International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

Improvement of the Mechanical System of a Winch

J. L. Hernandez, J. Carmona, M. Sanchez
Professor
Department of Industrial Maintenance Engineering
Universidad Tecnologica De Tlaxcala, Mexico

M. Morales, R. Perea, C. Vasquez,
O. Zempoalteca, E. Vargas
Students
Department of industrial maintenance Engineering
Universidad tecnologica de Tlaxcala, Mexico

***Abstract*— This article shows the research work and activities carried out to improve the mechanical system of a winch by means of a thermic treatment that will give it hardness, resistance and elasticity. Solidworks was used for the simulation of the resistance and the structure of the mechanical components finite element method. Two simulations were carried out, one of them in the original state of the mechanical system. In order to determine which are the pieces that generated major resistance in the mechanism. Once thermic treatment was carried out, the second simulation was done that showed that the material resistance changed. The results showed that the parts this thermic process was applied to is more resistant fatigue, in order to the mechanism improving the useful life and its efficiency. In all greenhouses one of the important aspects is the winch, this equipment is essential in ventilation, to control the passage of air and temperature.**

INTRODUCTION

Mechanical systems are essential in industry and in daily life as they lead to efficient work. The mechanical characteristics of a material depend on both its chemical composition and its crystalline structure. Thermic treatments modify this structure without the chemical composition, by means of a successive heating and cooling process until the desired crystalline structure is achieved. These systems are found throughout our environment, in our case we will use a winch to facilitate the work that is done in the curtain of a greenhouse, thus determining the analysis of the improvement of the mechanical system of the manual winch. Among the most important characteristics is the resistance to wear, which offers a material that is allowed to erode when in contact with another material by friction. That is why the thermic treatment was chosen in the foreground. This project is based on an improvement of the winch, the gears will be heated and cooled in water to increase the hardness of the steel, this is a thermic treatment called tempering.

Solidworks is a 3D CAD design software (computer aided design) for modeling 3D parts and assemblies and 2D drawings. It offers the possibility to create, design, simulate, manufacture, publish and manage the data of the design process.

Finite element method was used within the work that was done, to determine the fatigue to which the gear of the winch is exposed, by means of a weight that was applied in the simulation in Solidworks.

Finite element analysis is a numerical method widely used in engineering to solve problems described by a series of partial differential equations. These types of problems are commonly found in mechanical design, acoustics, electromagnetism, fluid mechanics, among other studies and specifically in mechanical

THERMIC TREATMENT

Thermic treatment is essential to improve both the surface and hardness of the gear core, enhancing its ability to withstand tensile stress, improve strength and reduce wear. [1]

TEMPERED

Its purpose is to increase the hardness and resistance of steel. Hardening produces a fine granular structure that increases tensile strength and decreases ductility. Steel can be hardened by heating to its critical temperature, which is approximately 790 to 830 °C, which is identified when the metal turns a bright cherry red color. Important factors in heat treatment are temperature, dwell time and cooling rate. [1]

TEMPERATE COOLED IN WATER

Pieces to be cooled in water that have already been heated and maintained at 820 ºC during the calculated time (t), will be removed with pliers heated with to the torch or in a pre-heating muffle and quickly immersed in a brine bath (salt dissolved in the water until saturation). The quenching water must be clean and at a nearby temperature of 20 ºC. The specimens are shaken in the cooling bath until their temperature drops to about 100 ºC. [1]

HARDNESS TEST – VICKERS

Vickers hardness (HV) is calculated by optically measuring the diagonal lengths of the impression left by the penetrator. The measurements are converted into HV by means of a formula: D= (D1+D2) / 2,

HV = (1,854*P) / D.

FINITE ELEMENT METHOD

Application of the finite element method by means of Solidworks Simulation allows the minimization or

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

maximization of mass, volume, tensile energy, tensile stress, force, displacement, speed, etc. As load conditions can be applied to the system point loads, pressure, thermal, gravity, static centrifuges, dynamic gravities. [5]

GEAR TEMPERING

For the realization of the tempered of the winch gears, cooling was carried out in water as it was more efficient to achieve greater hardness. Using the temperature that was calculated and verified with table 1. [4]

Heat treatment	temperature	Cooling medium
Forging	850-1150	Dry sand
Normalized	880-920	Air
Annealing	660-720	Oven
Cementation	900-930	Oven / Water
Quench cemented layer	850-900	Water
Tempered cemented layer	180-240	Air

Table 1. Steel 1018

The gear used for the test has the dimensions shown in Fig. 2, With a center diameter of 5.04 cm, a primitive diameter of 7 cm and with a number of teeth of 41. These measures were taken to calculate the ramps and use it in the execution of the tempered. The heating time for the gears depends on the size and shape of the part.

