ADAPTATION OF ELECTRONIC INJECTION ENGINE, BOX AND TRANSMISSION TO PEUGEOT 604 BUGGY OF NORTH TECHNICAL UNIVERSITY

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Abstract. *At present the vehicles with engine carburator consume a lot of fuel and emit a large amounts gas emissions, electronic injection engines have better advantages which the research, for the execution of the thesis has as main objective the adaptation of an electronic injection engine, transmission box and adapt the vehicle peugeot 604 buggy, getting to improve vehicle performance, based on the weight of the new prototype is selected the engine that best suits the requirements we need, which are: power, safety and efficiency, with the help of "MATLAB" software was calculated the fuel consumption and emissions of pollutant gases, then running the simulation of the sensors and solenoids in the "LIVEWIRE" software checking the operating parameters and adapting the electronic management besides the designed engine components using "SOLIDWORKS" software achieving simulation of assembly and operation thereof and design of the mechanism of the gear selector lever for construction and adaptation, replacing the manual box by an automatic gearbox with converter par improving the aesthetics and comfort in driving the vehicle, making general adjustments to the components that work in conjunction with the engine management system achieving optimal overall performance, this makes the new vehicle ford buggy a unique prototype with similar characteristics to modern vehicles that driving and are currently marketed.*

Keywords

Adaptation, Modification, Efficiency.

Resumen. *En la actualidad los vehículos con motor a carburador consumen una gran cantidad de combustible y emiten grandes cantidades de emisiones de gases, los motores a inyección electrónica presentan mejores ventajas por lo cual la investigación realizada en el trabajo de grado tiene como objetivo la adaptación de un motor a inyección electrónica, caja y transmisión al vehículo Peugeot 604 Buggy, mejorando las prestaciones del vehículo, en base al peso del nuevo prototipo, seleccionando el motor que mejor se adapte a los requerimientos los cuales son: potencia, seguridad, eficiencia, mediante el software Matlab fue calculado el consumo de combustible y emisiones de gases contaminantes, posteriormente ejecutando la simulación de los sensores y solenoides en el software Livewire para verificar los parámetros de funcionamiento, además del diseño de los componentes del motor utilizando el software Solidworks, logrando la simulación del ensamblado y funcionamiento del mismo y el diseño del mecanismo de la palanca selectora de marchas para su construcción y adaptación, reemplazando la caja manual por una caja automática mejorando la estética y el confort en la conducción del vehículo, efectuado adaptaciones generales de los componentes que trabajan conjuntamente con la gestión del motor obteniendo un óptimo desempeño general.*

Palabras Claves

Adaptación, Modificación, Eficiencia.

1. Introduction

The main objective of this work is the adaptation of an engine to electronic injection and 4x4 automatic transmission system, acquiring knowledge about the operation of the same by means of the practice, obtaining in this way to provide a vehicle more updated and with better Performance that resembles the models that are currently on the market. This research will have its fundamental base in the workshops of the Technical University of the North in addition to some mechanics of the city of Ibarra.

The research problem is that currently, Technical University Del Norte has a Peugeot 604 Buggy vehicle designed by students of previous levels, the vehicle is in poor condition has obsolete systems such as the carburetor engine, which emits a large amount Of contaminants, does not have the characteristics of a sandpit vehicle and the auxiliary systems of the vehicle are deteriorated, which will be replaced with a motor to electronic injection, box and transmission.

It is vital to meet certain specific objectives such as conducting a study on the adaptation of an engine to electronic injection, gearbox and transmission, in addition to reducing fuel consumption and emissions of polluting gases.

It will present all the theoretical data and technological advances that exist on the subject in question, detailing the operation of a four-stroke internal combustion engine with their respective parts and their operation, also explained about the types of engines such as: , Squares and super squares and the differences between these, it covers electronic management elements such as sensors, solenoids and control module due to the implementation of an automatic box is detailed its operation by means of solenoid valves, electronic management and control module In addition to the parts that make it up.

A brief description of the new prototype, which is made up of four main parts, will be presented in the first part. The first part explains the reception status of the Peugeot 604 Buggy, the operation check and the total exploded view. Details the acquisition of the new Ford Explorer vehicle, the extraction of the engine and the automatic box, in addition to the electronic management for the adaptation in the new prototype, in the third part explains the general repairs that were made in the new systems, to finalize With the fourth part proceed to assemble and adapt all components to the new prototype Buggy Ford.

