Corrosion behavior of A4032 in Citric acid and Nitric acid Medium

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Abstract - The corrosion behavior of aluminum alloy in Citric acid and nitric acid was studied. To investigate their role in the corrosion process, experimental approaches were used to investigate the corrosion behavior is a chemical method in which the dissolved metal concentration was measured after immersion of a sample in citric acid and nitric acid and there after the surface morphology is studied.

Key words: Citric acid,NH3Solution,A4032 alloy.

I. INTRODUCTION

The increase of the vehicles fleet year by year in the world has generated a direct relation with the environmental contamination by the greenhouse gas constant emissions. Furthermore, the variability in oil prices has shown a clear need for new opportunities of fuel generating based on renewable resources; currently, the implementation of biofuel is given in some countries with small plants producing of bioethanol of crude sugar origin, which has been established for a mixture of 10% bioethanol with gasoline from fossil origin. This scenario has motivated an incessant search of solutions to the energetic problem. The answers aim to the possible substitution of the petroleum fuels by cleaner fuel; such as the biofuels of vegetal or animal origin. [1-4]. In particular, acetic acid needs to be taken into corrosion consideration, due to its wide usage in food industry (vegetable and fish pickling), and its representative properties among acids and juices in fruits, vegetables and other organic materials that can corrode metals. Although aluminium has a good resistance to acetic acid solution at room temperature, aluminium can corrode in almost any concentration of acetic acid at any temperature if the acid is contaminated with the proper species [5]. corrosion is a naturally occurring phenomenon commonly defined as the deterioration of a material of construction or its properties due to a reaction with the environment [6]. Aluminium is widely used in a plenty of industrial applications such as constructions, electrical engineering, transport, and especially in food industry for the manufacture of processing, production, storage and transportation equipment and machinery. Despite the good properties of aluminium, aluminium and its alloys are not perfect materials for engineering applications in all environment, since they suffer from corrosion caused by chemical interactions with their surroundings. High corrosivity environment for aluminium in food industry are foodstuffs with pH 3 – 5, such as fruit juices, jams and acidic canned fruits or hot gravies, sauces as well as dressings, vegetables and fish pickled in brines with 1 –3 % salt [7]. Corrosion has been a major problem in food processing industries, where in the loss of production time for maintenance and equipment failure, there exists the additional risk of product contamination by corrosion products which may results in food poisoning. Corrosive effects are of remarkable consequence in the food processing industry as fruits contain corrosion aggressive substances, thereby causing significant impact on the degradation of constructional materials and the maintenance or replacement of products lost or contaminated as a result of corrosion reactions. The important material used in the manufacturing sector is mild steel. It is usually selected because of its strength, ductility and weldability [8-9]. Mild steel corrodes when exposed to air and the oxide formed on it is readily broken down, and in the presence of moisture, if it is not repaired [10-11]. The organic acids present in most foods are the most important corrosion agents. The effects of these chemicals can be influenced by the environmental conditions of processing such as temperature, flow rate, viscosity of the food media, and presence of stresses in the system [12]. Organic acid contains citric acid hence known as citrus fruit, citric is a mild acid with a pH of 3.5 of which when exposed to mild steel can form stress corrosion cracking on the

steel. The exact analysis of the constituents of food stuff is a challenge due to their very complex compositions. Citrus species are utilized in many industries for the production of various brands of citrus juices [13]. Ashassi-Sorkhabi et al, [14] and Jabeera et al, [15].Deepa and Padmalatha[16] reported , results of corrosion behavior of 6063 aluminium alloy in phosphoric acid medium and sodium hydroxide medium of different concentrations at different temperatures. Phosphoric acid medium is widely used for acid cleaning and elector polishing of aluminium Christian et al[17]. Even though dissolution rate of aluminium in phosphoric acid medium is lower, compared to the dissolution of the same in hydrochloric medium or sulphuric acid medium, it does corrode aluminium and its alloys

II. .EXPERIMENTATION PROCEDURE

The alloy used in the present study is A4032 alloy which has chemical composition in terms of weight percentage as listed in table 1.The Testing of composition for the Specimens Were carried out by using optical spectroscopy Technique.

Constituent	Al	Mg	Si	Fe	Cu	Zn	Mn	Cr
Wt.%	96.50	0.956	0.562	0.532	0.236	0.202	0.102	0.046

Table 1: Chemical composition of A4032

A4032 Sample of length 2 cm and 1 inch dia is fabricated by using the sand casting process.The specimens were sent to NDT testing for examining the blow holes. The Machining operation were performed to obtain clean surface finish.Later the polishing operations are carried out on the specimens by using Disc polishing machine by using Fluorine as etching agent.The polished specimens are immersed completely in citric acid solution and Nitric Acid,citric acid is obtained from lemon and nitric acid is prepared by mixing ammonia and water . Each of the weighed samples were then immersed in an Citric acid and Nitric acid with a measured pH of 10.00 & 9.2 for 30 days. The weight losses of the samples were measured at every 2 days intervals using the procedures and precautions described by Chen et al [18].

