Corrosion Behavior of Aluminum Zinc Alloy Coated Steel in Cassava Juice, Maize Pulp, and Seawater Solution.

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ABSTRACT

This study was carried out to investigate and evaluate the corrosion behavior of aluminum zinc alloy coated steel sheet in three different media (cassava juice, maize pulp, and seawater).The samples were prepared for the study by cutting into 5cm x 5cm squares. The soaking media were also prepared by extracting cassava juice from cassava tubers and maize pulp from maize grains. Seawater solution was obtained from Bar Beach (Atlantic Ocean).The weight loss of each sample for specific periods of immersion (72, 144, 216, 288, 360 and 432 hours) was determined on average of two samples exposed under the same conditions and test media in different containers.

The findings showed that cassava fluid had highest corrosion rate of the samples, followed by maize pulp, and seawater. Also, the pH of cassava fluid is more acidic, while that of maize pulp and seawater increased from acidity to neutral. Corrosion rates of samples in cassava fluid and maize pulp showed an increasing trend with time but later decreased, while that of seawater showed a decreasing trend.

(Keywords: aluminum, Al, zinc, Zn, steel, coating, corrosion resistance, cassava fluid, maize pulp, salinity, media)

INTRODUCTION

Aluminum is one of the most abundant elements in the Earth's crust, but, owing to its high affinity for oxygen, it cannot be reduced to the metallic state by reduction with carbon and carbon monoxide, as is the case with many metallic oxides (John, 1999). Aluminum may be alloyed with a number of elements to produce a series of useful engineering materials (Kameya, 1989).

The principal heat treatable alloys are those of the following systems: aluminum zinc (Al -Zn), aluminum cooper nickel (Al-Cu-Ni), aluminum magnesium silicon (Al-Mg-Si), aluminum zinc copper (Al-Zn-Cu), and aluminum lithium (Al-Li). Those various alloys types respond to age hardening or precipitation hardening treatments.
A 55% A1-2n alloy coated steel is comprised of 55% aluminum, 43.5% zinc, and 1.5% silicon. Although the corrosion performance is mostly related to the aluminum zinc alloy, the addition of approximation 1.5% silicon is vital. The primary purpose of the silicon is to control the growth of a brittle intermetallic layer that would otherwise form during manufacturing of the product (Townsend and Meitzner, 1983).

The effects of fluid squeeze from cassava tuber on the corrosive behavior of Al-Zn coated steel were investigated. The researchers equally carried out develop models to show that the correlation coefficient between the experimental values of corrosion rates and predicted values was high (Jekayinfa et al., 2005).

MATERIALS AND METHODS

Aluminum zinc alloy coated steel sheet samples (Al-Zn), cassava juice (undiluted cassava fluid), maize pulp, sea water, plastic containers, distilled water, paper tape, plastic bowls, pH meter, sensitive weighing balance, and a bench shearing machine were used in the conduct of this experiment.

Aluminum zinc coated steel sheet samples were sourced from Kolorkote Otta and had a thickness of 0.5mm.

The cassava fluid was sourced by grinding pealed cassava tubers and squeezing out the fluid using a clean white cloth sieve. Sea water solution was obtained from Bar Beach at Lagos State.

The plastic containers were first washed with detergent, rinsed in distilled water and were cleaned and allow to dry for hours.

Each of the measured samples was inserted into identified plastic containers, cassava juice was poured to cover the samples, maize fluid was poured to cover the sample, and saltwater solution was poured to cover the sample.

The sourced samples were cut into sizes 50mm by 50mm using a shearing machine, scriber, steel rule and Engineer's tri-square. The cut samples were made into forty-eight pieces of the same thickness.

The samples were weighed and recorded before and after immersion into the testing fluid using a sensitive weighing balance.

Each weighed sample was separated and fully immersed into plastic containers filled with testing media and then covered.

RESULTS AND DISCUSSION

The results obtained are contained in Tables 1 to 3. The weight loss per surface area of aluminum zinc alloy coated steel sheet in cassava juice with reference to time of immersion had an averagely increasing trend (Table 1).

Table 1: Average Corrosion Rates and Weight Loss/Surface area of Aluzinc in Cassava Juice.

Time (hrs)	Wd (g)	Area (m^2)	WL (g/m^2)	pH	CR (mm/yr)
72	0.0280	0.0025	11.1867±1.1547	3.5433±0.0058	0.1750±0.0181
144	0.0714	0.0025	22.7600±9.0084	3.6700±0.0173	0.2237±0.0224
216	0.1132	0.0025	45.2667±2.18	3.6967±0.0551	0.2362±0.0114
288	0.1407	0.0025	56.2800±1.3804	3.8500±0.00	0.2202±0.0054
360	0.1719	0.0025	68.7600±1.7004	3.8733±0.0058	0.2152±0.0054
432	0.1781	0.0025	71.2400±6.4800	3.7870±0.0234	0.1858±0.0169

Table 2: Average Results of Samples in Maize Pulp.

