Analysis Of Effect Of Mechanical Properties Of Aluminum Alloy Addition Of Zinc Corrosion Resistance Of Carbon Steel A325 Bolts Process Of Hot Dip Galvanizing

Ery Diniardi, Anwar Ilmar Ramadhan, Hasan Basri

Abstract: The world oil industry are common in offshore areas that are included in a corrosive environment, so that the low-carbon steel bolts A325 will gradually corroded. Therefore, an alternative that can be done to reduce the corrosion rate that is by coating with a Hot dip galvanizing method. The purpose of this study to improve the quality of products from low carbon steel bolts A325 with the addition of Zinc Aluminium alloy on the results of the Hot Dip Galvanizing. Results of testing the hardness of the lowest obtained in quenching time of 30 seconds is 162 037 HVN and the highest hardness obtained on quenching time of 60 seconds is 203 688 HVN. To microstructure shows that the phase Eta which is soft on the surface of the outermost started a little not as much time quenching 30 seconds so that the nature of its decline and violence increased, the phase Zeta that are hard are widely spread meet the layer of phase resulting in hardness of the coating while quenching 45 seconds exceed the hardness of quenching time of 30 seconds. Results of analysis of the rate of corrosion that galvanized coating on each test is different and the structure of ferrite and pearlite, it looks clear. For quenching time of 30 seconds obvious difference in galvanized layer thicker than quenching time of 45 and 60 seconds. This happens because of the influence of factors zinc layer that coats the base material, so that decreased levels of corrosion (%) is comparable to the time Salt Spray Test (SST) performed.

Index Terms: Bolts, A325 carbon steel, Hot Dip Galvanizing, mechanical properties, corrosion rate

1 INTRODUCTION

Steel products are often used for applications in the construction sector one of them is Hexbolt (bolt). Hexbolt in the field of construction is usually used as a connector pipes the oil and gas industry. In general, many industries are petroleum in the offshore area that is included in a corrosive environment so Hexbolt will gradually corroded. Therefore, an alternative that can be done to reduce the corrosion rate that is by coating with other metals that are resistant to corrosion which in this study using zinc metal that serves as upholstery bolts, which is where the properties of zinc is more anodic than the bolt itself [1-2]. Hot dip galvanizing is the steel coating process using a metal coating that has a melting point lower than the melting point of steel. The process of galvanizing steel used way immersion into molten zinc at a temperature of 450 - 460oC metallurgical bond that is formed between the molten zinc to the steel surface produces a coating of intermetallic alloy Fe – Zn [3-6]. In the galvanizing process, the addition of small amounts of aluminum in zinc is essential. Aluminium is used to polish the surface layer, arranged on the composition of 0.4% - 0:08%. If the aluminum content is less than 0.4% will cause the color of the material surface dull, it will even be red if no aluminum content [7-9].

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The addition of a small amount of aluminum in the zinc bath will produce a very thin layer and polish color display than the zinc bath without being given the content of aluminum. Aluminum is the inhibitor to slow the rate of reaction galvanizing, zinc coating so formed is very thin, have a resilient nature, as well as high adhesion properties [10]. In the process of bolts that have been made can be found frequently galvanized zinc coating uneven and too thick, it causes the nut hard to get into the bolt in the assembly process between the bolt with a nut. So that a thin layer of zinc which is needed in the application of the screws products [11]. This research was conducted to analyze the nature of the mechanical structure in low carbon steel bolts A325 towards corrosion resistance results from the addition of Zinc Aluminium alloy on the results of the Hot Dip Galvanizing, so that the optimum conditions will result in the production process of carbon steel bolts in the industrialized of the world.

2 RESEARCH METHOD

Methodology or approach taken is to use experimental methods, by first doing a preliminary analysis based on the literature used. Step-by-step methodology, as follows:

a. From the literature and the analysis was based on initial data from the study of corrosion rate and mechanical properties of low carbon steel bolts that have been done.
b. Make a test sample by adding a zinc aluminum alloy with the method of Hot Dip Galvanizing. For immersion times: 30, 45, 60 (seconds).
c. Testing the mechanical properties: hardness, corrosion rate and microstructure on low carbon steel bolts A325.
d. Analysis and discussion of test results (c) the addition of the zinc aluminum alloy.

