Article
Journal of Mechanical Engineering
December, 2020 Vol.4 No.14 1-5

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

CERRITO-TOVAR, Iván de Jesús†*, GARCÍA-DUARTE, Oscar Enrique, HUERTA-GÁMEZ, Héctor and CERRITO-GONZÁLEZ, Neftali Carolina

Universidad Politécnica de Juventino Rosas

ID 1st Author: *Iván De Jesús, Cerrito-Tovar* / **ORC ID**: 0000-0002-8601-9911

ID 1st Coauthor: *Oscar Enrique, García-Duarte* / **ORC ID**: 0000-0002-4781-8438, **CVU CONACYT ID**: 290387

ID 2do Coautor: *Héctor, Huerta-Gámez* / **ORC ID**: 0000-0002-5088-310X, **CVU CONACYT ID**: 373690

ID 3er Coautor: *Neftali Carolina, Cerrito-González* / **ORC ID**: 0000-0002-1811-9363

DOI: 10.35429/JME.2020.14.4.1.5 Received: June 30, 2020; Accepted: December 20, 2020

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

* Correspondence to the Author (e-mail: maguilera@hotmail.com)
† Researcher contributing as first author.

December, 2020 Vol.4 No.14 1-5

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.

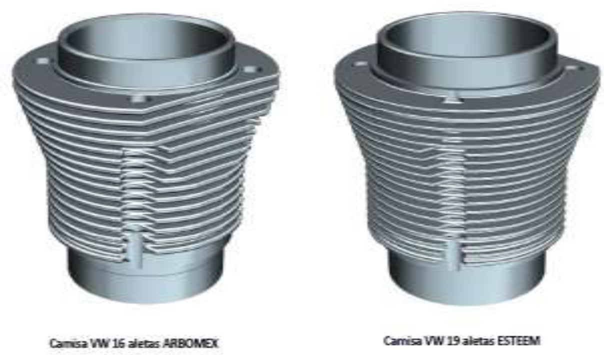

Figure 1 16 and 19 fin shirts, respectively
Source: Own Elaboration [CAD Software])

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.

ISSN-2531-2189

December, 2020 Vol.4 No.14 1-5

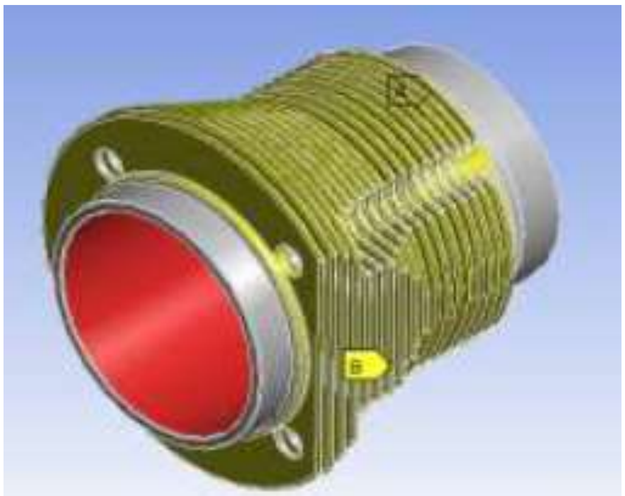

Figure 2 Parameters used in the simulation
Source: Own Elaboration [CAE Software]

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.

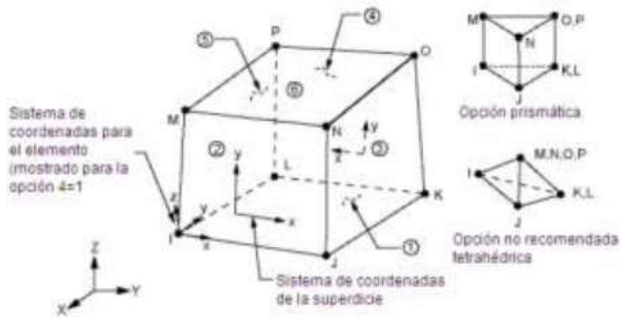

Figure 3 3D solid element
Source: Own Elaboration [Word]

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..