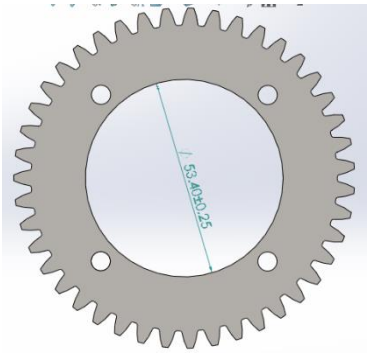

Figure 2 Gear dimensions

A furnace was used to carry out the tempering process. The gears were introduced into the furnace when the temperature increased to 850°C. Once this temperature was reached, the gears were left inside for 10 minutes so that the Steel could reach thermal equilibrium. In the fig. 3, the gear is shown in heating.

Figure 3 Gear heating

With the necessary safety equipment (tweezers, mask, gloves, dungarees and boots) the gears were removed after the mentioned time.

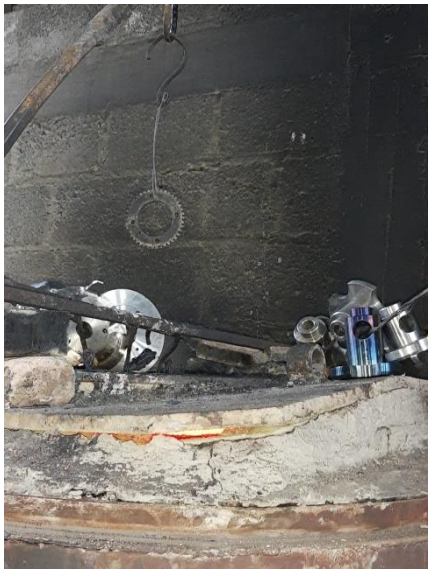

Figure 4 Gear Retreat

The cooling was done by putting the gears in clean water at a temperature required, these gears stirred in the cooling bath until its temperature decreases to about 100°C. As shown in fig. 5.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

Figure 5 Gear Cooling

HARDNESS TEST

For know the hardness of the gear was used a Vickers durometer whose unit of measure is HV (Vickers), the penetrator that was used was a diamond pyramid with angle of 136°, when applying the load, left a square footprint on the material of the piece, as shown in Fig. 6.

Figure 6: Load application.

The load that is used to press the penetrator against the piece varies between 1 and 120 Kp, mainly load values of 1, 2, 3, 5, 10, 20, 30, 50, 100 and 120 Kp are used. However, the load used was 30 Kp. As shown in fig. 7, the time of application of the load during the Vickers hardness measurement ranges from 10 to 30 seconds, 15 seconds being the most used time for the duration of the measurement.

Figure 7: Application of load for 15 seconds

Once the application of the load was removed, the diagonals of the square penetration that resulted on the surface of the piece were measured as shown in figure 8, calculating the average of the measurements obtained.

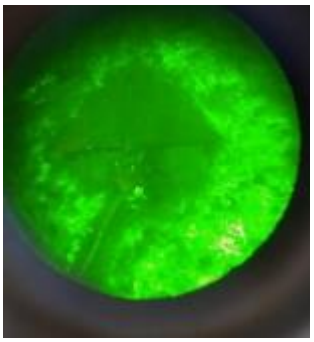

Figure 8: square penetration

The Vickers hardness (HV) was obtained by dividing the load P (Kp) applied by the surface of the footprint S (mm2) left on the part.

$$HV = P / S = 1{,}854 \cdot P / d2$$

Being:

- P the load applied in the test (Kp)
- S is the surface of the footprint (mm2)
- D is the average value of the diagonal of the print on the specimen (mm).

