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Journal of Mechanical Engineering

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Presentation of the Content

In the first chapter we present, *Simulation of the cooling process between 16 and 19 fin liners of a sedan automobile*, by CERRITO-TOVAR, Iván de Jesús, GARCÍA-DUARTE, Oscar Enrique, HUERTA-GÁMEZ, Héctor and CERRITO-GONZÁLEZ, Neftali Carolina, with adscription in the Universidad Politécnica de Juventino Rosas, as next article we present, *Analysis of the operation processes and application of optimization tools to improve the productivity of operations in an Automotive Service Center*, by MARCIAL-OLALDE, Ana Delia & GARCIA-DUARTE, Oscar Enrique, with adscription in the Universidad Politécnica de Juventino Rosas, as next article we present, *Design methodology applied in piston testing device*, by RAMÍREZ-CRUZ, José Luis, JIMÉNEZ-RABIELA, Homero, VÁZQUEZ-GONZÁLEZ, Benjamín and GARCÍA-SEGURA, Pedro, with adscription in the Universidad Autónoma Metropolitana, as last article we present, *Transformation of a Sedan car (volkswagen) to hybrid and fully electric*, by CHAVEZ-MENDOZA, Juan Manuel, with adscription in the Universidad Tecnológica Fidel Velázquez.

Content

Article Journal of Mechanical Engineering
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Simulation of the cooling process between 16 and 19 fin liners of a sedan automobile

Simulación del proceso de enfriamiento entre camisas de 16 y 19 aletas de automóvil sedan

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Abstract

In this paper a finite element analysis is carried out on the mechanical element called the piston liner; The main objective of the analysis is to know the advantages of increasing the number of fins in said mechanical element. For the piston to have greater durability and to function optimally, it is necessary to make certain adjustments to the cooling system, hence the fact of making modifications or improvements within the piston liner. Models of the piston liner were made, which were considered the most suitable to be subjected to simulations. Various simulations were carried out, which helped to conclude that the more fins there are, the better the piston performance. Basically, an analysis was made between the 16-fin liner and another analysis with the 19-fin liner, the results were as expected, the 19-fin liner gives us a more favorable cooling time for the piston

Piston, Aluminium Oxid, Hardness

Resumen

En este artículo se lleva a cabo un análisis de elementos finitos en el elemento mecánico denominado camisa de pistón; el objetivo principal del análisis es conocer las ventajas que se tiene al aumentar el número de aletas en dicho elemento mecánico. Para que el pistón tenga una mayor durabilidad y su funcionamiento sea óptimo, es necesario realizar ciertos ajustes en el sistema de enfriamiento, de ahí el hecho de hacer modificaciones o mejoras dentro de la camisa del pistón. Se realizaron modelos de la camisa del pistón, los cuales se consideraron los más adecuados para someterlos a simulaciones. Se realizaron diversas simulaciones, las cuales ayudaron a concluir que efectivamente entre mayor cantidad de aletas se tiene, mejor será el desempeño del pistón. Básicamente se hizo un análisis entre la camisa con 16 aletas y otro análisis con la camisa de 19 aletas, los resultados eran los esperados, la camisa de 19 aletas nos da un tiempo de enfriamiento más favorable para el pistón.

Pistón, Óxido de Aluminio, Dureza

Citation: CERRITO-TOVAR, Iván de Jesús, GARCÍA-DUARTE, Oscar Enrique, HUERTA-GÁMEZ, Héctor and CERRITO-GONZÁLEZ, Neftali Carolina. Simulation of the cooling process between 16 and 19 fin liners of a sedan automobile. Journal of Mechanical Engineering. 2020. 4-14: 1-5

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1. Introdution

At present, efficiency within mechanical systems has become fundamental, since the correct operation, work capacity and optimization in its design depend on it. The piston liner is a type of mechanical system, which is subject to various changes in temperature, which leads to a poor or good operation of the piston and even more, this affects or benefits the operation of the piston.

It is important to consider that any geometric change that is made to the piston liner must be subjected to various tests or simulations to know the mechanical behavior.

To make any geometric change to a mechanical system, it must be taken into account to make a model in CAM, to later pass it to a simulation stage in CAE, with this it can be ensured that the results obtained will be the closest to reality, considering entering the most real data possible to the simulator.

2. Development of the methodology to obtain parameters

For the development of this project, there were a series of activities and use of software to acquire the parameters closest to the reality of the process; In the first instance, previous projects that had something in common with this project were reviewed in order to develop a possible idea of them, secondly, there is software that indicates the working conditions of a sedan car engine, which is used by laboratories. of the manufacturing company of the same, therefore, the conditions established in such software are the closest to reality. Finally, the simulation of the engine's work process was carried out, focusing on the specific part of the cooling in the so-called engine piston liners using software that works with finite element (CAE).

3. Obtaining the CAD model

Both sleeve models (16 and 19 fins) were obtained and the dimensions were taken in a metrology laboratory to make the CAD model, as can be seen in figure 1; with the exact measurements to later import said model into the software that was used for its simulation using finite elements.

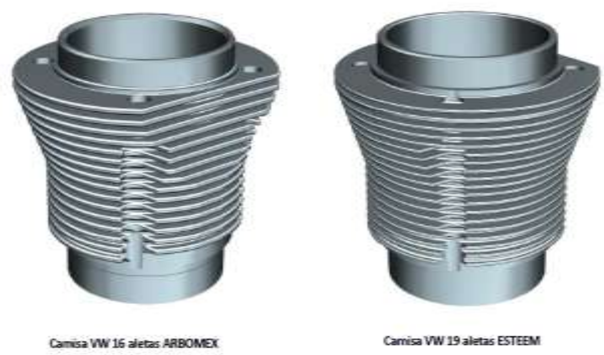

Figure 1 16 and 19 fin shirts, respectively
Source: Own Elaboration [CAD Software])

4. Materials

The software used for the simulation must work with the exact chemical composition in order to demonstrate an approximation of what a real result would be, therefore, the alloy with said composition is shown in table 1.

Element	F-132
%Si	8.5 - 10.5
%Fe	1.00 max
%Cu	2.0 - 4.0
%Mn	0.5 max
%Mg	0.5 - 1.50
%Ni	0.5 max
%Zn	1.00 max
%Ti	0.25 max
%Ca	0.007 max

Table 1 Chemical composition of the shirt
Source: Own Elaboration [Word]

5. Loads

The type of analysis used was coupled field (thermal-structural), with pressure and temperature effects of variable amplitude, that is, with load histories corresponding to those presented during a normal running cycle with a temperature of 400 ° C. inside the jacket and a convection equivalent to an air flow, as can be seen in Figure 2.

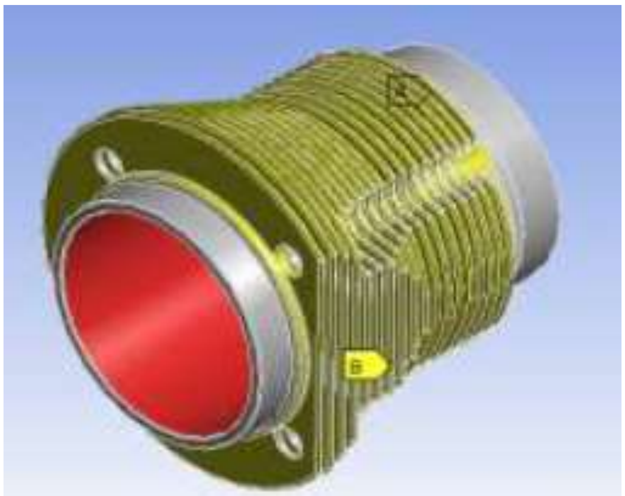

Figure 2 Parameters used in the simulation
Source: Own Elaboration [CAE Software]

The temperature used in the simulation was calculated by a program which is given as input data, the parameters of the engine that uses that piston and as a result gives the temperatures that are generated in the component used, as shown in Table 2.