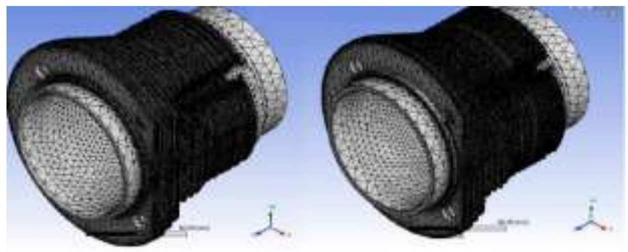

Figure 4 Resulting mesh in jacket of 16 and 19 fins respectively
Source: Own Elaboration [CAE Software]

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.

ISSN-2531-2189

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.

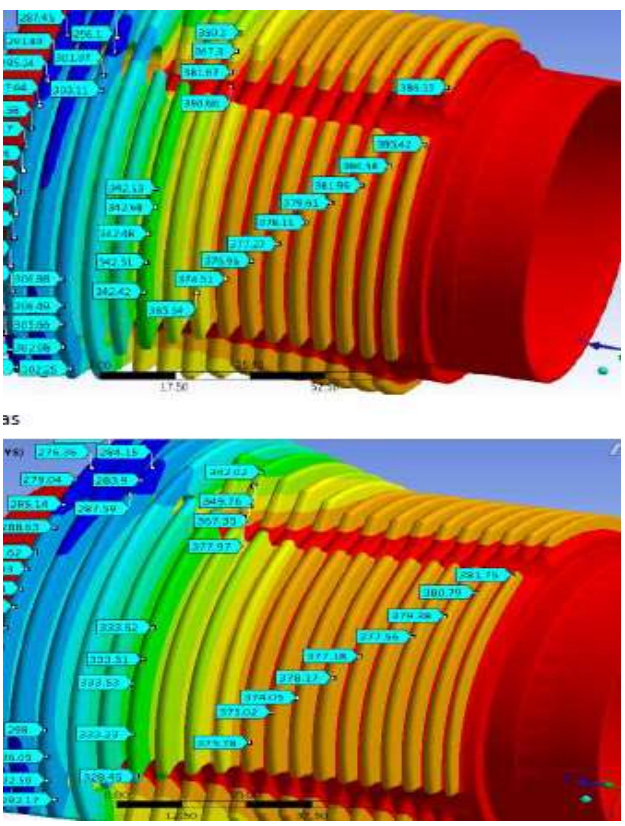

Figure 7 16 and 19 fin liner simulation result, upper and lower. Respectively
Source: Own Elaboration [CAE Software]

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.

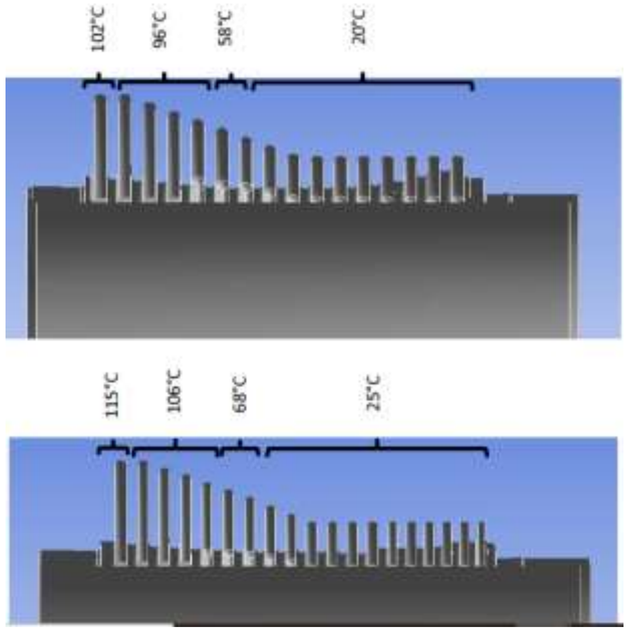

Figure 8 Temperature difference in 16 and 19 fin liners, upper and lower, respectively
Source: Own Elaboration [CAE Software]

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.

9. References

[1]. Bauman Moscow State Technical University. Diesel RK. 2010.

[2]. Volkswagen. Technical data.

[3]. ANSYS, Inc. Contact Analysis in ANSYS. Help online, R12, 2011.

ISSN-2531-2189