500 RPM rises to almost 69 hp and drops at 2000 RPM to 30 hp, it rises again to almost 50 hp at 2700 RPM and then there is a rise and fall of torque, rises and falls again until it stabilizes from 3500 RPM [19].

The tests carried out and the values obtained are used to analyze the behavior of the vehicle, which will be used to develop the pertinent analysis regarding the performance of the engine. We will proceed as follows, working with the average power values obtained [12]. Figure 9 shows the power variation differences for the standard working tests and the cylinder head modification, clearly evidenced in the chassis dynamometer. It is then established according to the measurements made that there is an increase of 30.08% in the performance at 4400 rpm with respect to the engine power with the modifications of the cylinder head, and it is clearly seen in Table 6 the difference between the performance of power before and after the modifications of the cylinder head. All the tests were carried out with the premium gasoline that is commercialized in the country. Several authors show similar data, confirming the increased engine efficiency [4].

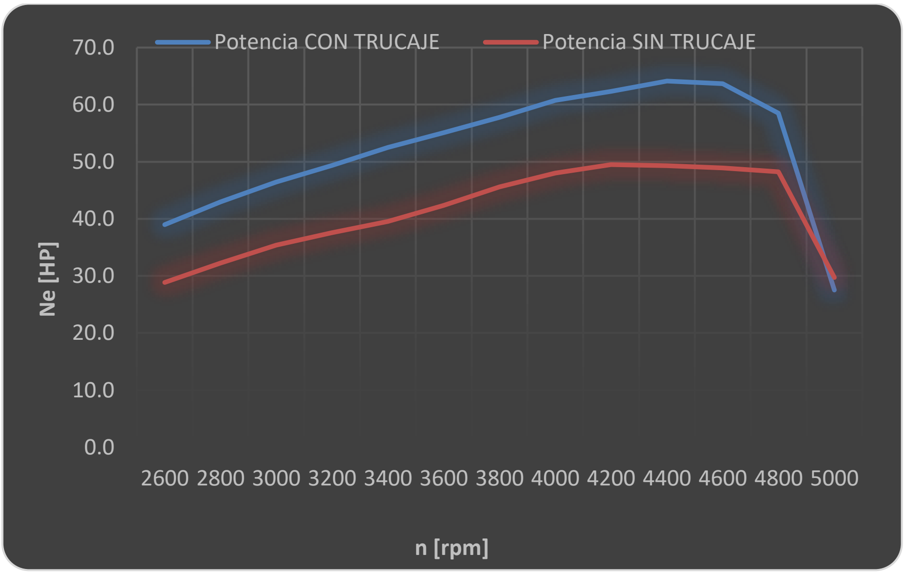

Fig. 8. Developed powers before and after the engine cylinder head tuning.

4 Conclusions

An analysis is made by researching the adaptations and modifications in the cylinder head and engine tuning to find the best performance and yield. In the analyzed studies, it has been found that the best angle of the valve seats is at 30 degrees in the intake and exhaust nozzles and ducts of the cylinder heads, and they are truly relevant and have the greatest influence on the performance of the engine's ITBs (Individual throttle body)**.**

The measurements performed show an increase in power performance of 8 hp in general during the course of the engine operation from idle to maximum power. Therefore, with the modifications and specifically at the maximum power at 4500 rpm, an increase of 13.08% measured in the chassis dynamometer was observed as a result of the modifications of the cylinder head of the Aveo vehicle with respect to the standard cylinder head of the Corsa Wind vehicle.

References

1. Repositorio de la Universidad de Fuerzas Armadas ESPE: Artículo Científico - Estudio y análisis teórico práctico del comportamiento de un motor SUZUKI G10 previo y posterior a su trucaje.
2. Herrera Martínez, J. J. (2016). Trucaje de un motor Renault 1022 CC referencia R850 de serie.
3. Jovaj M, 1982, Motores de automovil, Editorial MIR, Mosc˙.
4. Lukanin V, 1985, Motores de combustion interna, Editorial MIR, Mosc˙.
5. M. R. Indudhar, N. R. Banapurmath, K. G. Rajulu, A. Y. Patil, S. Javed, and T. M. Y. Khan, "Optimization of piston grooves, bridges on cylinder head, and inlet valve masking of home-fueled diesel engine by response surface methodology," *Sustainability*, vol. 13, no. 20, p. 11411, 2021.
6. A. Shah, P. Tunestal, and B. Johansson, "Effect of pre-chamber volume and nozzle diameter on pre-chamber ignition in heavy duty natural gas engines," SAE technical paper, 2015.
7. H. Ge, A. H. Bakir, S. Yadav, Y. Kang, S. Parameswaran, and P. Zhao, "CFD optimization of the pre-chamber geometry for a gasoline spark ignition engine," *Front. Mech. Eng.*, vol. 6, p. 599752, 2021.
8. G. T. Kalghatgi, C. R. McDonald, and A. B. Hopwood, "An experimental study of combustion chamber deposits and their effects in a spark-ignition engine," SAE Technical Paper, 1995.
9. Kindler, H. (2007). Matemática Aplicada Para La Técnica Del Automóvil. Barcelona España: Reverté
10. Gillieri, S. (2006). Preparación de Motores de Serie para Competición. Barcelona España: CE
11. J. P. F. Rosales, J. D. G. Revelo, E. M. C. Cárdenas, and P. A. M. Paz, "Determinación experimental de la eficiencia mecánica de un motor de combustión interna de encendido provocado por medio de las curvas de torque y potencia," *Polo del Conoc.*, vol. 7, no. 7, pp. 1735–1759, 2022.
12. C. A. Romero-Piedrahita, L. A. Mejía-Calderón, and Y. A. Carranza-Sánchez, "Estudio de sensibilidad del desempeño durante el calentamiento en vacío de un motor de combustión interna a cambios en su relación de compresión, el contenido de etanol en la mezcla combustible con gasolina y el material de la culata," *Dyna*, vol. 85, no. 204, pp. 238–247, 2018.
13. J. Galindo, H. Climent, J. De la Morena, R. Pitarch, S. Guilain, and T. Besançon, "A methodology to study the interaction between variable valve actuation and exhaust gas recirculation systems for spark-ignition engines from combustion perspective," *Energy Convers. Manag.*, vol. 250, p. 114859, 2021.
14. 04 MAUT 014 TRABAJO DE GRADO.pdf (utn.edu.ec).

15. A. Corsini, R. Di Antonio, G. Di Nucci, A. Marchegiani, F. Rispoli, and P. Venturini, "Performance analysis of a common-rail diesel engine fuelled with different blends of waste cooking oil and gasoil," *Energy Procedia*, vol. 101, pp. 606–613, 2016.
16. S. Yu and M. Zheng, "Future gasoline engine ignition: A review on advanced concepts," *International Journal of Engine Research*, vol. 22, no. 6. pp. 1743–1775, 2021, doi: 10.1177/1468087420953085.
17. S. Yu and M. Zheng, "Future gasoline engine ignition: A review on advanced concepts," International Journal of Engine Research, vol. 22, no. 6. pp. 1743–1775, 2021, doi: 10.1177/1468087420953085.
18. R. C. Costa and J. R. Sodré, "Hydrous ethanol vs. gasoline-ethanol blend: Engine performance and emissions," Fuel, vol. 89, no. 2, pp. 287–293, 2010.
19. Modificación mecánica y electrónica de un motor Corsa Wind 1300 cc distribución OHC con la implementación de una unidad de control electrónico programable y un sistema de distribución DOHC de 16 válvulas.