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ANALYSIS OF ONE OF THE COMPONENTS OF A NEW ECOLOGICAL WATERING CAN DESIGN

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Abstract: The purpose of this work is to analyze one of the components of an ecological shower, which is very important because it reduces the passage of water flow by approximately 50% according to the conventional shower that has a cost of $10\frac{liters}{minute}$, in ecological and economic terms, this way gas consumption is reduced by up to 30%. The design of the proposed shower is based on the NOM-008-CNA-19988 standard (Hydraulic installation and operation). The stainless steel spring used is an important part of the work to regulate the flow of water. This device was obtained by a manufacturer that did not provide its mechanical characteristics, it was only known that it had to work at a pressure of $3\ \frac{kgf}{cm^2}2$, so a stainless steel was used (ASTM A313, which includes steels 302, 304 and 306) which are common for small springs that work in contact with fluids, have good resistance to oxidation in addition to withstanding stress under repeated loads. Therefore, it was necessary to carry out a characterization study using the metallographic technique, of which later, using the optical microscope and scanning electron microscope equipment, the type of microstructure present was observed, as well as the chemical composition of the sample in each one. of the aforementioned equipment respectively. This way, it was found that the material used for the spring belongs to an AISI 304 steel according to the chemical properties obtained from the study are within the range of the compositions according to the ASME standard.

Keywords: watering can, spring, metallography, optical microscope, electron microscope.

INTRODUCTION

In the design of the shower, different materials were used, but an essential part was the design and manufacture of the spring, this was ordered to be manufactured, but the exact characteristics were not provided, only that it belonged according to the ASTM A313 standard, in the where steels 302, 304 and 306 Bautista are found [1].

Austenitic 304 stainless steel is widely used in both the oil industries and the food industry since it has good resistance to corrosion, which is why its applications in industries are extensive. This type of steel is also used because other of its applications are subject to cyclic loading conditions and/or compression-decompression stresses, in this case, for the use of an ecological shower spring.

Life predictions with respect to fatigue and crack initiation sites are important aspects in both design and development. Fatigue failures are usually caused by the creation of micro cracks that are smaller than the grain size, followed by the stable propagation of a dominant macro crack and structural instability or complete fracture finally Jiawa[2].

Due to these types of problems, in engineering, grain boundaries are now emerging as a potential manufacturing route to design and optimize microstructure for critical applications including greater intergranular enhancement and good corrosion resistance, as well as greater Hanning fatigue resistance[3].

As done by I. Gurappa [4], who evaluated and compared the breakdown potential, corrosion rates, as well as resistance to pitting and/or crevice corrosion and the ability to form protective oxide scales in both titanium as in 316L stainless steel.

That is why when using the spring as a fundamental part of the ecological watering can it was decided to characterize it, since even though commercial Austenitic stainless steels type 304 and 316 have been widely investigated as a function of the applied tension, fatigue problems and factors environmental parameters such as pH from which it has been possible to obtain important parameters such as being able to predict the failure time of the material, as well as failure criteria due to cracks due to Rokuro corrosion processes [5].

For future work on characterization, new techniques can be used, such as those used by P. Asgari and collaborators [6], who introduced reflective digital holographic microscopy (rDHM). In which their experimental results show the ability of rDHM to analyze microstructural corrosion in AISI 304 stainless steel. This method presented as indicated by P. Asgari, can also be applied as a surface characterization method for the analysis of a variety of metallurgical effects such as elasticity and crystal orientation.

METHODOLOGY

For the case study in this research work, we worked with a stainless steel spring used in the manufacture of sustainable watering cans, in the first instance a fraction of it was taken which was used to carry out the characterization process using the metallographic technique and Additionally, through SEM, with these techniques there is greater certainty of knowing the type of material that is being studied as opposed to using only metallographic characterization, that is, observing and comparing the microstructures that are already established in books or magazines. scientific which would be difficult to interpret without having the proper experience.

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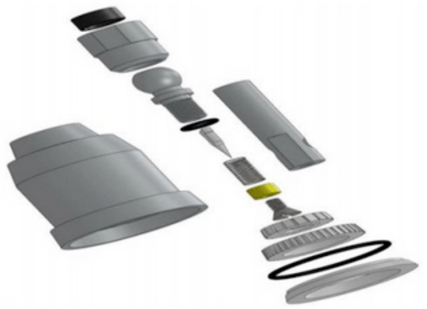


Figure 1. Explosion of elements from the entire shower.