2. Materiasl and Methods

2.1 Materials.

Automotive Tools

There are different types of automotive tools that are very important for the preventive or corrective maintenance of the different systems of the vehicle and that helped us to make adaptations and modifications in the new prototype Buggy Ford.

Automotive Multimeter

It is used for the measurement of the different operating parameters of the sensors and solenoids of the vehicle.

Software Solidworks

The design of the movable and fixed elements of the engine and of the selector lever was realized, later assembling them and obtaining the simulation of its operation.

Software Livewire

Simulation of the electrical and electronic circuits of the vehicle is obtained obtaining the parameters of operation of the sensors and solenoids to different rpm of the engine.

Software Matlab Measurement of results

Simulation of measurements of fuel consumption and emissions of pollutant gases at different speeds and vehicle travel.

2.2 Methods

Analytical Synthesis, synthesizes the data collection and processes all the information necessary for the elaboration of the project.

Adaptation.- How to adapt the engine to electronic injection, automatic gearbox and the different components working together to reduce fuel consumption and CO2 emissions and get better power output.

Analysis of mechanisms.- Design of the crank selection mechanism to be adapted to the 5R55W automatic gearbox by analyzing the operating angles in each gear.

Drawing up plans.- Using the Solidworks software, A3 (ISO) drawings of the movable and fixed elements of motor and box were elaborated, obtaining the simulation and later the assembly in the prototype Buggy Ford.

Measurements.- Data collection with the aid of measuring instruments such as caliper foot, king, flexometer and multimeter which were used for the preparation of plans and technical guide of electronic management.

Simulation.- Through the Solidworks software, the elements that make up the engine were assembled by simulating the operation, as well as the adaptation of the engine and box to the chassis of the prototype Buggy Ford.

3. Results

The next section focuses on determining calculations to identify the type of engine and adaptations, modifications to the prototype to reduce fuel consumption and reduce emissions of pollutants and improve the efficiency of the Buggy Ford vehicle.

It will be selected following some parameters of calculations like: power and torque required according to the weight of the prototype, to identify the type of motor that provides the benefits to achieve the optimal work in the city, road and 4x4 in addition to determine the fuel consumption And the emissions it generates.

3.1 Results of calculations to identify the type of engine

Calculation of the new weight of the vehicle

G=Ga+Gr+m(P1+P2)

Where:

G= Weight (kg)

Ga = Own weight of the vehicle (1025 kg)

Gr = Loading capacity (50kg)

m = Number of passengers (4)

P1 = Weight per passenger (75kg)

P2 = Weight of luggage per passenger (10kg)

G= 1025kg+50kg+4(75kg+10kg)

G=1075kg+4(85kg)

G=1415kg

Calculation of the angular velocity of the tires

Where:

n= Engine revolutions (6000rpm)

v= Maximum speed (160km/h)

d= Diameter of vehicle wheels (0.7m)

r= Tire radius (0.35m)

CR= Coefficient of rolling of the vehicle (0.30) (sand)

G= Weight 1415kg

Distance traveled by the tires

Dr= π*D

Dr=1,88m

160km=160000m --1h=60 min

Returns =160000m/1.88m = returns 85106

To go 160km you need 85106 tire turns in an hour, transforming turns per minute we have:

Returns rpm=85106/60min=1418rpm

Torque needed to move the wheels

Where:

T= Torque needed to move the wheels (kg-m)

G= Weight 1415 (kg)

r= radio de los neumáticos 0.35m

CR= Coefficient of rolling of the vehicle (0.30) (sand)

T=G*r*CR

T=1415kg*0.35m*0.30

T=148,57kgm

Calculation of the required power

P=(Wheel revolutions rpm *T)/60

P=(1418rpm*148,57kg)/60

P=3511,20 kgm/s

Considering that the motor has a yield of 30%, and a constant in which 1 HP equals 75 kgfm / s, it was obtained:

P=(3511.20kgm/s)/0.30

P=11704 kgm/s

Required Power

Pr=(11704 kgm/s)/(75kgm/s)

Pr=156 HP

3.2 Determination of the type of motor suitable for adaptation in the prototype

Once the calculations have been carried out to identify the type of engine that provides the required performance to achieve the optimum work of the vehicle and a maximum speed of 160 km / h at 6000 rpm, a motor that generates 156 hp is needed, then some engines that Resemble the required characteristics.