	16 Fins ARBOMEX			19 Fins ESTEEM		
# Fins	Max	Min	Prom	Max	Min	Prom
1	387°C	281°C	334°C	388°C	240°C	314°C
2	386°C	281°C	332°C	382°C	250°C	316°C
3	386°C	278°C	337.5°C	380°C	234°C	307°C
4	386°C	302°C	344°C	380°C	284°C	332°C
5	392°C	316°C	354°C	380°C	262°C	321°C
6	393°C	334°C	363°C	386C	297°C	341.5°C
7	393°C	350°C	371°C	387°C	300°C	343.5°C
8	393°C	363°C	378°C	388°C	323°C	355.5°C
9	394°C	373°C	383.5°C	388°C	338°C	363°C
10	394°C	375°C	384°C	389°C	350°C	369.5°C
11	394°C	376°C	385°C	389°C	362°C	375.5°C
12	394°C	377°C	385.5°C	390°C	365°C	377.5°C
13	394°C	378°C	386°C	390°C	364°C	377°C
14	391°C	381°C	386°C	391°C	366°C	378°C
15	391°C	383°C	387°C	392°C	368°C	380°C
16	390°C	383°C	386.5°C	392°C	372°C	382°C
17				389°C	376°C	382.5°C
18				388°C	380°C	384°C
19				391°C	381°C	386°C

Table 2 Temperatures obtained in simulation
Source: Own Elaboration [Word]

6. Discretization of the model

The type of finite element to be used was selected considering the type of analysis required, the geometric irregularities that are present, the materials to simulate and the possible behaviors to obtain. The most suitable element is solid 185 defined by 8 nodes each with 3 degrees of freedom, as shown in Figure 3.

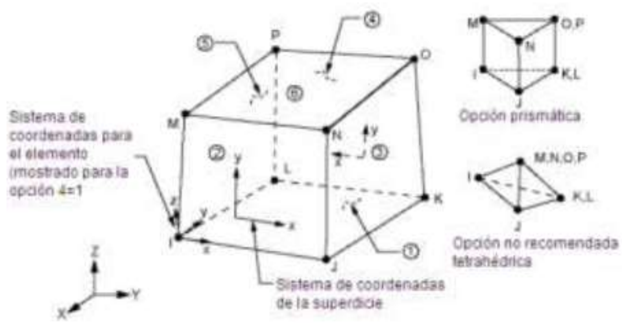

Figure 3 3D solid element
Source: Own Elaboration [Word]

The resulting mesh can be seen in Figure 4, which shows that it became finer in the more closed areas, so it was considered that it could have a greater complication when cooling..

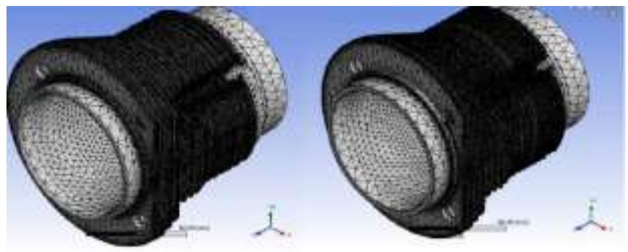

Figure 4 Resulting mesh in jacket of 16 and 19 fins respectively
Source: Own Elaboration [CAE Software]

7. Results

The process was simulated with the aforementioned conditions and a process time of 2 minutes was assigned, enough to be able to establish the maximum temperature and thus be able to observe a cooling process more attached to reality. In Table 3 you can see a difference in colors and values according to the simulation carried out. Figures 5 and 6 show the behavior in the liner with 16 and 18 fins, respectively, taking into account the conditions mentioned.

		16 fins model	19 fins model	Difference
Fin area (mm2)		1.35E+05	1.51E+05	10.55%
Heat flow Area 1 (W/mm2)		0.26103	0.35836	27.15983927
Heat flow Area 2 (W/mm2)		0.23203	0.31854	27.15828467
Heat flow Area 3 (W/mm2)		0.20303	0.27873	27.15889929
Heat flow Area 4 (W/mm2)		0.17402	0.23891	27.16085555
Heat flow Area 5 (W/mm2)		0.14502	0.19909	27.1585715
Heat flow Area 6 (W/mm2)		0.11601	0.159727	27.36982476
Heat flow Area 7 (W/mm2)		0.087011	0.11945	27.15696944
Heat flow Area 8 (W/mm2)		0.058008	0.079636	27.1585715
Heat flow Area 9 (W/mm2)		0.029004	0.039818	27.1585715

Table 3 Results of the temperatures and range of colors obtained in the simulation
Source: Own Elaboration [CAE Software]

In Figure 5 you can see the heat dissipation in the 16 fin model.

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Figure 5 16 fin liner cooling
Source: Own Elaboration [CAE Software]

In Figure 6 you can see the heat dissipation in the 19-fin model.

Figure 6 19 fin liner cooling
Source: Own Elaboration [CAE Software]

As can be seen, the greater dicipation in the 19-fin liner is evident, since its structure allows the heat generated in the car's combustion process to dissipate faster in that liner. Figure 7 shows another form of solution regarding the complete shirt, it is possible to see through the range of colors the heat dissipation of the shirts. In the same way, the range and change of colors in both is very evident, thus indicating the dissipation of heat in the jackets, again having faster cooling in the 19-fin jacket.

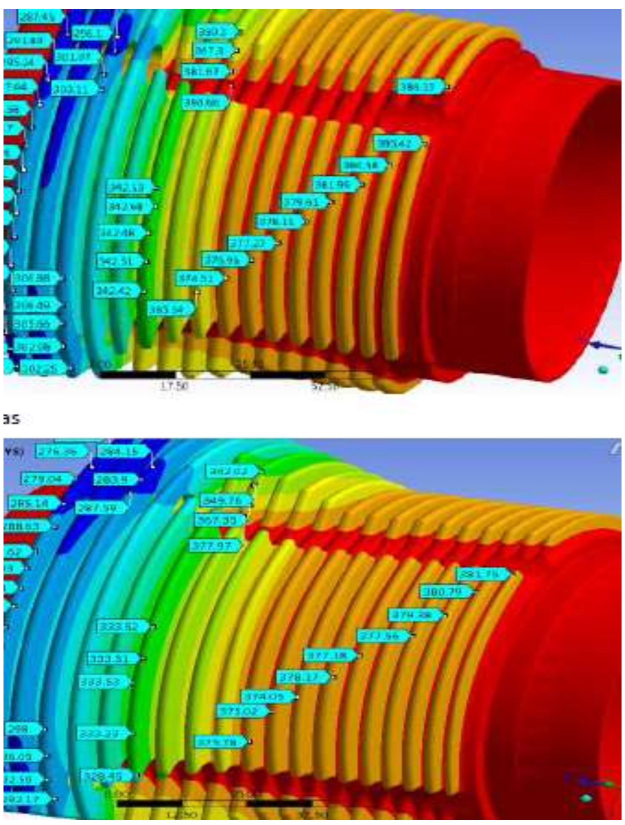

Figure 7 16 and 19 fin liner simulation result, upper and lower. Respectively
Source: Own Elaboration [CAE Software]

Finally, it was necessary to know more directly the difference in temperatures in the different areas of the fins, as shown in Figure 8, this in order to have a more precise conclusion about the results obtained.

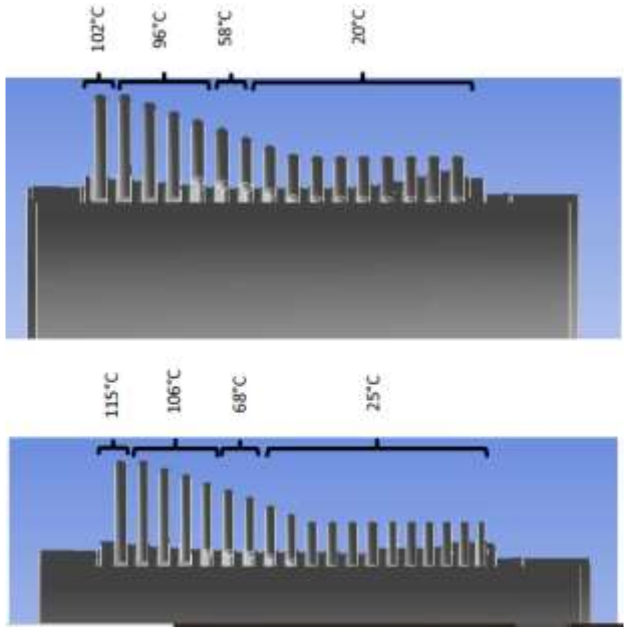

Figure 8 Temperature difference in 16 and 19 fin liners, upper and lower, respectively
Source: Own Elaboration [CAE Software]

According to the behaviors shown in the previous images, it can be deduced that:

- First fin 11.30% more dissipation in 19 fins model.
- Second to fifth fin 9.43% more dissipation in the 19 fin model.
- Sixth to seventh fin 14.73% more dissipation in the 19 fin model.
- The remaining fins 20% more dissipation in the 19 fin model.

8. Conclusions

The results obtained show that the greater the number of fins, the better the cooling in the piston. The jacket with a greater number of fins tends to be more efficient, since the cooling time is shorter. The above benefits the piston to cool faster and its efficiency to be better, due to the heat dissipation that the liner has.

