ZINC ANODE ANALYSIS USED KRI WITH COMPOSITION AND POTENTIAL CORROSION PARAMETERS TEST

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ABSTRACT

Several types of zinc anodes have been produced with a variety of different compositions. The variations in the composition of the zinc anode provide different corrosion protection performance. In this study, tested the characteristics of several zinc anode products and their performance in steel corrosion protection. The tests carried out included the composition test using the dry method and the wet method on KRI Zinc, Pure Zinc, and Commercial Zinc. The standard used is the US Military Specification (MIL - A - 18001 - H) standard. In addition to composition testing, the potential difference of each zinc anode is also taken, to determine the potential value of each zinc anode for protection potential, and also for cathodic protection. From the results of the dry composition test, a value that is easy to evaluate is obtained. For testing with the wet method, the value that comes out still needs to be converted to weight percent units. Of the three Zinc, which does not meet the US Mlitary Specification (MIL - A - 18001 - H) standard, namely commercial zinc, because there is an impurity in the form of Fe whose value is greater than the allowable amount of 0.005% according to the US Mlitary Specification (MIL - A - 18001 - H), which can interfere with the performance of the Zinc Anode itself. For the results of the potential difference test, the three Zinc can be used as a sacrificial anode in cathodic protection because there are impurities in the form of Fe whose value is greater than the allowable amount of 0.005% according to the US Military Specification (MIL - A - 18001 - H) standard, which can interfere with the performance of the Zinc Anode itself. For the results of the potential difference test, the three Zinc can be used as a sacrificial anode in cathodic protection because there are impurities in the form of Fe whose value is greater than the allowable amount of 0.005% according to the US Military Specification (MIL - A - 18001 - H) standard, which can interfere with the performance of the Zinc Anode itself. For the results of the potential difference test, the three Zinc can be used as a sacrificial anode in cathodic protection.

Keywords: zinc anode, offering anode, protection potential.

1. INTRODUCTION

The Indonesian Navy as the guard of the Indonesian sea, very much depends on the readiness of a defense equipment, including the KRI, which is an underwater building that is exposed to very corrosive sea water conditions, where sea water corrosion is the biggest source of damage to the ship. Corrosion to the hull of the ship can result in a decrease in ship resistance, ship life time and reduce the safety and security of the ship crew. To avoid losses due to seawater corrosion, the ship hull plate needs regular corrosion protection to slow down the corrosion rate. To protect the hull plate against seawater corrosion, 2 (two) methods are used, namely passive protection (by painting) and active protection (by using the cathodic protection method). Cathodic protection can be carried out in two ways, namely by using the sacrificial anode and the pressure current (ICCP). Cathodic protection with sacrificial anodes occurs when a metal is connected to a more reactive metal (anode). This relationship leads to a galvanic circuit. In order to effectively remove corrosion from metal structures, the anode material must have a potential difference large enough to generate an electric current. The effective use of cathodic protection will provide good protection over the entire surface area of the material. The combination of coating and cathodic protection will provide a more economical and effective option to protect materials in soil and sea water environments. This final project focuses on testing the composition of the sacrificial anode made of zinc (Zn) metal according to US standards

2. THEORETICAL BASIC

2.1 Zinc and Characteristics

It is the 24th abundant element in the Earth's crust and has stable isotopes. The most abundant zinc ore in the mine is salerite (zinc sulfide), brass which is a mixture of copper and zinc alloys. It has been in use since at least the 10th century BC. The metal impure zinc began to be produced on a large scale in the 13th century in India, when the metal was still unknown to Europeans until the end of the 16th century. Alchemists burned zinc to produce what they called "white snow or philosopher's wool. ". The German chemist Andreas Sigismued Marrgraf is generally credited with discovering pure zinc metal in 1746. Luigi Galvani and Alessandro Volta's work successfully revealed the electrochemical properties of zinc in 1800 AD.