III. RESULTS AND DISCUSSION

The A4032 specimens are immersed in citric acid and Nitric acid solution and the weight is measurement is carried out for every 2 days .it was found that the specimens immersed in nitric acid has more loss of weight compared to specimens immersed in the citric acid solution fig 1 shows the graph for the specimens immersed in nitric acid.fig 2 shows the graph of the specimens which are immersed in citric acid solution.

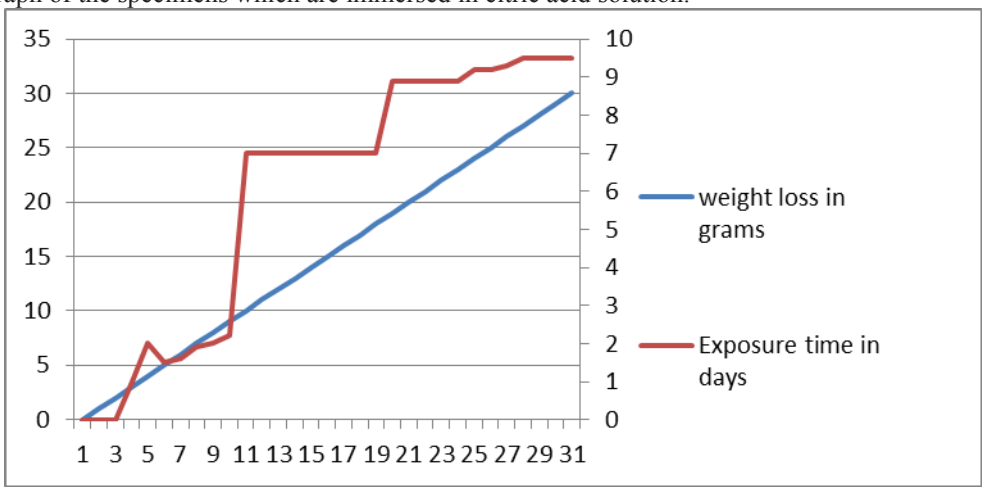


Fig. 1. Weight loss versus exposure time for the A4032 Nitric acid samples

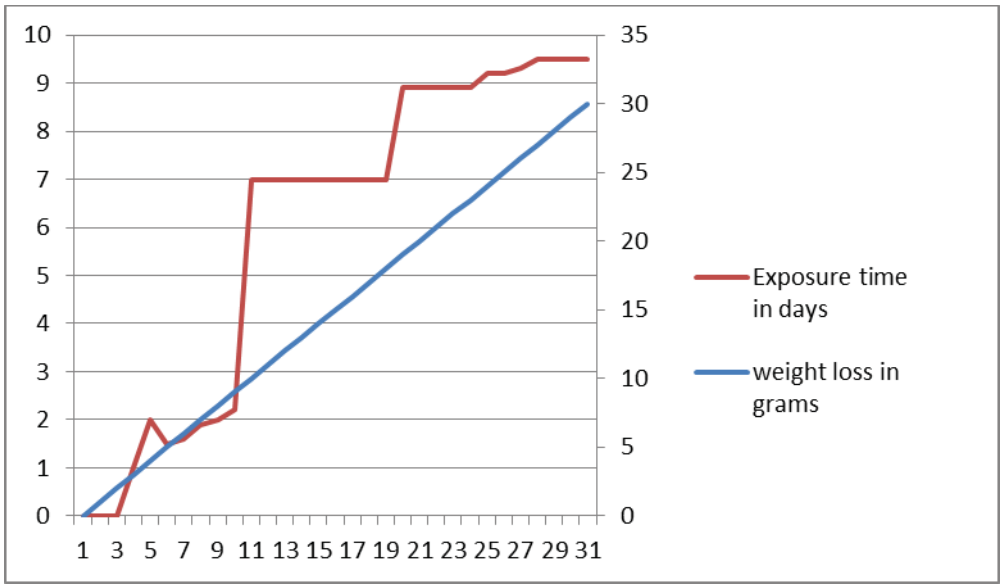
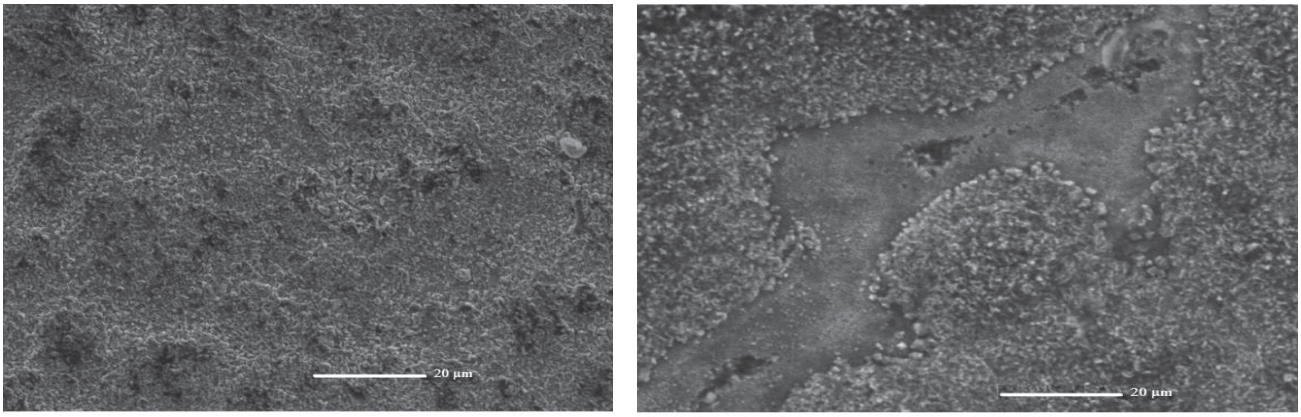