Possible engines for adapting to the Peugeot Buggy vehicle

Brand	Nissan
Model	Patrol Y60
Number of cylinders	L6/OHV- 160Hp
Displacement	4169cc
Compression Ratio	8,5:1

Table 1. Nissan Patrol Y 60 engine 4.2 L.

Brand	Jeep
Model	Cherokee
Number of cylinders	L6/OHV- 189Hp
Displacement	3960cc
Compression Ratio	8,8:1

Table 2. Jeep Cherokee engine 4.0 L.

Brand	Isuzu
Model	Trooper
Number of cylinders	V6/OHC- 211Hp
Displacement	3944cc
Compression Ratio	9,1:1

Table 3. Isuzu Trooper engine 3.5 L.

Brand	Ford
Model	Explorer
Number of cylinders	V6/OHC160 Hp
Displacement	4011cc
Compression Ratio	9,7:1

Table 4. Ford Explorer engine 4.0 L.

Decision Matrix:

By means of the elaboration of a decision matrix it was possible to determine which vehicle counts on the greater number of characteristics required for the execution of the project, in this case Ford Explorer is the most suitable option since it has a V6 engine to electronic injection with 160 hp which is required according to the calculations in addition its automatic box improves the driving comfort.

Model	Injection engine	Automatic transmission	Displacement 4000 cc	4 Wheel Disc Brakes	TOTAL
Nissan Patrol	X		X	X	3
Jeep Cherokee	X		X	X	3
Isuzu Trooper	X		X		2
Ford Explorer	X	X	X	X	4

Table 5. Decision matrix for the choice of vehicle.

3.3 Assembly and simulation of V6 engine operation in SOLIDWORKS 2016 software

All the movable and fixed elements of the engine were designed and the assembly of each of them was proceeded, through the program SOLIDWORKS the operation of all the parts of the engine was simulated.

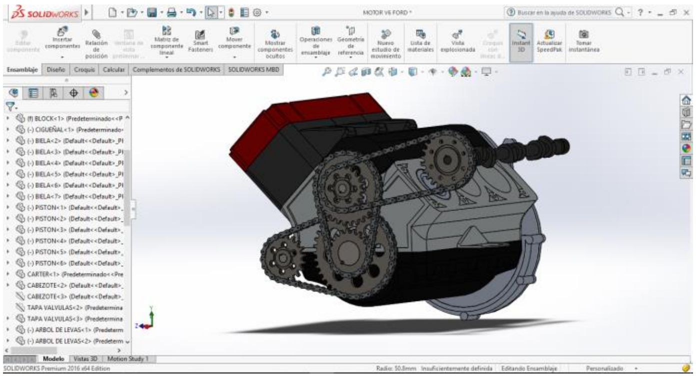

Figure 1. Simulation of the V6 engine assembly.

After the simulation of the assembly of the V6 engine to electronic injection and having completely disassembled the motor Ford V6 proceeded the real assembly.

1.- The number one cylinder of the engine was placed in the PMS
2.- The gear marking of the balancer shaft or balancer aligned with the mark found on the monoblock (4x4 full)
3.- The gear of the crankshaft and the chain that goes to the balancer shaft were placed taking into account that the marked links are well aligned
4.- The chain tensioners were installed, checking that they are tensioning the chain from the gear of the crankshaft to the large of the balancer shaft
5.- The intermediate shaft gear, chain and screw were inserted without tightening
6.- The guidewire and the main chain limiter were placed from the intermediate shaft to the crankshaft shaft
7.- The front and rear intermediate shaft spindle bolts were adjusted with a force of 20Nm and then the gear was adjusted to 90 degrees, extra the two bolts this is done by manual recommendation
8.- The two cylinder heads were placed on the monoblock, adjusting the 12mm bolts (bolt head) to a force of 35 Nm following the order of adjustment in X starting with the bolts of the medium outwards, the 8mm bolts Bolt) at a force of 30 Nm
9.- The camshaft camshaft bolts were set unadjusted, turning the camshaft to check that it rotates freely and is free of friction
10.- The guides and tensioner bolts of the distribution assembly from the camshaft to the intermediate shaft
11.- The crankshaft was turned to place the number one piston back into the PMS
12.- Crankshaft and camshaft gear engaged

13.- The rear distribution hydraulic damper was set and adjusted with a force of 60 Nm
14.- The front or main transmission hydraulic torsion was set and adjusted with a force of 60 Nm

Table 6. Steps that were followed for proper engine calibration.