2.2 Zinc Alloy

a. Mixture of Zn with Cu

CuZn alloys with a Cu content of at least 55% are known as Brass. Brass is usually used for pipes that are corrosion resistant. The color of brass is influenced by the amount of Zn.

b. Mixture of Zn with Mg

The combination of Zn and Mg is commonly used in household appliances.

Mixture of Zn with Cu and Ni

c. This alloy is commonly referred to as silver. Its composition is Cu 60%, Zn 20%, Ni 20%. Examples of use in spoons, silver metal, and so on.

d. Mixture of Zn with Al

Zn and Al alloys are commonly used for steel protection, so that the steel is not exposed to corrosion, which is commonly referred to as Zn Anode.

2.3 Elements in Zinc

The alloying elements in Zinc Alloy are: Tin (Sn), Cadmium (Cd), Iron (Fe), Copper (Cu), Aluminum (Al), Lead (Pb), Magnesium (Mg)

2.4 Corrosion and protection

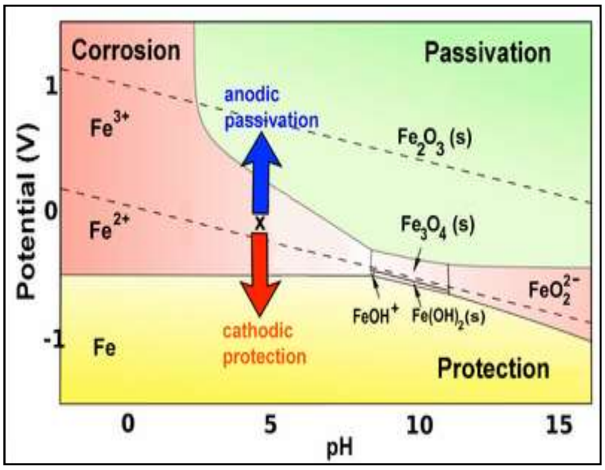
Corrosion is the degradation of metals due to interaction with their environment, because naturally the metal will return to a more stable thermodynamic condition as its compounds.

2.5 the Pourbaix diagram

If iron (Fe) immersed in an electrolyte solution undergoes four types of corrosion that may occur:

1. Formation of iron hydroxide (only H^+ plays a role).
2. Anodic reaction (only e^- plays a role).
3. Formation of iron hydroxide (H^+ and e^- which play a role).
4. Formation of carbonic acid (both H^+ and e^- have no role).

Reaction a, depending on pH. Reaction b, depending on the potential. The c reaction depends on both the pH and potential components, while the d reaction is independent of pH or potential. The four reactions above, if substituted with the Nernst equation, get a potential and pH relationship, which when a potential = f (pH) diagram is made is called the Pourbaix diagram.



3. DATA ANALYSIS

Dry Composition Test Results

Testing the chemical composition of the KRI, Pure and Commercial Zinc anode in the dry way using the Foundry Master Pro tool.

Table 4.1 The chemical composition of the dry method of the three types of Zinc Anode

Element	Zn Anode (% weight)			US(Mil-A-18001-H)
	Indonesian warship	Pure	Commercial	
Zn	99.8	99.9	99.6	Remainder
Al	0.1210	0.0045	0.102	0.10-0.50
Cd	0.0141	0.0001	0.0023	0.025-0.15
Cu	<0.0020	0.0026	0.0777	Max 0.005
Fe	<0.0020	<0.0020	0.0272	Max 0.005
Pb	0.0087	0.0111	0.0422	Max 0.006
Si	0.0007	0.0005	0.0008	Max 0.015
Mg	0.0033	0.0069	0.0175	
Sn	0.0077	0.0112	0.021	