3 Results and Discussion

Testing of chemical composition

The test aims to determine the composition of the levels (percentage) for each element of the formation of a metal both ferrous and non ferrous metals, the sample used in this test as shown in Figure 1.

Figure 1. *Sample testing results bolt A325 Hot Dip Galvanized*

Chemical composition testing is done in PT Bukit Baja Nusantara in Jababeka area 1 using the test sample as shown in Table 1.

Table 1. *Results of chemical composition testing*

Element	Chemical Composition (%)
Carbon (C)	0.45
Mangane (Mn)	0.72
Phosphor (P)	0.009
Sulfur (S)	0.008
Silicate (Si)	0.23

Properties of carbon steel depends on the carbon content therefore carbon steels are grouped according to their carbon content. Steel with a carbon content of less than 0.3% so-called low-carbon steel, steel with carbon content (0.3 - 0.7)%-called medium carbon steel, and steel with carbon content (0.7 – 0.15) % called high-carbon steel. The test results indicate that the composition of the material used in this study, including the classification of medium carbon steel, because it contains the elements carbon (0.3 - 0.7) %.

Hardness testing

Hardness testing is intended to determine and compare the three specimens bolt A325 with different quenching time - the difference between 30 seconds, 45 seconds and 60 seconds so that it can be seen the value of its hardness. Of the three specimens bolt A325 testing done eight points each specimen of the bolt. With a load of 50 Kgf, and the angle of 120^{o} diamond indentation, hardness values obtained for each specimen in Figure 2.

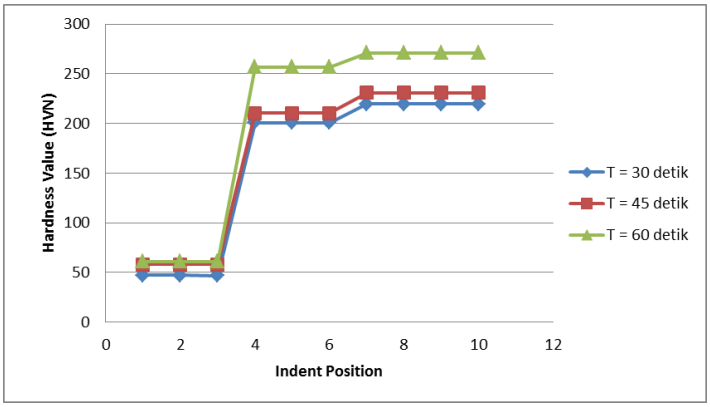

Figure 2. *Graph of the relationship between the hardness (HVN) to the position of the indentation hardness testing*

Figure 2 above shows the pattern of hardness (HVN) on the test results by using each time a different quenching have a similar value. For the time quenching 30 seconds on the position of the indentation beginning at point 1 to the position 10 increased gradually, then get the results of coating hardness average - average of 162 037 HVN, ditto for the time quenching 45 seconds results obtained coating hardness average - average of 172 845 HVN and the quenching time of 60 seconds is obtained coating hardness average - average of 203 688 HVN. Violence is the lowest obtained in quenching time of 30 seconds is 162 037 HVN and the highest hardness obtained on quenching time of 60 seconds is 203 688 HVN. The longer it can be concluded quenching the harder coating also produced, this is because more and more movement and diffusion of Zn atoms to form a coating layer on the surface of the work piece, so that the layers are stuck getting thicker. The thicker the layer results in more phases formed Zeta and Gamma, Zeta and Gamma phases known to have the properties that hard so that the thicker layer of the harder layer bolts.