Time (hrs)	Wd (g)	Area (m^2)	WL (g/m^2)	pH	CR (mm/yr)
72	0.0030	0.0025	1.1733±0.9238	4.9800±1.2384	0.0184±0.01455
144	0.0010	0.0025	0.3200±0.06928	6.1500±0.0866	0.0025±0.00052
216	0.0015	0.0025	0.6000±0.000	6.4200±0.1559	0.0031±0.00
288	0.0035	0.0025	1.4000±0.08314	5.8900±1.2759	0.0055±0.00191
360	0.0044	0.0025	1.7600±0.6235	5.5900±1.2529	0.0055±0.00191
432	0.0034	0.0025	1.3500±0.1848	7.2200±0.1501	0.0035±0.00052

Table 3: Average Results of Samples in Seawater.

Time (hr)	Wd (g)	Area (m^2)	AWL (g/m^2)	pH	Cr (mm/yr)
72	0.0009	0.0025	0.3600±0.1600	6.7300±0.1562	0.0056±0.0025
144	0.00053	0.0025	0.2133±0.0231	6.9033±0.07506	0.0017±0.00017
216	0.00053	0.0025	0.2133±0.1405	7.0200±0.0265	0.0011±0.00754
288	0.00025	0.00025	0.0800±0.0400	7.2233±0.0751	0.0004±0.00015
360	0.0010	0.0025	0.4133±0.2411	6.7033±0.1674	0.0013±0.00075
432	0.00125	0.0025	0.6533±0.2663	7.0833±0.0153	0.0013±0.0012

Due to acidic nature of the cassava juice as shown by pH values recorded which causes dissolution of aluminum zinc alloy coated steel sheet in contact with it. The relationship is further shown in Figure 1.

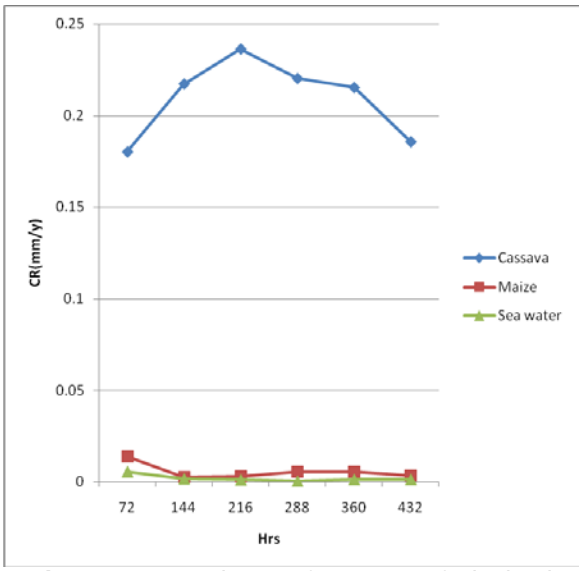

Figure1: Corrosion Performance of Aluzinc in Media.

Comparative study between pH values Al-Zn in cassava fluid, maize pulp, and seawater with reference to time of immersion. Comparatively, as shown in Figure 2, the pH values of Al-Zn in cassava fluid increased in acidity over a period of immersion. The pH values of Al-Zn in maize pulp and seawater reduced in acidity over a period of immersion. This implies that cassava fluid had highest impact on the tested samples than maize pulp and sea water over a period of immersion.

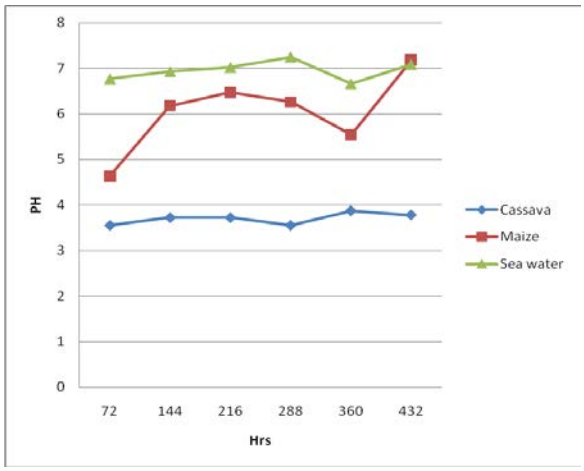

Figure 2: pH of Media against Immersion Time.