From Table 4.1 the testing of the three samples, according to the US Military Specification (Mil - A - 18001 - H) standard, for KRI samples the elements can be obtained from the composition test, namely Zn of 99.8%, entering the remainder as the main element forming Zinc Anode metal, included in the US Military Specification standard (Mil - A - 18001 - H). Al element is 0.121%, included in the US Military Specification (Mil - A - 18001 - H) standard, which is between 0.10 - 0.50%. The Cd element of 0.0141% is not included in the US Military Specification (Mil - A - 18001 - H) standard, which is under the 0.025 - 0.15% range. The function of Cd in the zinc anode is to reduce the intergranular corrosion resistance of the steel, if the element of Cd exceeds the upper range, it will cause the intergranular corrosion resistance of the steel to decrease, if the Cd is below that range, then the intergranular corrosion resistance will decrease, which causes the zinc anode to run out quickly. Cu element is <0.0004%, this value is below the max 0.005%, which is included in the US Military Specification standard (Mil - A - 18001 - H). Fe element of <0.0020%, whose value is below the max. 0.005%, is included in the US Military Specification standard (Mil - A - 18001 - H). The Pb element has a value of 0.0087%, this value exceeds the max. 0.006%, with an excess of 0.0027% that does not enter the US Military Specification standard (Mil - A - 18001 - H). The function of Pb on the zinc anode if the value exceeds it will cause the formation of intergranular corrosion. The element of Si is 0.0007%, this value is below the Max.0.015%, entering the US Military Specification standard (Mil - A - 18001 - H). From these data, it can be concluded that Zinc KRI is still included in the standard U.

In pure zinc, the elements are obtained from the composition test, namely Zn of 99.9%, the remainder is the main element that forms Zinc Anode metal, which is included in the US Military Specification standard (Mil - A - 18001 - H).

Elemental Al of 0.0045%, is included in the US Military Specification (MIL - A - 18001 - H) standard, which is under the range 0.10 - 0.50%. The aluminum element itself in Zinc Anode affects the strength, ductility and hardness of Zinc anode. The Cd element of 0.0001% does not enter the US Military Specification (MIL - A - 18001 - H) standard, which is below the 0.025 - 0.15% range. The function of Cd in zinc anode is to reduce intergranular corrosion resistance in steel. If the element Cd exceeds the upper Range, it will cause the intergranular corrosion resistance of the steel to decrease, if the Cd is below that Range, then the intergranular corrosion resistance will decrease, which causes the zinc anode to run out quickly. Cu element is 0.0026%, this value is below the max 0.005%. included in the US Military Specification Standard (MIL - A - 18001 - H). Fe element of <0.0020%, whose value is below the max. 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). The value of Pb element is 0.0111%, this value exceeds the max. 0.006%, with an excess of 0.0051% that does not enter the US Military Specification Standard (MIL - A - 18001 - H). The function of Pb on the zinc anode if the value exceeds it will cause the formation of intergranular corrosion. Element Si is 0.0005%, this value is below Max.0.015%, entered into the US Military Specification Standard (MIL - A - 18001 - H). From these data, it can be concluded that Pure Zinc is still included in the U standard.

