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EFFECT OF MUNICIPAL LIQUID WASTE ON CORROSION SUSCEPTIBILITY OF GALVANIZED STEEL PIPE

Kogo, A. A.
Department of Integrated Science, Federal College of Education, Kano, Nigeria.
E-mail: kogofceng@yahoo.com

ABSTRACT
This investigation studied the effect of municipal liquid waste discharged into the environment within Kano municipal area on the corrosion susceptibility of galvanized steel pipe burial underground. Six stagnant and six moving municipal liquid waste samples were used for the investigation. The corrosion rate of the galvanized steel pipe was measured using the gravimetric technique. The results obtained from weight loss measurement shows a serious corrosion effect of municipal liquid waste on the galvanized steel pipe. The overall corrosion rates are much higher in the stagnant and moving liquid waste samples collected within the core city than the liquid waste samples collected outside the city, but become low with the formation of passive films on galvanized steel surface after 2500 hours. Therefore, this investigation revealed that the galvanized steel pipes used to supply the city with pipe borne water are at high risk of supplying contaminated water due to some leaking pipes.

Key words: Liquid waste, galvanized steel, weight loss, gravimetric, corrosion, leaking

INTRODUCTION

Corrosion is the process of gradual deterioration of a metallic material from its surface due to the unwanted chemical or electrochemical interaction of metal with its environment. Metallic corrosion by electrochemical process requires the simultaneous occurrence of both oxidation, and reduction processes. For metallic corrosion to occur, it requires a system or environment where the electron is librated during the metal oxidation process and accepted by other process or system (Kenneth and Michael, 2002). Corrosion of metals is a major industrial and domestic problem that has attracted many investigators (Atia *et al,* 2003). Iron and its alloys are widely used in many applications, which have resulted in researches into the corrosion effect and resistance into various aggressive environments (Yawas, 2006). The environmental condition that causes corrosion, especially in tropical region, falls into two broad categories: complete immersion in seawater or exposure to an environment charged with salts particles or solutions, both categories are subjected to many variables and pollutants (Kareem, 2006). Also the corrosion behaviour of galvanized steel in industrial effluents discharged into the environment, was found to corrode the galvanized steel with long time of exposure and later decreased with the formation of passive films on the surface of the galvanized steel (Kogo, 2005). The aim of this investigation is to assess the corrosion susceptibility of galvanized steel pipe subjected to total immersion into municipal liquid waste and to predict the lifetime expectancy based on the type of the galvanized steel pipe used to supply the municipal city with the pipe borne water.

MATERIALS AND METHODS

Materials

Galvanized steel pipe of commercial grade was mechanically pressed and cut into 40 x 40mm coupons for continuous immersion tests. The entire tests coupons were degreased in tri-chloro-ethylene, ultrasonically cleaned in alcohol, hot dried, and stored in a dessicator until required for use in the investigation. The immersion test coupons were weighed to an accuracy of 0.1mg (NACE, 1984).

Experimental Procedure

The coupons were totally immersed into twelve 50cm^3 beakers of untreated municipal liquid waste samples (six stagnant and six moving liquid waste) collected within Kano metropolis. The coupons were inclined to the side of the test tubes, so that each side would be equally affected. At specified time intervals, the coupons were withdrawn from the test environment, and the corrosion products removed under running water by a bristle brush. Any adherent corrosion products were removed by boiling in saturated ammonium acetate for 30 minutes. Finally, the coupons were washed in alcohol, dried, and reweighed to an accuracy of 0.1mg (Davis *et al.,* 1987). The corrosion rate was calculated from weight loss measurements using the relationship recommended in ASTM G31 (1987).

$$\text{Corrosion rate (mm/yr)} = \frac{87.6W}{DAT}$$

Where W is the weight loss in grammes, D is the density of the metal in kg/cm^3, A is the total surface area in cm^3 and T is the exposure time in hours.

RESULTS AND DISCUSION

The corrosion rate of the galvanized steel pipe in all the twelve municipal liquid waste environments was found to increase after 500 hours of immersion and attaining a maximum values at 2000 hours.