Corrosion testing

Corrosion testing is intended to determine and compare the three specimens bolt A325 with different quenching time - the difference between 30 seconds, 45 seconds and 60 seconds so that it can be seen the value of its corrosion. The three bolts A325 of specimen testing done by means of spray chamber with a solution of NaCl. Values of corrosion on each specimen can be seen in Table 2 below:

Table 2. *Results of corrosion testing for 72 hours for quenching time 30, 45 and 60 seconds*

No	Quenching Time (Second)	Corrosion Rate (%)	Failed Rating Number Area
1	30	98	0
2	45	92	0
3	60	88	0

Furthermore, it can be seen images microstructure of the corrosion test results so visible difference from before and after corrosion testing for 72 hours, such Figure 3 - 5 as follows:

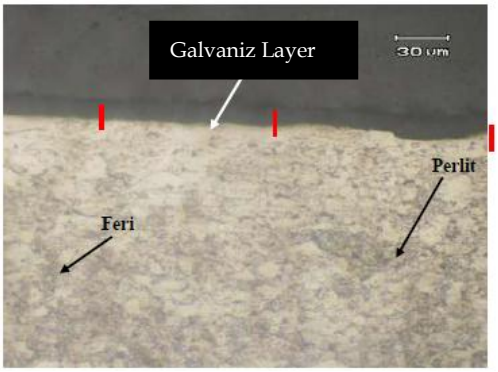

Figure 3. *Structure Micro corrosion test results for quenching time of 30 seconds for 72 hours*

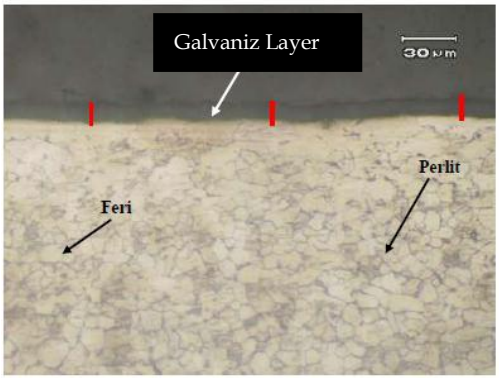

Figure 4. *Structure Micro corrosion test results for quenching time of 45 seconds for 72 hours*

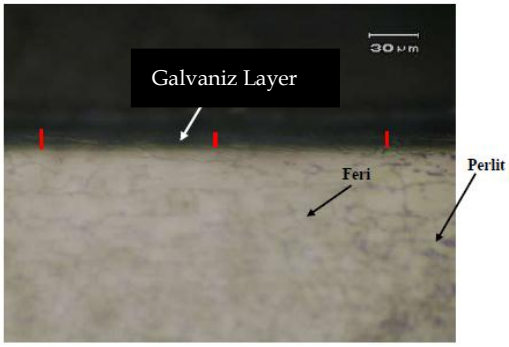

Figure 5. *Structure Micro corrosion test results for quenching time of 60 seconds for 72 hours*

Figure 3 -5 show that galvanized coating on each test is different and the structure of ferrite and pearlite, it looks clear. For quenching time of 30 seconds obvious difference in galvanized layer thicker than quenching time of 45 and 60 seconds. This happens because of the influence of factors zinc layer that coats the base material, so that decreased levels of corrosion (%) is comparable to the time Salt Spray Test (SST) performed.

4 CONCLUSION

The results provide the following conclusions:

1. Violence lowest quenching obtained at the time of 30 seconds is 162 037 HVN and the highest hardness obtained on quenching time of 60 seconds is 203 688 HVN. The longer it can be concluded quenching the harder coating also produced, this is because more and more movement and diffusion of Zn atoms to form a coating layer on the surface of the work piece, so that the layers are stuck getting thicker. The thicker the layer results in more phases formed Zeta and Gamma, Zeta and Gamma phases known to have the properties that hard so that the thicker layer of the harder layer bolts.
2. The results of the microstructure showed that Eta phase which is soft which is in the outermost surface of the start bit as much as quenching time of 30 seconds so that the nature of its decline and violence increased, Zeta phase which are hard are widely spread many meet-phase layer, resulting in violence layer quenching time of 45 seconds exceeded violence quenching time of 30 seconds. Violence galvanized coating produced an average of 172 845 HVN.
3. Analysis of the rate of corrosion that galvanized coating on each test is different and the structure of ferrite and pearlite, it looks clear. For quenching time of 30 seconds obvious difference in galvanized layer thicker than quenching time of 45 and 60 seconds. This happens because of the influence of factors zinc layer that coats the base material, so that decreased levels of corrosion (%) is comparable to the time Salt Spray Test (SST) performed.

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