In commercial zinc, the elements are obtained from the composition test, namely Zn of 99.6%, the remainder is the main element that forms Zinc Anode metal, which is included in the US Military Specification standard (Mil - A - 18001 - H). Elemental Al of 0.102%, included in the US Military Specification Standard (MIL - A - 18001 - H), which is between 0.10 - 0.50%. The aluminum element itself in Zinc Anode affects the strength, ductility and hardness of Zinc anode. The Cd element of 0.0023% is not included in the US Military Specification Standard (MIL - A - 18001 - H), which is under the Range 0.025 - 0.15%. The function of Cd in zinc anode is to reduce intergranular corrosion resistance in steel. If the element Cd exceeds the upper Range, it will cause the intergranular corrosion resistance of the steel to decrease, if the Cd is below that Range, then the intergranular corrosion resistance will decrease, which causes the zinc anode to run out quickly. Cu element is 0.077%, the value is above the max 0.005%. not included in the US Military Specification Standard (MIL - A - 18001 - H). The Cu element in the zinc anode will show a white (ε phase) color. Fe element is 0.0272%, whose value is above the max. 0.005%, with an excess of 0.0222%. If the Fe value exceeds the maximum standard of the US Military Specification Standard (MIL - A - 18001 - H), it will damage the performance of the Zinc anode. The Pb element has a value of 0.0422%, this value exceeds the max. 0.006%, with an excess of 0.0362% that does not enter the US Military Specification Standard (MIL - A - 18001 - H). The function of Pb on the zinc anode if the value exceeds it will cause the formation of intergranular corrosion. Element Si is 0.0008%, This value is below the Max.0.015%, entering the US Military Specification Standard (MIL - A - 18001 - H). From these data, it is concluded that commercial zinc is not included in the standard US Mil Specification (Mil - A - 18001 - H), because its impurities such as Fe and Pb are too large, the excess values are 0.0222% and 0.0362% which will be causing disruption of the zinc anode performance.

Of the three Zinc Anode products tested with the dry method, the ones that enter the US Military Specification Standard (Mil - A - 18001 - H) are KRI Zinc and Pure Zinc, while Commercial Zinc is not included in the US Military Specification standard (Mil - A - 18001) - H).

4.1 Wet Composition Test Results

Testing the chemical composition of the wet model on KRI, Pure and Commercial Zinc anode using ICP (Inductively
Coupled Plasma) which is owned by the Chemical and Materials Main Laboratory (LABIKIMAT) TNI - AL.

Unsur	Uji I	Uji II	Uji III	Standart US (MIL-A-18001-H)
Ag	-0,000906	-0,001156uv	-0,000591uv	
Al	18,821	16,2314	16,3297	0,10 - 0,50
As	-0,099822uv	-0,144847uv	-0,058109uv	
B	-0,011413uv	-0,013238uv	-0,010863uv	
Ba	0,014464	0,014546	0,014443	
Bi	-0,000210uv	-0,013684uv	-0,007798uv	
Ca	0,114438	0,104833	0,070759	
Cd	0,359672	0,303717	0,311698	0,025 - 0,15
Co	0,004956uv	0,004122uv	0,004122	
Cr	-0,000032uv	-0,000896uv	-0,000350uv	
Cu	-0,000681uv	0,194595	-0,002763uv	Max 0,005
Fe	2,22188	0,195595	0,059802	Max 0,005
Ga	-0,024241uv	-0,027504uv	-0,024821uv	
In	uncal	uncal	uncal	
K	0,516495	0,349446	0,971916	
Li	0,01011	0,010648	0,011128	
Mg	0,050177	0,006153	0,006807	
Mn	0,004487	-0,000061uv	-0,000127uv	
Mo	-0,00544uv	-0,008179uv	0,000577uv	
Na	0,402363	0,144762	0,247501	
Ni	-0,05948uv	-0,065068uv	-0,061959uv	
Pb	-0,006778uv	-0,000875uv	-0,005649uv	Max 0,006
Se	uncal	uncal	uncal	
Sr	0,000719	0,000543	0,000531	
Ti	0,079993uv	0,096293	0,033003uv	
Zn	145,012	140,652	142,731	Remainder

Conversion of units from (mg / L) to percent (%) by weight

For example: for the test results above with the results of Fe in test I, namely 2.22188 mg / L, i.e. with a sample of 1 gram in 100 mL of water