Once obtained the value of the Vickers hardness was observed in table 2, the equivalence in Rockwell hardness.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

Hardness table

682	-	65	885	91.0	232.9
652	-	63	820	87.2	221.5
627	-	61	765	84.8	213.5
600	-	59	633	76.5	188.7
578	-	59	717	81.5	204.0
555	120	57	675	78.5	195.1
534	119	54	598	73.5	181.3
514	119	52	567	71.0	174.9
495	117	51	540	68.5	166.0
477	117	49	515	66.7	162.2
461	116	48	494	65.0	157.0
444	115	46	472	63.0	150.6
429	115	45	454	61.0	145.6
415	114	44	437	59.0	140.0
401	113	42	420	57.2	136.0
388	112	41	404	65.8	132.0
375	112	40	389	54.0	127.5
363	110	39	375	52.2	123.4
	110	38	363	50.5	120.0
341	109	36	350	49.2	115.9
331	109	35	339	48.0	112.4
321	108	34	327	46.7	109.1
311	108	33	316	45.2	105.6
302	107	32	305	44.5	102.7
293	106	31	296	43.2	99.6
285	105	30	287	42.0	96.9
277	104	29	279	41.0	94.2
269	104	28	270	40.0	91.5
262	103	27	263	39.2	89.1
255	102	25	256	38.5	86.7
248	102	24	248	37.5	84.3
241	100	23	241	36.5	81.9
235	100	22	235	35.7	79.9
229	99	21	229	35.0	77.9
223	98	20	223	34.0	75.8

Table 2.

SOLIDWORKS SIMULATION

A drawing was made that will serve to represent the mechanical parts of the winch, shown in fig. 9 and 10, to make a simulation in finite analysis in SolidWorks, to make the drawing of the pieces were measured with a Vernier once having the measures were it was used the sheet metal tool, rounding, extruding and extruding cut.

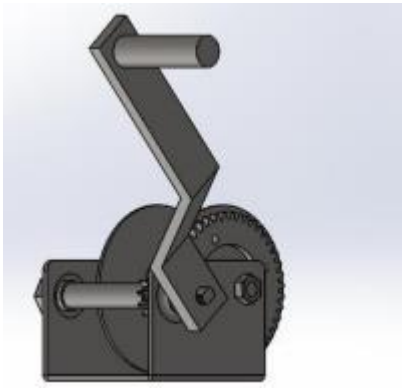

Figure 9. Winch in Solidworks

Figure 10. Gear in Solidworks

Once the pieces were drawn, we created the simulation by joining the gears, we added fixed geometry, fastenings, torsion, a mesh and a torsion force in order to have a finite analysis result, in one simulation the 1020 steel was used and in the other simulation the 1020 steel was used to visualize the resistance differences with the help of the colors code stress forces in each of the simulations. As shown in fig. 11 and 12.

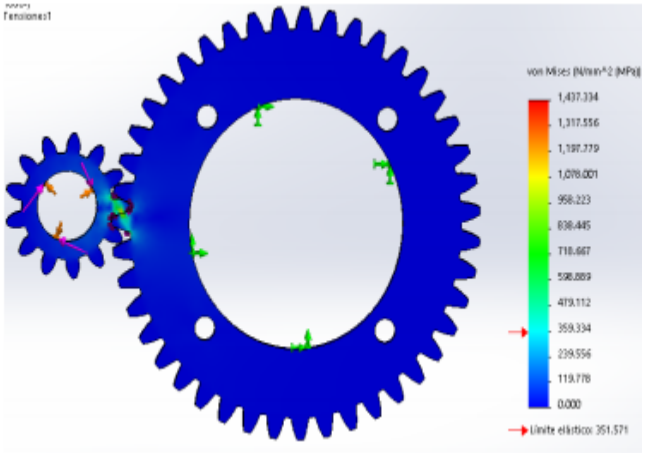

Figure 11. 1020 Steel Torque Simulation

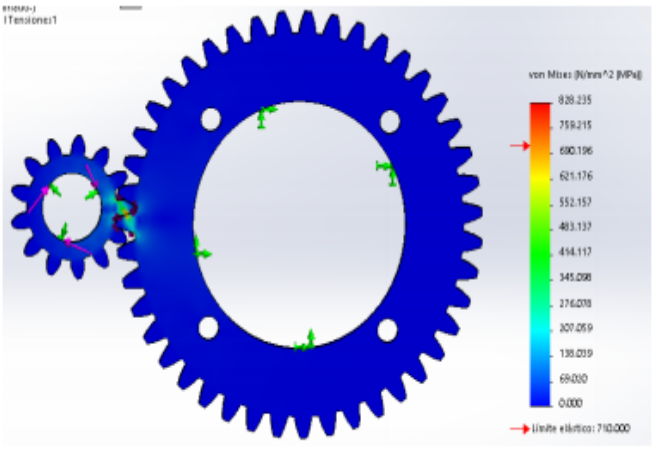

Figure 12. 1020 Steel Torsion Simulation annealing

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

RESULTS OBTAINED

The obtained values of hardness are the following:

	Experimental	Theory
Hardness Before tempering	-2HRC	-5HRC
Hardness After tempering	51,7HRC	50-60HRC

Table 3.