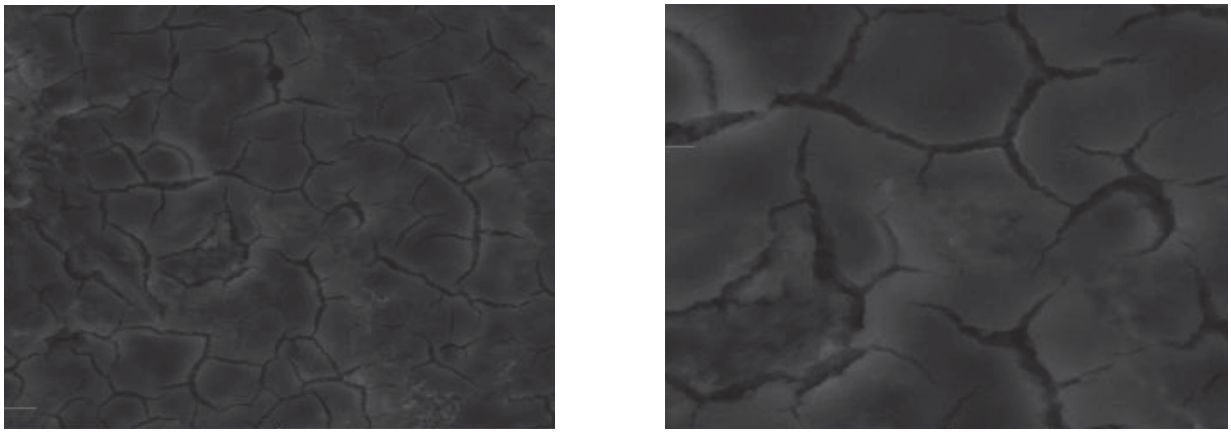
Fig. 2. Weight loss versus exposure time for the A4032 Citric acid samples

Microstructural analyses of a A4032 sample immersed in Citric acid and nitric acid medium were investigated in this study.



(a) **(b)**

Fig 3: SEM micrograph for aluminum samples (A4032). a) Specimens immersed in Citric acid b)Specimens immersed in Nitric acid solution.



(a) **(b)**

Fig 4: SEM micrograph for aluminum samples (A4032). a) Specimens immersed in Citric acid b)Specimens immersed in Nitric acid solution.

The above figure shows the microstructure images of corroded specimen which were carried out by using scanning electron microscope. From the above images we can conclude that the specimens which are immersed is Nitric acid solution are more corroded than the specimens immersed in the citric acid solution. The weight of the Specimens which are dipped in the Nitric acid solution is found to be having more amount of loss of weight compared to specimen immersed in the specimen citric acid. Micro pores are formed on the specimens which are immersed in the Nitric acid solution.

IV. CONCLUSIONS

- 4032 aluminium alloy undergoes corrosion both in Nitric acid medium and in Citric acid medium.
- The corrosion rate increases with an increase in the concentration of Nitric acid medium as well as Citric acid medium.
- The corrosion rate increases with an increase in number of days.
- The corrosion of 4032 aluminium alloy is more severe in Nitric acid medium than in Citric acid medium.
- The results obtained showed that materials in form of transgranular and intergranular in shape .i.e specimens which are immersed in citric acid showed microstructure in transgranular in shape similarly the specimens immersed in Nitric acid showed intergranular structure

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