1000 mg / 0.1 L = 10000mg / L

$$\frac{2{,}22188\ mg/L}{10.000 mg/L} \times 100\% = 0{,}0222188\%$$

Unsur	Zinc Murni	Zinc Komersial	Standart US (MIL-A-18001-H)
Ag	0,024116	0,002378	
Al	0,960495	8,96002	0,10 - 0,50
As	-0,132980uv	-0,114728uv	
B	-0,011936uv	-0,014585uv	
Ba	0,014573	0,014439	
Bi	0,000614uv	0,006979uv	
Ca	0,09715	0,09173	
Cd	0,020545	0,06535	0,025 - 0,07
Co	0,004384	0,003893	
Cr	-0,000776uv	0,02395	
Cu	-0,001860uv	0,592896	Max 0,005
Fe	0,161454	1,56379	Max 0,005
Ga	-0,019074uv	-0,018161uv	
In	uncal	uncal	
K	0,54522uv	0,558129	
Li	0,011595	0,01359	
Mg	0,038199	0,019548	
Mn	0,000203	0,007877	
Mo	-0,007502uv	-0,000042uv	
Na	1,1228	0,459948	
Ni	-0,063958	0,053083	
Pb	-0,007029uv	0,428611	Max 0,006
Se	uncal	uncal	
Sr	0,000703	0,000569	
Ti	0,053187	0,017195uv	
Zn	147,234	145,669	Remaider

From the test results of the three samples, according to the US Military Specification (Mil - A - 18001 - H) standard, for KRI samples the elements were obtained from the composition test, namely Zn of 1.4502%, entering the remainder as the main element that forms Zinc Anode metal, included in the US Military Specification standard (Mil - A - 18001 - H). Elemental Al of 0.163%, included in the US Military Specification Standard (MIL - A - 18001 - H), which is between 0.10 - 0.50%. The Cd element of 0.00311% is not included in the US Military Specification Standard (MIL - A - 18001 - H), which is below the 0.025 - 0.15% Range. The function of Cd in zinc anode is to reduce intergranular corrosion resistance in steel. If the element Cd exceeds the upper Range, it will cause the intergranular corrosion resistance of the steel to decrease, if the Cd is below that Range, then the intergranular corrosion resistance will decrease, which causes the zinc anode to run out quickly. Cu element is -0.0000276uv%, this value is below the max 0.005%, included in the US Military Specification Standard (MIL - A - 18001 - H). The element of Fe of 0.0005%, with a value of max. 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). The Pb element has a value of -0.000056uv%, this value is below the max. 0.006%, entered into the US Military Specification Standard (MIL - A - 18001 - H). From these data, it can be concluded that Zinc KRI is included in the US Military Specification (Mil - A - 18001 - H) standard. 0005%, with a max value of 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). The Pb element has a value of -0.000056uv%, this value is below the max. 0.006%, entered into the US Military Specification Standard (MIL - A - 18001 - H). From these data, it can be concluded that Zinc KRI is included in the US Military Specification (Mil - A - 18001 - H) standard. 0005%, with a max value of 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). The Pb element has a value of -0.000056uv%, this value is below the max. 0.006%, entered into the US Military Specification Standard (MIL - A - 18001 - H). From these data, it can be concluded that Zinc KRI is included in the US Military Specification (Mil - A - 18001 - H) standard.