3.4 Adaptation of components

Due to the modification of the whole body it was necessary to adapt the different components that work together with the engine without losing the aesthetics of the Buggy vehicle.

1.- Radiator.- A base was built in the front of the chassis, where the radiator was located at a distance of 0.10 m to the fan that is recommended for it to act, when the engine is at a temperature of 80 ° C at 90 ° C, initiating the passage of air to the engine assisting in cooling
2.- Coolant reservoir.- The reservoir was fitted to the right side of the body, next to the battery, the hose from the reservoir was connected to the coolant inlet next to the radiator cap, also the two hoses were installed Entry and return of the refrigerant to the engine, the refrigeration pipes of the oil of the automatic box
3.- Battery.- The base was attached to the upper right-hand part of the engine compartment by means of three 0.13-m bolt-head bolts securing the base of the battery to the body**.**
4.- Battery cables.- Due to the change of battery position, it was necessary to install longer cables, it was opportune to install a power cutter that allows us to join the cables and also cut the current through the security from the inside Of the passenger compartment of the body**.**
5.- Electronic control unit ECU.- It was fastened by two bolts of 0.13 m of bolt head by means of a holding bridge inside the passenger compartment of the body, in front of the passenger seat $1^{1/16}$mm as a safety measure.
6.- Control box of the automatic box EGS.- It was located inside the passenger compartment of the body, by means of straps, is next to the ECU, since these are the main controls for the electronic management of the vehicle.
7.- Communication interfaces.- Installed in the upper left of the engine compartment, it consists of three communication interfaces that are responsible for linking all electrical systems electrónicos del vehículo.
8.- Relay box and fuses.- Located in the upper left of the engine compartment, next to the communication interface as they work together for excellent management of the engine and vehicle.
9.- Fuse box.- It was placed on the left side at the height of the steering wheel to facilitate the review in case of any damage and was covered with a metal cover, to avoid contact with external agents.
10.- Adaptation of the conical air filter.- The normal filter of the Ford Explorer vehicle was replaced by a conical filter, due to the lack of space in the engine compartment, a plate attached to the body and the intake of air from the manifold Where the conical filter was located.
11.- Adaptation of the OBD2 connector. - Adapted in the passenger compartment of the vehicle, at the bottom of the steering wheel for immediate visualization and ease of diagnosis.

Tabla 7. Adaptations and Modifications of components.

Adaptation and operation of the selector lever

It was adapted to adapt the lever and check its operation of the different gears of the vehicle by measuring angles of the new mechanism checking the maneuverability and comfort in driving**.**

Figure 2. Adaptation of the selector lever.

3.5 Operating parameters of the sensors and actuators of the Buggy Ford prototype.

To verify the operating parameters of sensors and solenoid was used a multimeter, with which we obtained the following values, with the help of the following formula was calculated the fixed resistance.

$$Vs = \left(\frac{(Vr)(Rv)}{(Rv) + (Rf)}\right)$$

Where:

Vs = Sensor Signal Voltage (v).

Vr = Sensor reference or power supply voltage (v).

Rv = Variable resistor (Ω).

Rf = Fixed resistance (Ω).

Sensors and Solenoids	Operating Parameters in Volts (V)	Operating Parameters in Ohms (Ω)
Air flow sensor MAF	0,8 V a 2,2 V	1050 Ω a 650 Ω
Intake air temperature sensor IAT	1,71 V a 2,23 V	3840 Ω a 2930 Ω
TPS Butterfly Valve Position Sensor	0,8 V a 4,7 V	1509 Ω a 345 Ω
Camshaft Position Sensor CMP	0,13 V a 0,25 V	380 Ω a 210 Ω
Crankshaft Position Sensor CKP	at idle 1,54 V	500 Ω
Engine coolant temperature sensor ECT	0,85 V a 1,70 V	7600 Ω a 3840 Ω
Oxygen sensor	0.53 V a 0.74 V	26 Ω a 12 Ω
Air Control Valve IAC	at idle 0,265 V	13 Ω

Tabla 8. Parámetros de funcionamiento de sensores y solenoides.

The test parameters of the sensors and solenoids were checked with the vehicle on and at different engine rpm..