This can translate into a more efficient piston work, which is reflected in the life of the vehicle's engine, which leads to savings in vehicle maintenance.

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Article
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Analysis of the operation processes and application of optimization tools to improve the productivity of operations in an Automotive Service Center

Análisis de los procesos de operación y aplicación de herramientas de optimización para mejorar la productividad de las operaciones en un Centro de Servicio Automotriz

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Abstract

The management of operations in any business unit has been a fundamental element that contributes to increasing its productivity. In order to establish improvement action plans that contribute to generating more efficient operations that improve productivity and the quality of the service provided, it is important to understand how these operations are carried out and the productive factors that intervene to optimize them within organizations. This article shows an analysis on the analysis of operations in an automotive service center, through a study of times carried out on the technical staff of the center, identifying productive and unproductive times, making an analysis of the sequence of operations, identifying operations that represent bottlenecks in the process, as well as the elements available to the staff to carry out their work. An analysis will be carried out of the work carried out in accordance with the repair orders entered at the service center from receipt to delivery, so that an opportunity area is established in the processes that are carried out to generate improvements that contribute to optimization of the resources.

Time study, Operations analysis, Productivity, Optimization

Resumen

La administración de operaciones en cualquier unidad de negocio ha sido un elemento fundamental que contribuye a incrementar su productividad. Para establecer planes de acción de mejora que contribuyan a generar operaciones más eficientes que mejoren la productividad y la calidad del servicio suministrado, es importante comprender cómo se realizan dichas operaciones y los factores productivos que intervienen para optimizarlos dentro de las organizaciones. El presente artículo muestra un análisis sobre el análisis de operaciones en un centro de servicio automotriz, mediante un estudio de tiempos efectuado al personal técnico del centro, identificando los tiempos productivos e improductivos, haciendo un análisis de la secuencia de las operaciones, la identificación de operaciones que representan cuellos de botella en el proceso, así como de los elementos con que cuenta el personal para efectuar su trabajo. Se realizará un análisis de los trabajos efectuados conforme a las órdenes de reparación ingresadas al centro de servició desde su recepción hasta su entrega, de forma que se establezcan área de oportunidad en los procesos que se llevan a cabo para generar mejoras que contribuyan a la optimización de sus recursos.

Estudio de tiempos, Análisis de operaciones, Productividad, Optimización

Citation: MARCIAL-OLALDE, Ana Delia & GARCIA-DUARTE, Oscar Enrique. Analysis of the operation processes and application of optimization tools to improve the productivity of operations in an Automotive Service Center. Journal of Mechanical Engineering. 2020. 4-14: 6-12

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Introduction

Today, business units are facing a changing, more competitive and globalized economic environment, making the management of operational-productive issues a key element for the proper functioning of the business, directing their efforts towards productivity, taking care in at all times the quality of the products or services supplied in such a way as to satisfy the needs or requirements of the client. However, the challenge becomes greater for companies that seek to remain in the market, since customers have a greater number of possibilities where they can purchase the products and services they want, they have easy access to information that allows them to make purchasing decisions. Therefore, improvements in the operation of operations within the organization have been vital to increase productivity in companies in any market sector.

Productivity is measured considering the degree of efficiency with which material and human resources are used, machinery, as well as the methods to achieve organizational objectives. Tools must be applied to measure their degree of efficiency, which leads to balancing the lines or work stations, reducing or eliminating movements that do not add value to the process, thus improving uptime, therefore, it is important to calculate in the process their standard production time, in order to separate productive time by identifying unproductive time.

The objective of this study is to establish strategies that contribute to improving the productivity of the automotive service center operations, through the study of the operation processes that are carried out and the application of elements that contribute to optimization, which allows identifying and eliminate activities that do not add value to them, in order to reduce cycle times and increase the quality of customer service.

Literature review

We could define productivity as the relationship between the outputs of goods and services in a production process and the input elements or productive factors necessary to carry out said processes.

Kanawaty (1996) defines productivity as the relationship between production and inputs, applicable to an organization, an economic sector or the economy in general. Therefore, the measurement of productivity helps to identify the degree to which a certain product can be obtained from an input used, making this measurement easier when both the product and the input have tangible characteristics, however, the identification of the Productivity levels become difficult to calculate when intangible assets are involved in the measurement.

Drucker (1999) establishes that the most important asset in 20th century organizations consisted of their production apparatus, for the 21st century, the most valuable asset of any organization is in the knowledge workforce, as well as the productivity of these . Gutiérrez (2014), for example, establishes that wealth is generated from knowledge and information, intangibles that give rise to aspects such as leadership, productivity and quality improvement.

In a globalized and competitive market, a good number of consolidated companies establish key performance indicators as measurement of their processes, allowing thus follow up on vital aspects within the organization that lead them to meet their objectives, identifying areas of opportunity within operations seeking to be more productive while reducing operating costs, having the possibility of offering their customers products high quality at competitive prices.

In their work Chase, Jacobs and Aquilano (2009), they indicate that to create a competitive advantage in business operations, it is necessary to understand how the operations and supply function allows to increase their productivity. According to Niebel and Freivalds (2009), the way in which an organization can increase its profits is by increasing its productivity. The increase in the amount of production per hour of work employed is an indication of the improvement in productivity.

When the organization dedicates efforts to improve its processes, a positive effect is achieved that can represent benefits, by reducing rework, waste, delays, reducing scrap and reducing the possibility of presenting customer complaints.

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By having fewer defects, costs are reduced and there is the possibility of allocating the material and human resources available to develop more products, address other problems, reduce and improve delivery times or offer better customer service, thus increasing productivity , increasing the satisfaction of the company's internal and external customers (Gutiérrez, 2014).

Methods engineering is a technique that seeks, through the study of operations, to improve the processes and procedures of the workplaces, through the analysis of the design of the equipment, the facilities and the conditions in which productive operations are carried out, contributing to the establishment of strategies that allow the performance of the productive factors of the business unit to be made more efficient, allowing the processes to flow in a simpler and safer way, generating more productive, profitable and safe environments.

According to Peralta, López, Alarcón, & Rocha (2014), the result of this analysis will allow the identification of critical points in the process that represent areas of opportunity, by finding bottlenecks, losses, waste or simply activities that contribute to that the system becomes unproductive.

On the contrary, in his publication, Kanawaty (1996) establishes that Productive Time is that in which activities are carried out that will add value to the production process.

Smith (1988) mentions that the productivity of technical personnel is the ratio of the speed with which technicians perform a job and the qualities or capabilities they have.

Methodology

This study was carried out with a quantitative approach, data collection was based on standardized instruments, through observation, measurement and recording of measurements. Instruments that have been validated and demonstrated their reliability in previous studies were used (Hernández, Fernández & Baptista, 2010).

The operations for the operation of an Automotive Service Center were studied, during a week the information was collected through the data of the repair orders that were raised in the Service Center when a unit entered the workshop. Monitoring them by registering in previously designed formats. The analysis of the information was another important activity of the study, so that areas of opportunity are identified and to complete this study, proposals for improvement are generated.

The scope of this analysis was divided into two moments:

a. Determination of Standard Times of operations for repairs.
b. Optimization of car repair processes.

The compilation of the information involved areas that intervene in the service, among which the departments of reception of units, head of the workshop (control of operations), spare parts warehouse, workshop, quality control and customer service were analyzed. For each operation, the time taken was carried out, from the moment the unit is assigned to the technician, until the completion of the entire maintenance service. The time recording was generated continuously, analyzing the services depending on the level of complexity based on the replacements and inspections recommended by the manufacturer according to the mileage of the unit, including the alignment and balancing service.

Through interviews, information is collected from the areas that contribute to the service, especially the spare parts warehouse and customer service, the cycle times and operating times, the sequence of activities were analyzed considering the procedures already established in the workshop, as well as the perception that the client has with the aspects of the service. Flow charts and path diagrams were used to support the analysis of operations.

In the Automotive Service Center, 9 technicians collaborate, 2 of them are specialists in Nissan-Renault units, with this workforce an average of 800 repair orders are attended per month. The units that enter the service center commonly demand minor and major maintenance services, depending on the mileage they have, Table 1 shows the activities carried out in each maintenance.

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Maintenance service under 5,000 km includes:	Maintenance service for more 10,000 km includes:
Oil change, Oil filter, Suspension adjustment, Brake cleaning and adjustment, Checking lights, Checking levels, Washing and vacuuming the body	Oil change, oil filter, air filter, fuel filter (if the model requires it, they do not include filters that are installed in the fuel tank), major tuning, spark plugs, suspension adjustment, cleaning and adjustment of brakes, inspection lights, Level check, Body wash and vacuum

Table 1 Description of scope of minor and major maintenance
Source: Own Elaboration [Microsoft Excel]

Figure 1 shows the flow chart with the description of the activities that are followed from the moment the unit is received until the completion of the repair and delivery to the customer.

