In a 21-2n deformed stainless steel influence of recovery temperature

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Abstract. We present the influence high heat treatment temperature of a nitrogen austenitic stainless steel, deform by cold compression, in 10 different percentages. The steel contains high chromium (19.25 %), nickel (1.5 %) and nitrogen (0.2 %). The typical applications for this alloy are automobile parts and special valves for his excellent mechanical properties and corrosion resistance. Produced by hot rolling, they were subjected homogenized treatment at 975 °C for 45 minutes. Subsequently, deformed, by cold compression. We get ten different deformations, from 3 % to 22 %. These samples then to a heat treatment at 750 °C for one, 2 and 4 hours respectively. To observe the microstructure all samples were metallographic study and measured also their Rockwell C hardness. The initial sample has an austenitic matrix with a small amount of precipitates with a 42 RC average hardness. The homogenized sample had a 39 RC hardness. The deformed samples increased their hardness with a maximum of 49 RC. The samples with the treatment, showed a lower hardness with longer time with high dispersion. The decreased of hardness is due to the elimination of residual stresses and precipitates increasing size.

1. Introduction
In the car, industry different and special metals are use in certain parts. The valves of combustion motors have to be heat, corrosion and wear resistance. In the search of better performance the austenitic stainless steel 21 - 2 N has been used for this application. However, not all the mechanical or thermal characteristics of these alloys are well known [1]. We are want to find the time and temperature dependence in which the alloy can work with the best properties. In previous works we were study other heat temperature treatment, a lower one 650 °C [2-4].

2. Experimental
Our austenitic stainless steel has a nominal composition: 0.50 % C, 8.0 % Mn, 0.25 % Si, 0.05 % P, 0.06 % S, and the main components: 20.50 % Cr, 1.50 % Ni, and 0.3% N. The steel was originally obtained by hot rolled in cylindrical bar form. Then with a solution treatment at 975 °C for 45 minutes and finally air - cooled. To test the recrystallization process we compressed samples from 3 % to 22 % in a 100 ton machine in 10 different deformation steeps. Then three samples from each deformation grade were heat - treating at 750 °C for one, 2, 3 and 4 hours respectively.

To observe the microstructure all samples were metallographic study, to reveal the internal structure we measured as a main characteristics their Rockwell C hardness. We had as much as 21 cylindrical samples, 13.5 mm diameter and 9 mm height.
3. Results
The initial sample has an austenitic matrix with a small amount of precipitates with a 42 RC average hardness as shown in figure 1.

![Figure 1. Hot rolling structure, 100 X, 42 Rc.](image)

In figure 1, we can see mainly austenitic phase, a small part of martensitic phase and carbides in and out of the grains. After the solution treatment at 975 °C for 45 minutes and finally air - cooled, the hardness is reduces just a little to 39 RC. The changes in the structure were only small also. However, the martensitic phase is not present.

The next step was the deformation in compression. We used a very hard materials as base or support for the compression because the hardness of the original material. We used a 100 ton Satec machine. We compressed samples from 3 % to 22 % in 10 steeps. The hardness increased with the deformation and the result is present in the figure 2. The best fit was a polyonomic curve. It is clear the carbide increased precipitation and small reorientations of the grains, as shown in figure 3.

![Figure 2. Hardness vs. deformation in compression.](image)
Figure 3. Compressed structure, 22 %, 100 X, 49 Rc.

Then two samples from each deformation grade were heat-treating at 750 °C for one, 2 and 3 and 4 hours respectively.

Figure 4. Hardness vs. deformation, as deformed and by one hour heat-treating.

In figure 4, we have the one-hour result and the as deformed hardness. We used a polynomial for the best fit of the curve. In figure 5 are the 2, 3 and 4 hour heat treatment. The best fit was a second grade polynomial. The r values were between 0.6 and the best was 0.9 for the 2 hours. Great data dispersion was observed.
4. Discussion

As in general, the hardness lows with the heat treatment time. More or less 5 points were measured between the intervals of 2 hours heat treatment. The origin of the dispersion data was to be related with the bars fabrication process. It was hot rolling and despite of the homogenized treatment it was impossible to obtain a very homogeneous grain size of the bars. It was greater corn at the outside than the inside of the bar. The means values had a big variation.

5. Conclusion

The austenitic stainless steel 21 - 2 N, normal automotive valve material steel shows the hardness increase with the deformation in compression and a decreasing behaviour by heat - treating. The first effect is more pronounce in the first process than the second one. That means a 10 HRC values for hour of heat treatment at almost every percent of deformation. The best fit was a polynomial approach.

6. References

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