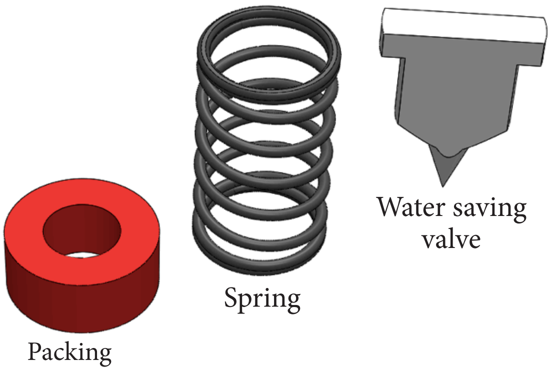


Figure 2. Main elements of the water saver.

DEVELOPMENT

The specimen obtained will be characterized, it was mounted in Bakelite, Figure 1, in order to carry out the metallography process which consisted of carrying out the roughing process using silicon carbide abrasive paper with the following types of grain, 80, 180, 220, 320, 400 and 600 respectively, for the roughing process the sample must slide, in this case on a manual rougher, repeatedly until uniform lines are generated, once this is done the sample must be rotated 90 degrees and generate new roughing lines until the previous ones disappear, and so on on each of the abrasive papers mentioned.

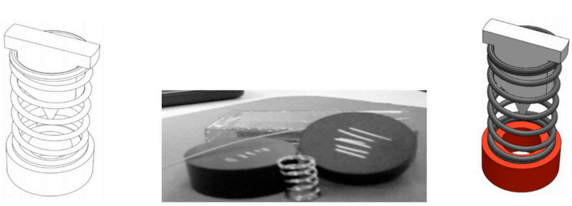


Figure 3. Spring specimen mounted in Bakelite

Figure 4. Spring dimensions.

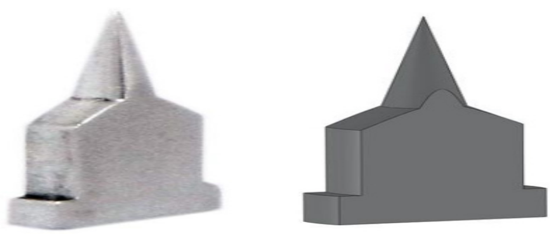


Figure 5. Water saving valve.

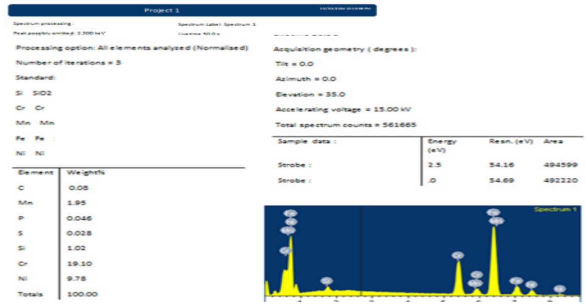
As support, an optical microscope, Figure 2, is used to verify that the specimens are free of surface defects and scratches. The sample is pressed against the cloth with some pressure, moving it in the opposite direction to the rotation of the disk. This ensures a more uniform and effective polishing action, resulting in a mirror-like, scratch-free surface, with an almost unpredictable distorted metal layer, which will facilitate optimal chemical attack and a clear view of the microstructural morphology of the sample.

Figure 2. Olympus-PMG3 metallographic optical microscope, adapted to a PIXELIN hardware camera

After mirror polishing the specimens, they will be cleaned by ultrasonic vibration, Figure 3, in a beaker with acetone inside the ultrasonic vibrator for 15 minutes, later in another beaker with isopropyl alcohol for 15 minutes. The handling of the test tubes is carried out with clean tweezers and nitrile gloves. The test tubes must be stored in airtight plastic containers with silica gel, taking care that there is no contamination from oils or cotton.