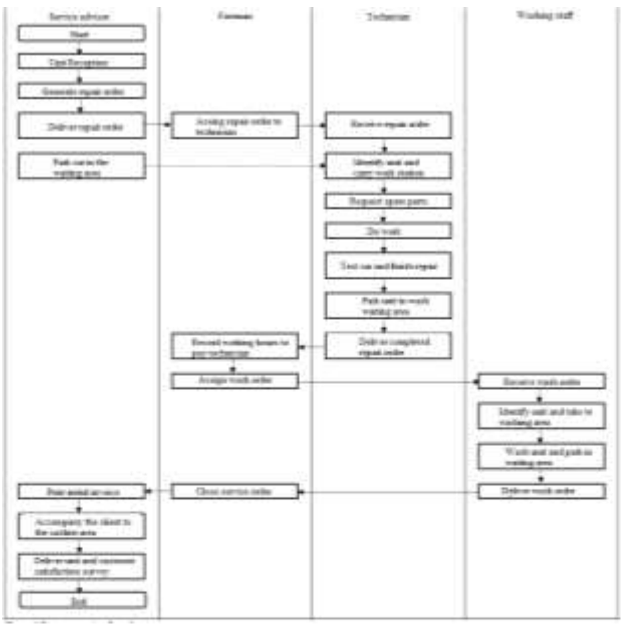


Figure 1 Center operation flow diagram
Source: Own Elaboration [Microsoft Excel]

Results

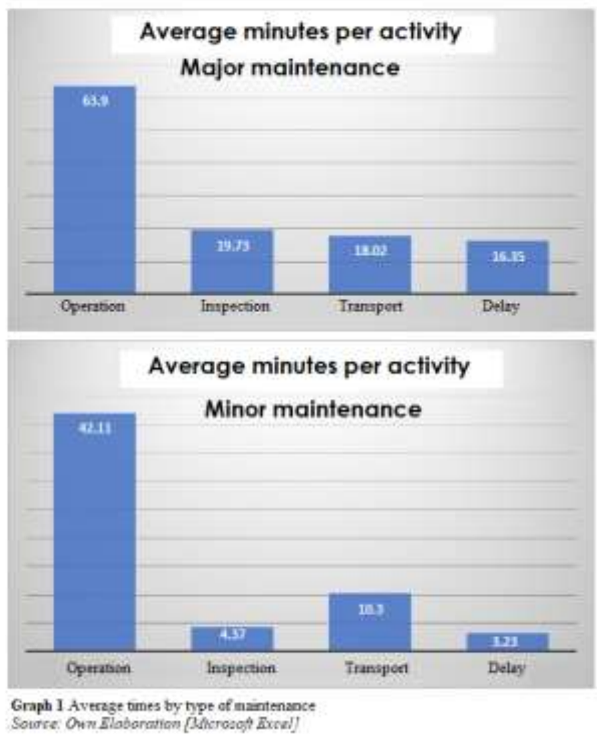
As part of the analysis of the operation processes, among other things, the time of receipt of the vehicles, the time of assignment of the work, the start time of the technician's work, the time the technician finished the work and the time he delivered the the repair order to the personnel responsible for the control of the operations of the workshop, in the same way the movements made to carry out the work, tools and equipment used, the activities in which tools were used, sequence of activities carried out and years are observed and recorded of staff experience.

The data was captured in the system to obtain the results for each order, in Table 2, a sample of the analysis of the operation at the beginning of the study is presented, where the average time for major maintenance was 118 minutes and the lowest 60.01 minute.

Order number	Type of job	Ramp type	Technician type	Years of technician experience	Total activity time	Total frequency	Total travel
2648	Major maintenance	Hydraulic jacks and towers	No specialization	3	02:25:00	73	731.22
2649	Minor maintenance	Hydraulic jacks and towers	No specialization	22	00:00:00	19	88.92
2660	Major maintenance	Hydraulics	With specialization	8	01:11:00	53	362.3
2674	Major maintenance	Hydraulics	With specialization	3	02:18:00	80	578.89
2680	Minor maintenance	Hydraulics	No specialization	7	00:53:00	33	294.19
2897	Minor maintenance	Hydraulics	No specialization	10	00:41:00	18	169.07
3080	Minor maintenance	Hydraulics	No specialization	2	01:29:00	53	557.61

Table 2 Analysis of the initial operation
Source: Own Elaboration [Microsoft Excel]

Activities carried out by the technician were analyzed, as well as the measurement of the times for carrying out a breakdown of the major and minor maintenance repairs as they were carried out at the beginning of the study. (See Graph 1)



Graph 1 Average times by type of maintenance
Source: Own Elaboration [Microsoft Excel]

According to the results, most of the time was spent in the operation, carrying out activities such as mechanics, lubrication, brakes, balancing and inspections for the case of major services because it includes the balancing operation that was carried out in parallel with brake and mechanical activities.

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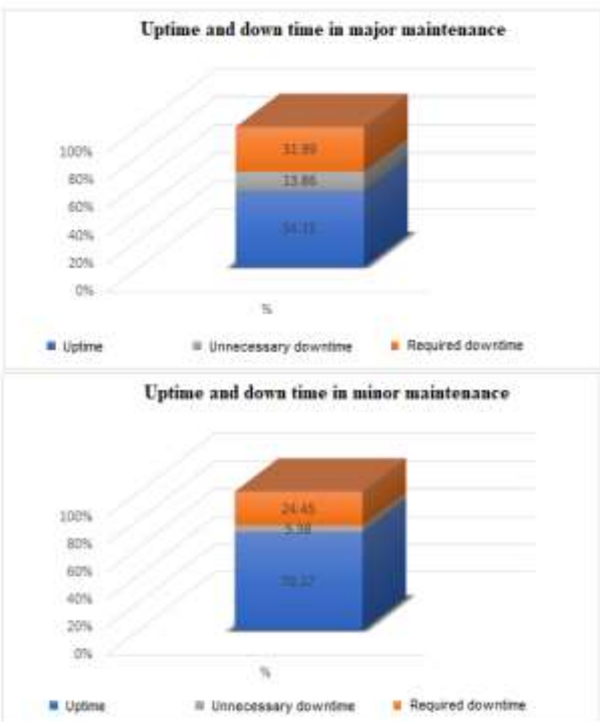
In this analysis, it is important to identify the productive and unproductive times that are incurred within the operation, considering that the Productive Time (TP) is that in which activities that add value to the process are carried out, therefore, the aforementioned activities they are part of this productive time. On the other hand, Unproductive Time can be divided into Necessary Unproductive Time (TIN) composed of activities that do not add value to the process, however, they are necessary to perform and finish productive tasks, while Unnecessary Unproductive Time (TII) refers to the time spent in activities that do not add value to the process, therefore, are considered as waste.

Graph 2 shows the percentages of average productive and unproductive times, when analyzing the operations carried out in the repair services offered by the service center.



Graph 2 Productive and unproductive times of maintenance
Source: Own Elaboration [Microsoft Excel]

Within the TIN, the transfers to the spare parts warehouse are considered, to receive or deliver a repair order, take the tires to be balanced, go for the assigned vehicle and place it in the workplace, as well as the inspections carried out to the unit to verify compliance with the requirements indicated in the maintenance order.

Regarding the TII, the activities of waiting for spare parts, waiting for balancing equipment, interruptions due to rest, waiting to start washing, searching for your tool or work equipment, as well as the waiting time when requiring confirmation of information are identified. . Therefore, all these activities were analyzed to establish improvement plans that contribute to their minimization since they represent wasted time. As an improvement strategy, the proposal is made that one of the workshop assistants support these activities.

Likewise, the activities that are part of the necessary unproductive times were sought to minimize them since transport does not contribute to the objectives of the service center. It is worth mentioning that this time analysis was carried out considering the activities that were carried out at that time in each repair, considering that at that time there was an area of opportunity in the work method. Therefore, these times are used as a reference to establish standard times when having a work method for each type of service or repair of units.

Another important point that was analyzed is the sequence of activities, through the standardization of the repair procedure, by performing the operations with a logical sequence that helps to optimize the total repair times. It was identified that at the beginning of the activities the activities among the technical personnel are very similar, however, in the middle of the procedure the technicians used a different sequence of activities. To address this point, a quality control sheet was generated, which describes the minimum operations that must be carried out in each unit to standardize the service and guarantee quality customer service, identifying if the technical staff makes any omission of operations.