3.6 Reduction in fuel consumption and emissions of polluting gases.

For the calculation of the average fuel consumption of the Buggy Ford vehicle, the MATLAB 2015 program was used, based on the fuel consumption data of the Ford Explorer vehicle manual with the help of the following formula:

Calculation of the average of consumption.

$$\boldsymbol{Consumption\ average = a * e^{(b*s)}\ liters/100km}$$

Where:

a = 2,366

e = 2,7183 (constante de Euler)

b = 0,1751

s = large * width (m)

- **Urban consumption of the Ford Buggy vehicle 4.0L is 17 liters/100 km**

Where:

17 liters ⟶ 100 km

1 liter ⟶ 5.88 km

CO_2 emission.

1 liter ⟶ 2,38 kg CO_2 (2380 g CO_2 constant)

If we have to:

17 liters ⟶ 100 km

Then for every 0.17 liters of fuel the vehicle will travel 1 km obtaining a value of 40460 g CO2 at a constant speed of 50 km / h.

Calculation of the average consumption

$$\boldsymbol{Consumption\ average = a * e^{(b*s)}\ liters/100km}$$

Where:

a = 2,366

e = 2,7183 (constant of Euler)

b = 0,1751

s = large* width (m) = (4.673*1.778) = 8.308 m

$$\boldsymbol{consuption\ averge = 2.366 * 2.7183^{(0.1751*8.308)}\ liters/100km}$$

$$\boldsymbol{consuption\ average = 10.127\ liters/100km}$$

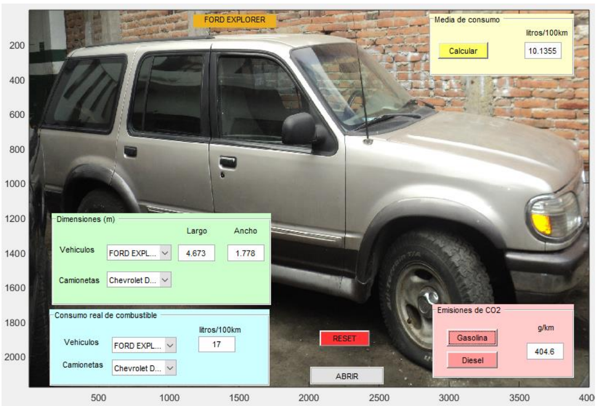

Figure 3. Ford Explorer vehicle fuel consumption.

- **Urban consumption of the prototype Buggy Ford.**

Where:

15.2 liters ⟶ 100 km

1 liter ⟶ 6.57 km

CO_2 emission.

1 liter ⟶ 2,38 kg CO_2 (2380 g CO_2 constant)

If we have to:

15.2 liters ⟶ 100 km

Then for each 0.152 liters of fuel the vehicle will travel 1 km, obtaining a value of 36176 g CO2 at a constant speed of 50 km / h.

$$consuption\ average = a * e^{(b*s)}\ liters/100km$$

Where:

a = 2,366

e = 2,7183 (constant of Euler)

b = 0,1751

s = large * width (m) = (3.650*1.778) = 6.489 m

$$average\ consuption = 2.366 * 2.7183^{(0.1751*6.489)}\ liters/100km$$

$$average\ consuption = 7.368\ liters/100km$$

Figure 4. Urban fuel consumption Ford Buggy.

With the adaptation of the V6 electronic injection engine of a Ford Explorer vehicle, automatic gearbox with torque converter 5R55E and modifications and adaptations of the components that work in conjunction with the engine, in addition to the modifications of the body in its weight, long and Width was obtained the reduction of the average fuel consumption of 10,127 liters to 7,368 liters and the reduction of CO2 emissions of 22.85% per 100 km traveled.

Conclusions.

- With the adaptation of the 4.0L engine to the Buggy Ford prototype, the MATLAB software calculated the reduction of the average fuel consumption from 10,127 liters to 7,368 liters and a reduction of CO2 emissions of 22.85% for each 100 km traveled. Is due to the reduction of the length and weight of the vehicle.
- With the adaptation of the engine 4.0 L to electronic injection to the prototype was necessary a maximum power of 156 HP to move a weight of 1455 kg.
- The actual parameters of the electronic management were obtained, later with the help of the program LIVEWIRE simulated the operation of the sensors and actuators obtaining the electronic diagram of the prototype.

Gratitude

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Areas of Interest: Mechanical Design, Automotive Mechanics, Automotive Diagnostics, Metrology, Heavy Machinery.

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