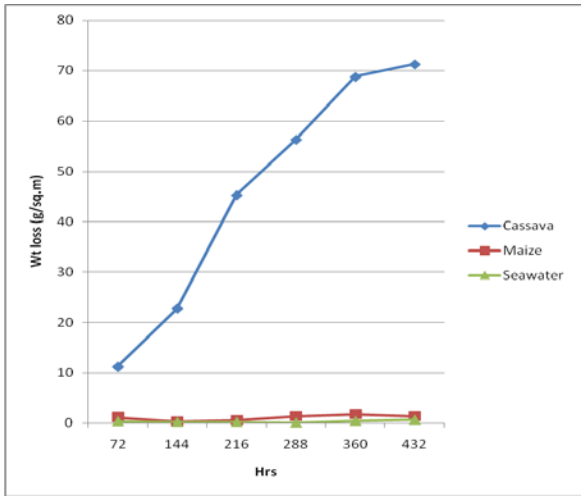

Figure 3: Weight Loss per Surface Area against Soaking Time.

Figures 4-6 showed the scanning electron microscope photographs of Aluzinc sample in cassava fluid, maize pulp, and seawater for twelve days.

The corrosion intensity (corrosion rates) of aluminum zinc alloy coated steel sheet with reference to time of immersion had an averagely increasing trend to certain level before it decreased (Table 1). This resulted from the fermentation process of cassava juice with time.

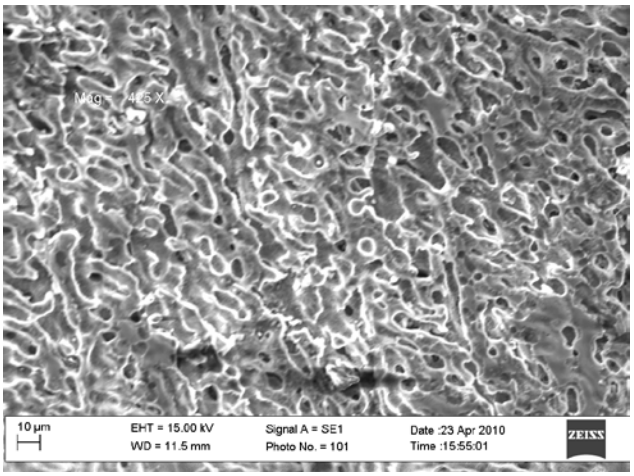

Figure 4: SEM for Aluzinc Soaked in Cassava Fluid for 12 days.

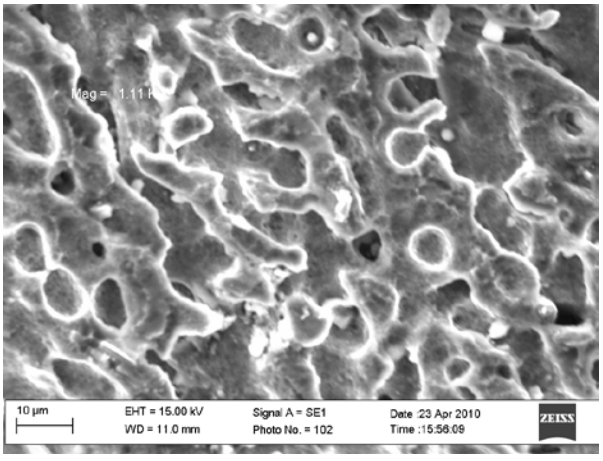

Figure 5: SEM for Aluzinc Soaked in Maize Pulp for 12 days.

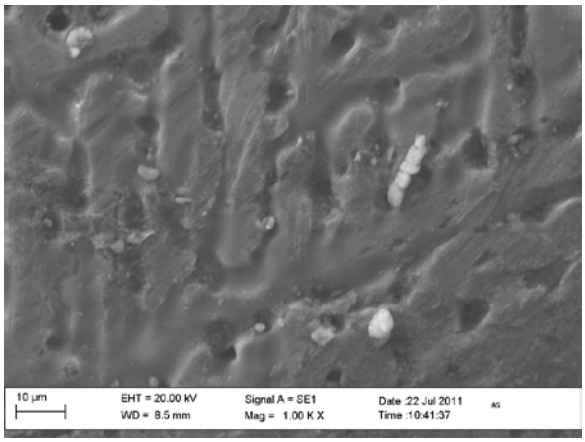

Figure 6: SEM for Aluzinc Soaked in Seawater for 12 days.

The weight loss per surface area of the samples in maize pulp with reference to time of immersion had an averagely increasing trend (Table 2). The pH of the maize pulp decreases from acidity to neutral over the time of immersion that implies that the maize pulp had less aggressive on the protective sample (Figure 2). The relationship between weight loss per surface area and time of immersion are shown (Figure 3)

CONCLUSION

From experiments carried out in this study and the results obtained, the followings can be concluded:

- The zinc aluminum coated steel sheets (Aluzinc) investigated showed higher corrosion rates when immersed in cassava juice compared with lower rates in maize pulp and seawater.
- The corrosion rates of Aluzinc in cassava fluid showed an initial increase up till 216 hours of immersion and decreased thereafter.
- The rates of corrosion of Aluzinc in maize pulp and seawater were very low proving its suitability in such environment.

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SUGGESTED CITATION

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