In the spare parts area, for its part, a bottleneck is generated in the mornings when the shift starts since the technicians have waiting times for the spare parts they require for the assigned work to be delivered, therefore the proposal is generated that the spare parts personnel prepare spare parts kits according to each repair order that is entered, having a reduction in waiting times to start with the replacement of the parts necessary to carry out the service.

In addition to this, containers are installed to pour the motor oil to be replaced, near the work stations of the technical personnel. With regard to machinery, equipment and facilities in general, an inventory is made of the tool commonly used by the staff that is located in the tool store, as well as the tool receipt sheets assigned to each technical staff. identifying material and equipment that is necessary to have at each work station. For maintenance work, air and water intakes are required, therefore, we worked so that the 2 intakes that were previously inoperable, functioned properly and contributed to the fact that the personnel did not have to travel by water, for example to fill the unit deposit levels.

Conclusion

The technical staff is becoming familiar with the new working methods, considering that prior to the study carried out, the staff was used to working without a standardization of operations, putting at risk even the quality of the service provided, knowing that no one inspected their work.

The times that were analyzed in the operations contributed to establish standard operating times considering also the personal needs of the productive personnel as well as a percentage of fatigue, considering that it is a physical job but that it also demands visual and mental wear when submitting their work to an inspection and a degree of concentration to identify the correct sequence of activities to be carried out, without forgetting the environment that can influence its performance such as temperature, humidity, lighting and ventilation of the workplace.

To reduce travel times, the personnel were provided with some mechanic's trolleys with at least 5 compartments so that they could place their tool in shelter and move around the unit to carry out maintenance service, avoiding moving from one place to another to locate the necessary equipment for shop operations.

In order to generate an adequate distribution of work, criteria are established to assign repair orders early in the shift, assigning the jobs that will require less repair time, with the intention of increasing the number of service orders concluded by turn.

These assignments are generated by a single person responsible for scheduling the work carried out in the service center from receipt of the unit to delivery to the customer.

The benefits of implementing these improvement strategies are as follows:

- Activities are carried out on a scheduled basis and operations can be anticipated.
- Delays by technical staff are reduced.
- Production capacity is increased
- Delivery times of the units to the customer are reduced.
- The review of each job is recorded in a control sheet, which allows standardizing operations and inspections.
- Variations in the unit maintenance and repair process are reduced, thus reducing errors at the end of the process and possible customer complaints.
- The technical staff is committed to paying attention to the activities carried out and participates in establishing proposals for improvement in the working methods.
- The reports made contribute to generate training programs, improvements in procedures that affect productivity.

The implementation of the description of procedures for the operation in the service center, the identification of productive and unproductive times, the generation of quality control sheets of the services, are tools that contribute to the operation within the service workshop improve and can be standardized.
It is important that, in this type of organization, where the quality of the maintenance service and customer service are essential for the permanence of customers, it is important that quality service proposals are implemented that contribute to a closer monitoring of repairs carried out by technical personnel.

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Article

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Design methodology applied in piston testing device

Metodología de diseño aplicada en dispositivo de pruebas en pistones

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Abstract

As part of the development and manufacture of engine pistons used by the automotive industry, a series of laboratory tests are carried out that include: Mechanical, metallographic and chemical analysis of the material, dimensional verification, final weight and piston finishes finished, tests on the engine dynamometer of the finished product, etc. The technological development department of an automotive piston manufacturing company, as part of the quality assurance process of its products, has established the need to assess the compressive and fatigue resistance of pistons, both at room temperature and at temperature normal operation of an internal combustion engine. The equipment proposed to carry out these tests is an hydraulic servo machine, which has the capacity to apply dynamic load and static load, with which extreme piston operating loads can be simulated. For this reason, the design goal of this work is to design a device with which the test specimens (pistons) can be held in the machine, in order to perform fatigue and compression tests and in which, the heat can be heated. piston at the required test temperature.

Piston, Mechanical Test, Fatigue, Simulation, Design

Resumen

Como parte del desarrollo y fabricación de pistones para motores utilizados por la industria automotriz, se realizan una serie de ensayos de laboratorio que incluyen: Pruebas mecánicas, metalográficas y análisis químico del material, verificación dimensional, del peso final y de los acabados de los pistones terminados, pruebas en el dinamómetro de motor del producto terminado, etc. El departamento de desarrollo tecnológico de una empresa fabricante de pistones automotrices, como parte del proceso de aseguramiento de calidad de sus productos, ha establecido la necesidad de evaluar la resistencia a la compresión y a la fatiga de pistones, tanto a temperatura ambiente como a la temperatura normal de operación de un motor de combustión interna. El equipo propuesto para realizar estas pruebas es una máquina servo hidráulica, la cual tiene capacidad de aplicar carga dinámica y carga estática, con las cuales se puede simular cargas extremas de operación de los pistones. Por este motivo, la meta de diseño de este trabajo es el diseñar un dispositivo con el cual se pueda sujetar las probetas de prueba (pistones) en la máquina, para poder realizar pruebas de fatiga y compresión y en cual, se pueda calentar el pistón a la temperatura requerida de prueba.

Pistón, Fatiga, Simulación

Citation: RAMÍREZ-CRUZ, José Luis, JIMÉNEZ-RABIELA, Homero, VÁZQUEZ-GONZÁLEZ, Benjamín and GARCÍA-SEGURA, Pedro. Design methodology applied in piston testing device. Journal of Mechanical Engineering. 2020. 4-14: 13-17

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Introduction

INEGI released the administrative records of the light vehicle automotive industry that develops in the country, from 21 companies affiliated to the Mexican Association of the Automotive Industry, A.C. (AMIA), such as sales to the public in the domestic market, production and exports for the month of September of this year. Approximately 63% of the light vehicles produced in Mexico are exported to the United States market [1] and, therefore, regulations and consumer preferences in this market affect both the vehicles produced in Mexico, as well as the parts and components thereof, including the original and spare piston sector.

(Unidades)

Marca	Septiembre			Enero-Septiembre		
	2018	2019	Var. %	2018	2019	Var. %
Total	**320,288**	**318,906**	**(-) 0.43**	**2,955,719**	**2,931,326**	**(-) 0.83**
Afiliadas	**320,071**	**318,568**	**(-) 0.47**	**2,953,735**	**2,927,733**	**(-) 0.88**
Audi	9,758	15,102	54.8	133,573	127,561	(-) 4.5
BMW Group a/	n.d.	3,197	n.c.	n.d.	11,841	n.c.
FCA México b/	57,643	45,814	(-) 20.5	492,547	440,119	(-) 10.6
Ford Motor	22,413	17,755	(-) 20.8	204,402	225,149	10.2
General Motors	75,010	75,293	0.4	647,463	673,032	3.9
Honda	3,589	16,698	365.3	114,321	163,035	42.6
KIA	28,300	24,200	(-) 14.5	211,900	216,400	2.1
Mazda	9,686	3,644	(-) 62.4	119,464	59,676	(-) 50.0
Nissan	66,043	60,142	(-) 8.9	569,734	517,043	(-) 9.2
Toyota	18,410	17,644	(-) 4.2	143,449	146,143	1.9
Volkswagen	29,219	39,079	33.7	316,882	347,734	9.7

Figure 1 Total production of light vehicles *(Taken from www.inegi.org.mx)*

It should be noted that the statistics on the production of pistons in the aftermarket does not include the production of pistons used in the production of engines, therefore the total production of pistons in Mexico for 2018 reached around 19 million pieces.

The trends in the manufacture of gasoline engines for the automotive industry can be included in the following requirements:

- Reduce polluting emissions
- Increase fuel efficiency
- Put up with:
- Elevated temperatures (> 350 ° C).
- High pressures in the combustion chamber (Figure 5)
- High revolutions per minute (> 5000).
- Attrition processes.
- Corrosion processes.

Figure 2 Piston damage due to fatigue and wear
Source: Self Made

The pistons are one of the most complex components among all the components of the automotive industry or others, being these the most important part of an engine. Due to the number of cycles and high temperatures, fatigue studies have been carried out in different cases, simulating these conditions. In Figure 3 it is possible to see the state of efforts of a piston under a working pressure.