Figure 3. BRANSON-2210 ultrasonic cleaning equipment

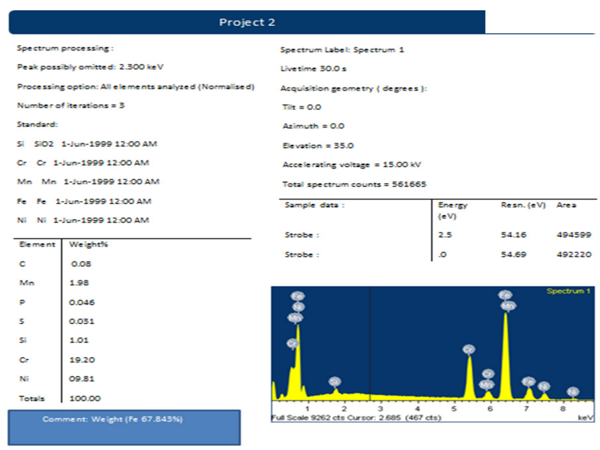
Chemical analysis by scanning electron microscopy was performed twice, yielding studies 1 and 2; where by comparison with the AISI standard it is proposed that it is an austenitic stainless steel type 304 or 316; It is also proposed that it is austenitic for the reason that it does not have magnetism when tested with a magnet, characteristic of austenitic steels.



Graph1. Results of the first chemical compositional analysis using the Scanning Electron Microscope (SEM).

Element	Weight
C	0.08
Mn	1.95
P	0.046
S	0.028
Si	1.02
Cr	19.10
Ni	9.78
total	**100.00**

Table 1. Elements and weights obtained by the first analysis scanning electron microscope



Graph2. Results of the second compositional chemical analysis using the Scanning Electron Microscope (SEM).

Element	Weight
C	0.08
Mn	1.98
P	0.046
S	0.031
Si	1.01
Cr	19.20
Ni	9.81
total	**100.00**

Table 2. The elements of the detected particles showing the presence of Pb, Ba and Sb obtained by (MEB) are shown.

CHEMICAL PROPERTIES				
	AISI 304	AISI 316	STUDY 1	STUDY 2
%C	0.08 mín	0.08 mín	0.08	0.08
%Mn	2.0	2.0	1.95	1.98
%Si	1.0	1.0	1.02	1.01
%Cr	18.0 – 20.0	16.0 – 18.0	19.1	19.2
%NI	8.0 – 10.5	10.0 – 14.0	9.78	9.81
%P	0.045	0.045	0.046	0.046
%S	0.03	0.03	0.028	0.031

Table 3. Comparison, ASME [7], between AISI 304 and AISI 316 with the results obtained by Compositional Analysis by SEM

RESULTS AND DISCUSSIONS

After having carried out the necessary metallographic and chemical tests, it was possible to determine the closeness between the AISI 304 and AISI 316 steels, this with respect to the chemical compositions found, so it can be determined that the type of steel to which the spring belongs is to AISI 304 because the results obtained in both studies are within the chemical composition range established by the ASME standard. Knowing the type of steel that is being used in the manufacture of ecological showers is of utmost importance because with this information the useful life could be determined through a simulation using finite element, as well as verifying that this material meets the in order to be exposed to the work load that the steel will have when it is in operation.

CONCLUCIONS

According to the chemical compositions of making 304 stainless steel they are essentially the same as 306 stainless steel, with a slightly higher amount of chromium (18% vs. 16%) and less carbon (0.08% vs. 0.12%), this influences In mechanical properties, in the case of 304 it has a higher elastic limit than grade 306. These are highly resistant to corrosion because they contain a high chromium content, but they have different levels of resistance depending on their environment, 304 is more resistant to the correction of salt water than 306, while this is resistant to corrosion to organic acids: such as vinegar, or citric acid.

The chemical compositions of 304 and 306 stainless steel are essentially the same, with minimal difference in chromium (18% vs. 16%) and carbon (0.08% vs. 0.12%) content. These variations affect the mechanical properties, giving 304 a higher yield strength than 306.

Both grades are highly resistant to corrosion due to their high chromium content. However, they differ in their resistance levels depending on the environment. 304 has greater resistance to corrosion by salt water than 306, while the latter better resists corrosion by organic acids such as vinegar or citric acid. In this handle, 304 stainless steel is used for the spring.

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