These values were obtained by performing the Vickers hardness test and converting them into rockwell hardness (HRC). As can be seen in table 3. The Tempered was successfully performed, increasing the gear hardness.

In the solidworks simulations in figure 11, a high torsional force scale is obtained while in figure 12. The scale of torsional force received by the gears is smaller, arguing that the resistance increases when the material is subjected to a thermal process, which in this case was tempered.

CONCLUSION

The heat treatments serve to improve the mechanical properties according to the application which is required, as reflected in the heat treatment performed on the piece, to be made successfully increases its hardness significantly and their functions. The simulation shows that there is less gear wear after heat treatment, the hardness test showed the increase in tolerance fatigue, concluding that it was a successful tempered.

AUTHORS AND AFFILIATIONS

José Luis Hernández Corona Candidate for a Doctor from the Autonomous University of Tlaxcala, Research Professor in the area of Industrial Maintenance, Desirable Profile before the PROMEP, responsible for the CA of Industrial Maintenance at the Technological University of Tlaxcala

Jonny Carmona Reyes graduated from the Technological Institute of Apizaco in 2010 with a bachelor´s degree in Electronic Engineering, specialty in automation and instrumentation. He worked as an electronic engineer in MIF company, developing electronic projects for the steel industry from 2010 to 2015. Since to 2013, he has been working as a teacher in the Technological University of Tlaxcala in the industrial maintenance career.

Moisés Sánchez Moredia earned a Bachelor of Arts in Applied Modern Languages, specialized in English as a second language teaching by Universidad Autónoma de Tlaxcala. He holds a Master´s Degree in School Administration and Management by Universidad Internacional de la Rioja (UNIR). From 2016 to 2018, He was the coordinator of the English area in Universidad Tecnologica de Tlaxcala where he currently teaches English in Industrial Maintenance Engineering.

Mauricio Morales Castañeda graduated from the Technological University of Tlaxcala in 2019 with a degree of Higher University Technician in Maintenance Industrial Area He completed his stay process at Tecnosuelo S.A C. V, is currently studying Industrial Maintenance Engineering at the Technological University of Tlaxcala.

Rogelio Perea Garcia graduated from the Technological University of Tlaxcala in 2019 with a degree of Higher University Technician in Maintenance Industrial Area He completed his stay process at Grúas Diaz Hnos. S.A C. V, is currently studying Industrial Maintenance Engineering at the Technological University of Tlaxcala.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

Luis Orlando Zempoalteca Lima graduated from the Technological University of Tlaxcala in 2019 with a degree of Higher University Technician in Maintenance Industrial Area He completed his stay process at SAGEMIC S.A.S, is currently studying Industrial Maintenance Engineering at the Technological University of Tlaxcala**.**

Cesar Vazquez Arenas graduated from the Technological University of Tlaxcala in 2017 with a degree of Higher University Technician in Maintenance Industrial Area he completed his stay process at REMSI, is currently studying Industrial Maintenance Engineering at the Technological University of Tlaxcala.

Edwin Vargas Flores graduated from the Technological University of Tlaxcala in 2019 with a degree of Higher University Technician in Maintenance Industrial Area He completed his stay process at SERVIMECI S.A, is currently studying Industrial Maintenance Engineering at the Technological University of Tlaxcala.

REFERENCES

[1] A. Guadalupe, “Tratamiento de acero”, 2014.
[2] G. Orozco “Pruebas del acero AISI-SAE 1018”, Ciencias de la ingeniería y mecánica, 2014.
[3] H. William, “Introducción a Solid Modelado”, Mc Graw Hill, 13 edición, 2017.
[4] I. Sacero “Propiedades mecánicas de acero 1018”, 2010
[5] J. Jiménez, “Introducción a Solidworks Simulation y análisis de elemento finito” DITLAG ingeniería y capacitación, 2018.
[6] R. Hermenegildo “Ensayo de dureza en los materiales”, Ingemecánica, 2018.
[7] W. F. Smith “Fundamentos de la ciencia e ingeniería de materiales” 3 edición, 1999.