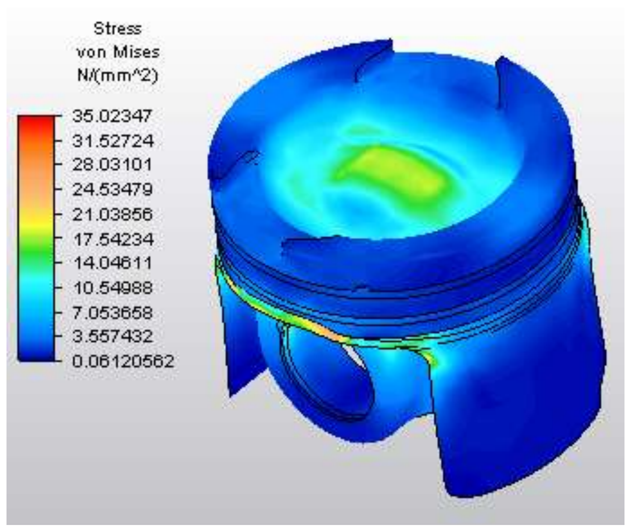

Figure 3 Simulation of forces in a piston
Source: Self Made

The technological development department of an automotive piston manufacturer, as part of the quality assurance process of its products, has established the need to evaluate the resistance to compression and fatigue of the pistons that it develops and manufactures, both at room temperature. as at the normal operating temperature of an internal combustion engine. The equipment proposed to carry out these tests is the servo hydraulic machine, which has the ability to apply dynamic load and static load, with which extreme piston operating loads can be simulated.

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The present work aims to show the design of a device with which the test specimens (pistons) can be held in a mechanical testing machine that will be used to carry out fatigue and compression tests and that can be heated in this the piston at the required test temperature.

Design requirements

Design activity begins with the recognition and determination of a need or desire for a product, service, or system, and the ability to satisfy that need. The requirements of the characteristics of the test device were generated by personal interviews and by telephone, which have been grouped and are described below:

Mandatory requirements

– That allows to evaluate the resistance to fatigue of a finished piston.
– That allows to evaluate the compressive strength of a finished piston.
– Let the device perform the test reliably.
– Have the device coupled to the Instron machine.
– That the assembly and disassembly maneuvers are safe.
– That unsafe conditions are not generated during the test.
– That it takes place within a maximum period of 8 months.
– That the cost of the device does not exceed $ 7,500.00 dollars.

Desirable requirements

– That reproduces wear phenomena on the test piston.
– That different pistons can be tested.
– That simulates the normal operating temperature of the piston.
– That the assembly of the device is easy.
– Make it easy to assemble and disassemble the testing device on the testing machine.
– Easy assembly and disassembly of the pistons in the test fixture.

Information concerning the identified problem becomes the basis for a problem statement, which may consist of information, presented for formal consideration.

			Design goals	
#	Variable	Unit	P-1	P-2
1	Maximum load.	KN	400	180
2	Minimum load.	KN	0	80
3	Load application frequency.	Hz	1	10
4	Test temperature.	°C	25-350	25-350
5	Percentage of area in contact with the piston head.	%	100	100
6	Device length.	mm	300	300
7	Device width.	mm	300	300
8	Device height.	mm	700	700
9	Piston diameter.	mm	55-100	55-100
10	Piston height.	mm	40-60	40-60
11	Piston race.	mm	60-100	60-100
12	Maximum weight of device parts.	kg	< 15	< 15
13	Maximum total weight of the device.	kg	< 50	< 50
14	Staff needed.	Cantidad	3	3
15	Tools needed.	Cantidad	4	4

Table 1 Design goals. P-1 Compression test. P-2 Fatigue test
Source: Self Made

Definition of the functional model

A function represents the role played by an item or a complete assembly. A product function is a statement of a clear and reproducible relationship between the available input and the desired output of a product, independent of any particular form.

The following describes the functional model of the Device for fatigue and compression tests, for pistons of gasoline engines. The service functions and their classification of the device for fatigue and compression tests, for pistons of gasoline engines, are indicated in Table 2 and, in Figure 4 the global service function is shown that relate to each of the service functions.

Key	Service function
A1	Mount the piston in the device
A2	Place interface between piston and device
A3	Heat piston and interface to test temperature
A4	Transfer fatigue and compression loads to the piston
A5	Fracturing the piston by fatigue or compression
A6	Remove the fracture piston

Table 2 Service functions and their classification
Source: Self Made

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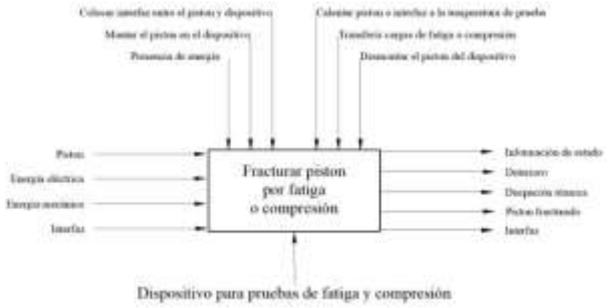

Figure 4 Description of the global function
Source: Self Made

Detail design

Design activity begins with the recognition and determination of a need or desire for a product, service, or system, and the ability to satisfy that need. Once the characteristics that must be met and how they will be covered have been defined, then we move on to the design stage to see the proposed characteristics obtained in a visual way.

At this time all parts are carefully designed based on their strength and function. Once the product is well defined and always taking costs into account, it must be built in a minimum period of time. At present, through a specialized computer program it is possible to obtain a virtual model very close to reality.

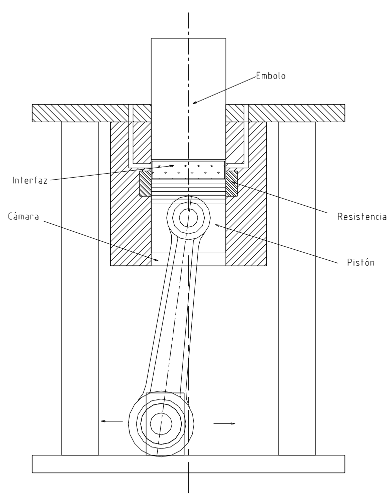

Figure 5 Outline of the device design concept for fatigue and compression tests
Source: Self Made

Figure 6 Exploded view of the virtual assembly of the device for fatigue and compression tests for gasoline engine pistons
Source: Self Made

To do this, software for 3D mechanical drawing and part and assembly modeling was used. In Figure 6, you can find the proposal that resulted from the analysis with the design methodology. The result of the design of the device characteristics is shown in Figure 7. This device contains the characteristics described above and would be the most suitable for machine manufacturing and placement.

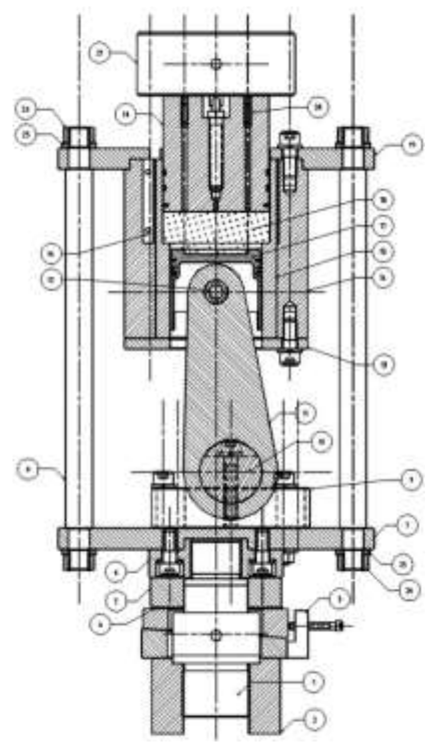

Figure 7 Virtual assembly drawing of the device for fatigue and compression tests for gasoline engine pistons
Source: Self Made

Conclusions

The proposed article refers to the development of a design methodology that applies to any type of machine, equipment or device to be developed.

The project satisfactorily meets the specifications established in the design, such as the capacity of the machine and its performance. It is concluded that the methodology is a tool that allows efforts to be focused in order to understand the client's needs and translate them into engineering design terms, thereby ensuring the success of the project.

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Transformation of a Sedan car (volkswagen) to hybrid and fully electric

Transformación de un auto Sedan (volkswagen) a híbrido y totalmente eléctrico

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Abstract

In this work, a proposal is made to transform the vw sedan vehicle into a hybrid and electric vehicle as a viable alternative, to reduce polluting emissions from combustion vehicles and the high costs that conventional fuels have managed to achieve in recent times, New structures have been implemented to improve vehicle propulsion conditions by reducing pollutants. For this reason, the option of vehicles that contain two systems to generate their operation is attractive. The option that we are going to analyze is a hybrid vehicle with a parallel arrangement, in which the electrical energy that drives it comes from batteries and alternatively from an internal combustion engine that drives a generator. Typically, an internal combustion engine can also drive the wheels directly. In the design of a hybrid car, the heat engine is the energy source that is used as last option, and an electronic system is arranged to determine which engine to use and when to use it.