In pure zinc, the elements are obtained from the composition test, namely Zn of 1.4723%, the remainder is the main element that forms Zinc Anode metal, which is included in the US Military Specification standard (Mil - A - 18001 - H). Al element is 0.0096%, not included in the US Military Specification Standard (MIL - A - 18001 - H), which is below the range 0.10 - 0.50%. The aluminum element itself in Zinc Anode affects the strength, ductility and hardness of Zinc anode. The Cd element of 0.0002% is not included in the US Military Specification Standard (MIL - A - 18001 - H), which is under the Range 0.025 - 0.15%. The function of Cd in zinc anode is to reduce intergranular corrosion resistance in steel. If the element Cd exceeds the upper Range, it will cause the intergranular corrosion resistance of the steel to decrease, if the Cd is below that Range, then the intergranular corrosion resistance will decrease, which causes the zinc anode to run out quickly. Cu element is -0.0000186uv%, this value is below the max 0.005%, included in the US Military Specification Standard (MIL - A - 18001 - H). Fe element of 0.0016%, whose value is below the max. 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). The Pb element has a value of -0.000070uv%, included in the US Military Specification Standard (MIL - A - 18001 - H), the value is below the max. 0.006%. From these data it can be concluded that Pure Zinc is included in the US Military Specification standard (Mil - A - 18001 - H), S Military Specification (MIL - A - 18001 - H). Fe element of 0.0016%, whose value is below the max. 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). The Pb element has a value of -0.000070uv%, included in the US Military Specification Standard (MIL - A - 18001 - H), the value is below the max. 0.006%. From these data it can be concluded that Pure Zinc is included in the US Military Specification standard (Mil - A - 18001 - H), S Military Specification (MIL - A - 18001 - H). Fe element of 0.0016%, whose value is below the max. 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). The Pb element is -0.000070uv%, included in the US Military Specification Standard (MIL - A - 18001 - H), the value is below the max. 0.006%. From these data it can be concluded that Pure Zinc is included in the US Military Specification standard (Mil - A - 18001 - H),

In commercial zinc, the elements are obtained from the composition test, namely Zn of 1.456%, entering the remainder, namely as the main element that forms Zinc Anode metal, which is included in the US Military Specification standard (Mil - A - 18001 - H). Al element is 0.0896%, not included in the US Military Specification Standard (MIL - A - 18001 - H), which is below 0.10 - 0.50%. The aluminum element itself in Zinc Anode affects the strength, ductility and hardness of Zinc anode. The Cd element of 0.00065% is not included in the US Military Specification Standard (MIL - A - 18001 - H), which is under the Range 0.025 - 0.15%. The function of Cd in zinc anode is to reduce intergranular corrosion resistance in steel. If the element Cd exceeds the upper Range, it will cause the intergranular corrosion resistance of the steel to decrease, if the Cd is below that Range, then the intergranular corrosion resistance will decrease, which causes the zinc anode to run out quickly. Cu element is 0.005%, this value fits within the max limit of 0.005%, is included in the US Military Specification Standard (MIL - A - 18001 - H). Fe element is 0.0156%, whose value is above the maximum, namely 0.005%, with an excess of 0.0106%. If the Fe value exceeds the maximum standard of the US Military Specification Standard (MIL - A - 18001 - H), it will damage the performance of the Zinc anode. The Pb element has a value of 0.00428%, this value is below the max. 0.006%, entered into the US Military Specification Standard (MIL - A - 18001 - H). From these data, it is concluded that commercial zinc is not included in the US Military Specification (Mil - A - 18001 - H) standard, because its impurities such as Fe, which have too large an excess value of 0,

Of the three Zinc Anode products tested using the wet method, the ones that enter the US Military Specification Standard (Mil - A - 18001 - H) are KRI Zinc and Pure Zinc, while Commercial Zinc is not included in the US Military Specification standard (Mil - A - 18001) - H).

From the composition test using either the wet method or the dry method there is not much difference in the composition results according to the US Military Specification standard (Mil - A - 18001 - H). Of the three samples tested, only commercial Zinc did not meet the US Military Specification (Mil - A - 18001 - H) standard, while KRI and Murni Zinc approached the US Military Specification standard (Mil - A - 18001 - H) with tolerance considerations due to not all zinc anode products meet the desired specifications.

The differences between the dry and wet method composition test, namely the dry method test results obtained values that can be directly compared to the specifications we want, while in the wet method testing, the results obtained are values that still have to be converted into mass quantities.