Conversion, Electrical Energy, Pollution

Resumen

El este trabajo se hace una propuesta de transformación del vehículo vw sedán a hibrido y eléctrico como una alternativa viable, para reducir las emisiones contaminantes por parte de los vehículos de combustión y a los elevados costos que los combustibles convencionales han logrado alcanzar en los últimos tiempo, se han comenzado a implementar nuevas estructuras que permitan mejorar las condiciones de propulsión del vehículo reduciendo los contaminantes. Por este motivo es que resulta atractiva la opción de vehículos que contienen dos sistemas para generar su funcionamiento la opción que vamos a analizar es de vehículo híbrido con un arreglo en paralelo, en el cual la energía eléctrica que lo impulsa proviene de baterías y alternativamente de un motor de combustión interna que mueve un generador. Normalmente, un motor de combustión interna también puede impulsar las ruedas en forma directa. En el diseño de un automóvil híbrido, el motor térmico es la fuente de energía que se utiliza como última opción, y se dispone un sistema electrónico para determinar qué motor usar y cuándo hacerlo

Conversión, Energía Eléctrica, Contaminación

Citation: CHAVEZ-MENDOZA, Juan Manuel. Transformation of a Sedan car (volkswagen) to hybrid and fully electric. Journal of Mechanical Engineering. 2020. 4-14: 18-23

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Introduction

The implementtation of this work is to establish a solution to the need to create new vehicles that have less polluting emissions. In our case, we chose the Volkswagen "vocho" sedan vehicle, where calculations and research were carried out for the conversion of electric and hybrid vehicles, knowing that the start of this vehicle is in Germany. In 1933, Ferdinand Porsche met with Adolf Hitler to discuss the idea of the Volkswagen. Hitler wanted a vehicle that was capable of transporting 5 people at 100 km / h and cost only 1000 Marks at that time.

This was Ferdinand Porsche's opportunity to carry out his idea and at the same time help Hitler to deliver him to the Volkswagens. Our task as an engineer is in the evolution of the car, where it has been introduced to electric and hybrid vehicles, this idea was started in 1938 when Robert Davidson managed to move a locomotive at 6 km / h without using coal or steam. The electric car triumphs for its simplicity, reliability, smooth running, energy costs,

Starting this work, the main characteristics of electric and hybrid cars were analyzed, it was found that the classification depends on the type of current it handles (direct / alternating), in the position of the motor (series, combined, parallel) the batteries are also a data very important since it is the heart of the system and the most expensive and heavy element. The battery not only stores electrical energy for use in the vehicle, but also determines the power that the engine can use, the range and the design of the vehicle. We found a compatible motor (impulse 9 ev dc). It is a 9.25 diameter DC motor with a double-ended shaft and is pre-drilled to allow the brush to advance. After showing all the technical data, the entire calculation memory will be delivered, thus having a theoretical argument for future generations.

History VOLKSWAGEN SEDAN

Literally the meaning of the word "Volkswagen" is "the people's car". In Germany, the idea was not exactly new. Before the 1930s, many efforts were made to create simpler cars that were available to everyone, but none did it like the Volkswagen.

Almost all automobiles before the 1930s, even when they tried to satisfy the simplest needs of workers, far exceeded their capacity to borrow. After the Second World War, a phenomenon began to be seen in which car owners modified them, this arose in some cases due to the need to have elements that would distinguish them from those that were produced in series.

At the beginning, small changes were made that over time became structural modifications that surprised locals and strangers. The car went from being a means of transport to a luxury that projects the personality of drivers who are increasingly concerned about the accessories of their vehicle. The demand for the phenomenon was so great that companies dedicated to providing accessories of all kinds to modify vehicles were established, they are called boutique cars, they are in charge of modifying the components of the cars and even their structure. The people who are dedicated to this business know mechanics, electronics and motor engineering to ensure that the results are the most convincing (VOLKSWAGEN, n.d.)

The electric vehicle

Steam could not replace the horse carriage, a new competitor came out. After the first experiments by Jedlik (1828, pictured) and Thomas Davenport (1835), we found the first electric vehicle in 1838, when Robert Davidson managed to move a locomotive at 6 km / h without using coal or steam. Between 1832 and 1839 Robert Anderson invented the first electric traction carriage, with a non-rechargeable battery. Shortly after the electrified line was patented, but that was not valid for cars, only for trolleybuses or trains. The first rechargeable batteries appeared before 1880, that's where they really began.

They took over the roads in a short time, in 1900 we can consider their apogee, when they were the cars that were sold the most, much more than those of steam or gasoline. In fact, in 1899 an electric car, "La Jamais Contente", exceeded 100 km / h for the first time and set a speed record. The first gasoline cars were very polluting, dirty, noisy, required gasoline or gasoline (it was not easy to buy it at first), you had to change gear very rudimentary, you had to start them with a crank and anywhere they were susceptible to failure.

That ended up changing… a bit. The electric car triumphed due to its simplicity, reliability, smooth running, no gear change or crank, they made no noise, they were fast, their autonomy was reasonable and their cost was bearable for the bourgeoisie and the upper classes, the first users of automobiles. They outperformed gasoline by 10 to 1. However the gasoline car received the starter motor (1912), Henry Ford invented mechanized mass production, gasoline reached a very popular price, roads began to be opened to traffic and then autonomy became a highly valued feature, in addition to the price. (COSTAS, MOTORPASION, 2010)

The electric vehicle

Today the electric vehicle represents 3% of the total world vehicle fleet and according to Navigant Research, that percentage will increase to 7% by 2020 (around 6.6 million cars per year). You can think of the electric car as a recent innovation making its way onto the market. However, being strict the electric car is not exactly a novelty. In fact, the first models hit the streets during the first half of the 19th century and were so popular that by 1900 they already represented a third of the cars of the time. The combustion car replaced it for its lower cost and ended up almost in oblivion.

Today is back and to stay. Its characteristics and qualities fit very well to our present day where the economy and the environment demand alternatives. The key is in its engineering, but how does it work? Everything is based on electric motors that convert electricity into mechanical energy to move the wheels. Its operation is relatively simple, at least compared to combustion. But we explain it a little more in detail. The most characteristic elements of electric vehicles are the charging port, transformer, battery, controller and the motor. (AGUILAR, 2015)

Loading port

The charging port of an electric car is the point through which we recharge the car. Generally, it is an exterior outlet in the style of the gas outlet of conventional cars. Each brand manufactures its own type of ports but they are usually three-phase contacts. To make it clearer, this is where you plug the car into electricity. As it is, it is the power input port to our unit.

Transformer

They are responsible for transforming the intensity and voltage of the electric current into valid values for the operation of the car. They also help cooling avoiding spills and accidents.

Controller

The controllers ensure that the operation is optimal, since it receives and recharges the energy of the motor. By needing few elements to function, the electric car becomes much more efficient than a combustion car, since they can convert up to 60% of their energy into mechanical energy; an internal combustion car that only converts up to 20%.

Options are: DC brushed motor, induction motors, and more. Within each of these options there are others, for example, in motors with DC brushes, it can have a wound field or with permanent magnets. This is also true for a brushless motor, although when looking for cheaper options, DC motors are the lowest priced. Currently we only recommend systems with brushes in the case of personal use projects where you have a small budget and efficiency is not the most important factor. (AGUILAR, 2015)

Current type

Now when it comes to commercial projects or where features such as high efficiency, zero maintenance, and operational reliability are needed, AC motors are definitely the right fit. Currently a good AC motor and its Speed Controller (Invert) with regenerative braking capability only cost a few dollars more than older DC systems. (Barrios, 2014)

DC (Direct Current)

In cars that have a direct current electric motor, this battery would be directly connected to the motor. On the other hand, in electric cars that have an alternating current electric motor, the battery is connected to an inverter. Lithium-ion batteries store the energy given by the charger in the form of direct current (DC). This main battery is the means by which the entire electric car is powered. This type of engine is more traditional, the acceleration is slower, but it has a very high maximum speed. Furthermore, direct current motors are less expensive than alternating current motors.

AC (Alternating Current)

In electric cars that have an alternating current electric motor, the battery is connected to an inverter. AC electric motors have a good reputation as they are used in cars from TESLA and Nissan, among other companies. They are more expensive than DC motors, but have a fast acceleration rate and are compatible with regenerative braking systems. This system converts the momentum of the electric motor and uses it to recharge the batteries. (Electricocar, 2013)

Hybrid Vehicle Features

A hybrid combines two engines, an internal combustion engine and an electric one powered by additional batteries to the main one. They have been a reality for many years and little by little they begin to become popular due to the crisis, fuel hikes, cheaper technology and environmental awareness.

Classification

- Series hybrid: The internal combustion engine (hereinafter heat engine) has no mechanical connection with the wheels, it is only used to generate electricity. This engine runs at optimum speed and recharges the battery until it is full, at which point it is temporarily disconnected. Traction is always electric.
- Parallel hybrid: Both the heat engine and the electric engine are used to power the transmission at the same time. It is a relatively simple solution, but it is not the most efficient.
- Combined hybrid: Any combination of the two engines serves to drive the car, it is like a series hybrid but with mechanical connection to the wheels. It is a very efficient solution but much more complex at a mechanical and electronic level. (COSTAS, MOTORPASION, 2009)

The most efficient system is in series, and the less the parallel. There is another way to classify hybrids:

- Micro hybrid: At stops the heat engine is switched off. When you want to resume running, a reversible alternator starts the engine using energy recovered before stopping. It only saves on urban cycle and there is no electric motor to power the car.
- Semi-hybrid or mild-hybrid: The electric motor is used as an assistance to the heat engine and is also a generator of energy during braking and holding, but it cannot be powered 100% electrically (heat engine off), although it can with the heat engine without consume but moving its mechanical parts.
- Pure hybrid or full-hybrid: It can be circulated under certain conditions only with the electric motor, while the thermal is completely off and does not move its parts. This change can be automatic or voluntary.
- Plug-in hybrid or PHEV: It belongs to this group if its batteries are rechargeable using conventional electrical energy, that is, by plugging it in, and it travels at least 20 miles without the need for another propulsion system.
- Extended range electric car or EREV: As in the previous case, but it is also a series hybrid. In practice, they are considered electric cars because they do not need the heat engine other than to sustain the load, and they can operate 100% without them. This means that when the batteries run out, the heat engine is used only to generate electricity at a constant rate to increase autonomy at a very low cost per kilometer. (COSTAS, MOTORPASION, 2009)

Calculation memory

Power needed to overcome drag:

$$Pw = (Rt * v) \ / \ (75 * nt)$$

$$Pw = (215.0576 * 35.2777) \ / \ (75 * 0.85)$$

$$\text{Pw} = 119.0076 \text{ CV} \qquad (1)$$

Rt: resistance to advance (kg)
v: car speed (m / s)
nt: transmission performance

Calculation of the gearbox ratio and its speeds

$$Rd = \frac{205*(80.60*2)+25.4*15}{2} = 313.5\, mm \qquad (2)$$

$$Rf = \frac{nm\ x\ 2\pi x\ Rd}{r4x\ vmaxx60} = \frac{4400*2\pi*0.3135}{88*35.2777*60} = 4.653 \qquad (3)$$

Rd: wheel radius in m
nm: engine rpm
rf: differential ratio
vmax: maximum speed of the car in m / s
n2: rpm at maximum power
n1: rpm at maximum torque
r1, r2, r3 and r4: gear ratio of each gear

$$r4 = \frac{n2\ x\ 2\pi x\ Rd}{rf x\ vmaxx60} = \frac{4400*2\pi*0.3135}{4.653*35.2777*60} = 0.880 \qquad (4)$$

$$r3 = r4x\frac{n2}{n1} = 0.88\frac{4400}{2600} = 1.4892 \qquad (5)$$

$$r2 = r3x\frac{n2}{n1} = 1.4892\frac{4400}{2600} = 2.52 \qquad (6)$$

$$r1 = r2x\frac{n2}{n1} = 2.52\frac{4400}{2600} = 4.2 \qquad (7)$$

$$rma = \frac{n2\ x\ 2\pi x\ Rd}{rf x\ vmaxx60} = \frac{4400*2\pi*0.3135}{4.653*8.001*60} = 3.88 \qquad (8)$$

Driving effort

$$F = \frac{Mm\ x\ rix\ rfxnt}{Rd} = \frac{103.986*2.6923*4.653*0.85}{0.3135} = 3531.9351\ N \qquad (9)$$

Mm: Torque at the motor
F: Motive effort
Mm = 10.6kg-m = 103.986 N-m (10)

Acceleration capacity

$$\gamma = \frac{F-Rt}{me} = \frac{3531.9351-2109.715}{1212} = 1.173 \qquad (11)$$

Me = 1.01xP = 1.01*1200 = 1212 kg (12)

Acceleration time 0 to 100 km / hr (27.77 m / sec)

$$tvf - vi = 1/\gamma \int_{vi}^{vf} dv$$

$$t0 - 27.77 = 1/1.1734 \int_{0}^{27.77} dv = 23.6728\ seg \qquad (13)$$

Vehicle power and torque calculation

The engine has a Troque of 10.6 kg-m at 2600 rpm and a maximum power of 55 hp @ 4400 rpm.

To convert from horsepower to horsepower, multiply by 0.985923 which is the Conversion Factor.

That is, 55 hp x 0.985923 Fac. = 55.785 Cv

Modifications to be made for the 100% electrical conversion

Electric motor and batteries. For the electric motor there is the IMPULSE 9 EV DC model. It is a 9.25 "diameter, direct current with a double-ended shaft and is pre-drilled to allow the advancement of the brush, either in neutral, CWDE advanced or advanced CCWDE (standard). With the motor specifications we know that a voltage of 144v to 450A is necessary each individual battery handles 24v to 18 then to compensate. Advantages of the Lithium-Ion battery over conventional lead-acid batteries

– High energy density: more energy with less weight;
– High charging currents (shortens charging time
– High discharge currents (allows, for example, to power an electric stove with a small battery bank);
– Long battery life (up to six times longer than a conventional battery)
– High efficiency between charging and discharging (very little energy loss due to heating);
– Greater continuity of the available current.
– Battery Specifications:

Lithium-Ion batteries 24V 180Ah 4.75kWh
Technology Lithium Iron Phosphate (LiFePo4)
Nominal voltage 26.4 V
Nominal capacity 180 Ah
Nominal power 4.75 KWh
Weight 55 kg
Power / weight ratio 86 Wh / kg
Dimensions (hxwxd) 625 x 195 x 355 mm
Load cut-off voltage at 0.05C 28.8V
Discharge cut-off voltage 20 V
Charge / discharge current
recommended 54 A (0.3C)
Maximum charge current (1C) 180 A
Maximum discharge current (1.5C) 270 A
Pulse discharge current (10s) 1,000 A
Number of cycles @ 80% DOD (0.3C) 2000
Series configuration Yes, up to 2
(more series if requested)
Parallel configuration Yes, easily up to 4
(more in parallel if requested)
Temp. working load 0 ~ 45 ° C
Temp. working for discharge -20 ~ 55 ° C
Temp. storage -20 ~ 45 ° C

Table 1 Battery data sheet (Compan, 2016)

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Results

Given the characteristics of the chassis of the selected car, the electric motor was installed directly to the transmission through a coupling plate, and the battery pack was arranged on the floor of the rear seat of the car itself, the junction boxes and control accessories were installed. distributed in the front trunk of the car. The entire assembly and testing process was carried out at the facilities and the vehicle was safeguarded from the sponsors for final disposal.

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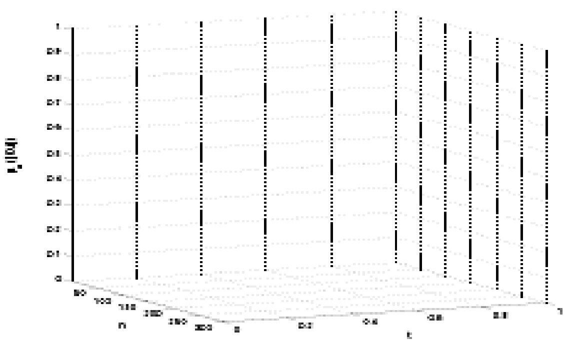

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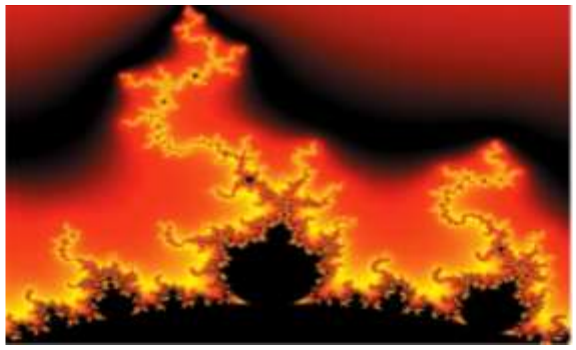

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