4.2 Testing Anova Test

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Zn	Between Groups	.136	2	.068	61.000	.000
	Within Groups	.007	6	.001		
	Total	.142	8			
Al	Between Groups	.024	2	.012	10579.900	.000
	Within Groups	.000	6	.000		
	Total	.024	8			
Cd	Between Groups	.000	2	.000	1627.000	.000
	Within Groups	.000	6	.000		
	Total	.000	8			
Cu	Between Groups	.012	2	.006	332.342	.000
	Within Groups	.000	6	.000		
	Total	.012	8			
Fe	Between Groups	.001	2	.001	3523.048	.000
	Within Groups	.000	6	.000		
	Total	.001	8			
Mg	Between Groups	.000	2	.000	49.069	.000
	Within Groups	.000	6	.000		
	Total	.000	8			
Mn	Between Groups	.000	2	.000	4.000	.079
	Within Groups	.000	6	.000		
	Total	.000	8			
Ni	Between Groups	.000	2	.000	.	.
	Within Groups	.000	6	.000		
	Total	.000	8			
Pb	Between Groups	.002	2	.001	55.834	.000
	Within Groups	.000	6	.000		
	Total	.002	8			
Sb	Between Groups	.000	2	.000	1.197	.365
	Within Groups	.001	6	.000		
	Total	.001	8			
Sn	Between Groups	.000	2	.000	5.019	.052
	Within Groups	.000	6	.000		
	Total	.000	8			
As	Between Groups	.000	2	.000	.000	1.000
	Within Groups	.000	6	.000		
	Total	.000	8			
Bi	Between Groups	.000	2	.000	25.147	.001
	Within Groups	.000	6	.000		
	Total	.000	8			
Ag	Between Groups	.000	2	.000	10.500	.011
	Within Groups	.000	6	.000		
	Total	.000	8			
In	Between Groups	.000	2	.000	.565	.596
	Within Groups	.000	6	.000		
	Total	.000	8			

Based on the table above, it is known that ANOVA produces a significance of <0.05. Thus H0 is rejected and Ha is accepted, and it is concluded that there are differences in the Dry and Wet Composition of Zn, Al, Cd, Cu, Fe, Mg, Pb, Bi, and Ag,

4.3 Testing the corrosion potential with artificial sea water with the Ag / AgCl comparison electrode

The results of the SACP (Sacrificial Anode Cahodic Protection) experiment:

N0	metal	potential(v)
1	Zn indonesian warship	-1.005
2	Zn pure	-0.977
3	Zn Commercial	-0.994
4	Fe steel	-0.463
5	Zn indonesian warship-Fe	-0.830
6	Zn pure-Fe	-0.870
7	Zn Commercial-Fe	-0.829

From the three results of testing the potential protection of zinc anode against steel, it was found that the three anodes were able to carry the steel to the protected area according to the criteria in the standard NORSOK M - 503 and on the pourbaix diagram for steel.

5. CONCLUSION

From the results of the analysis that has been done, the following conclusions are obtained:

a From the composition test using either the wet method or the dry method there is not much difference in the composition results according to the US Military Specification standard (Mil - A - 18001 - H). Of the three samples tested, only commercial Zinc did not meet the US Military Specification standards (Mil - A - 18001 - H), while KRI and Murni Zinc approached the US Military Specification standard (Mil - A - 18001 - H) with tolerance considerations because not all zinc anode products meet the desired specifications.

b. The results of the SACP experiment obtained from the potential of each metal, namely E° Zinc KRI of -1.005Volts, E Murni of Pure Zinc of -0.977Volts, E of Commercial Zinc of -0.994Volts,

E^o of -0.463Volts of E^o Fe. In addition, the cell potential between Zn KRI and Fe metals was -0.830 volts, cell potential between pure Zn metals and Fe was -0.870 volts, cell potential between commercial Zn metals and Fe was -0.829 volts. This proves that all three zinc anodes can be used as sacrificial anodes in cathodic protection, because these anodes are capable of carrying steel to protected areas according to the criteria in the standard NORSOK M - 503 as well as on the pourbaix diagram for steel.

c. The greater the difference in the potential value of the cell, the better the cathodic protection will be, but the faster the sacrificial anode will run out, in this case the Zinc anode.

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