Figures 1 and 2 shows the corrosion rate of galvanized steel versus exposure time, immersed into three stagnant liquid waste samples collected from the core municipal city (SLW1, SLW2, and SLW3) and three stagnant liquid waste samples collected outside the city (SLW4,SLW5, and SLW6) . The corrosion rate in all the samples increases with increase in the exposure time, but the samples collected within the core city showing the highest corrosion rates. With increased exposure time, a layer of protective corrosion products was formed on the galvanized steel surface and this stifled further corrosion attack after 2500 hours of exposure. This observation can be associated to residual inhibiting ions (e.g. chloride) that may be present (Ebenso, 1978; Loto and Mohammed, 2000; and Yawas *et al,* 2005).

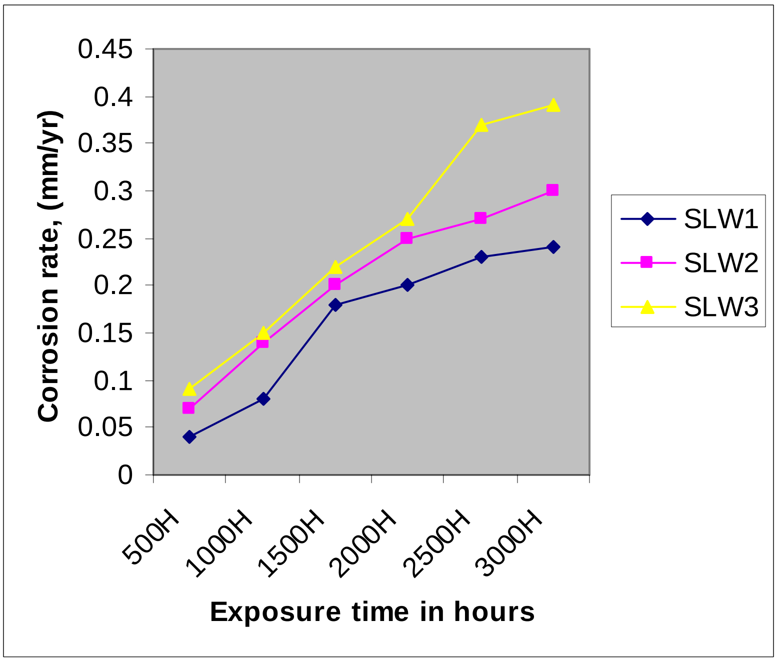

Figure 1: Corrosion rate of galvanized steel against exposure time in stagnant liquid waste samples collected within the core city.

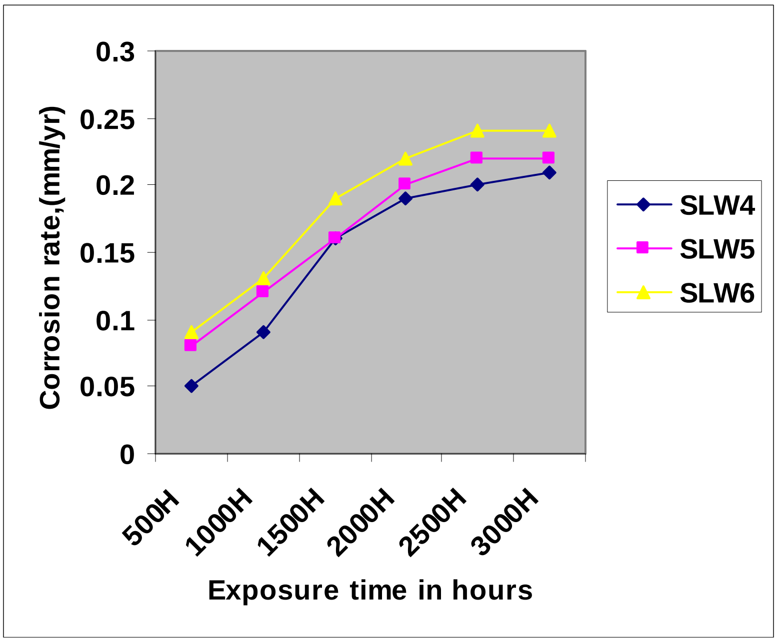

Figure 2: Corrosion rate of galvanized steel against exposure time in stagnant liquid waste samples collected outside the core city.

The corrosion rate of galvanized steel in the six moving municipal liquid waste samples, three collected within the core city (MLW1, MLW2 and MLW3) and three outside the city (MLW4, MLW5, and MLW6), were shown in Figures 3 and 4. The corrosion rates in all the moving liquid wastes increased with the increase time of exposure, with samples collected within the core city also showing the highest corrosion rate. Also after 2500 hours of exposure, the corrosion rate stabilized, as was observed in the stagnant liquid waste samples (Kogo, 2005).

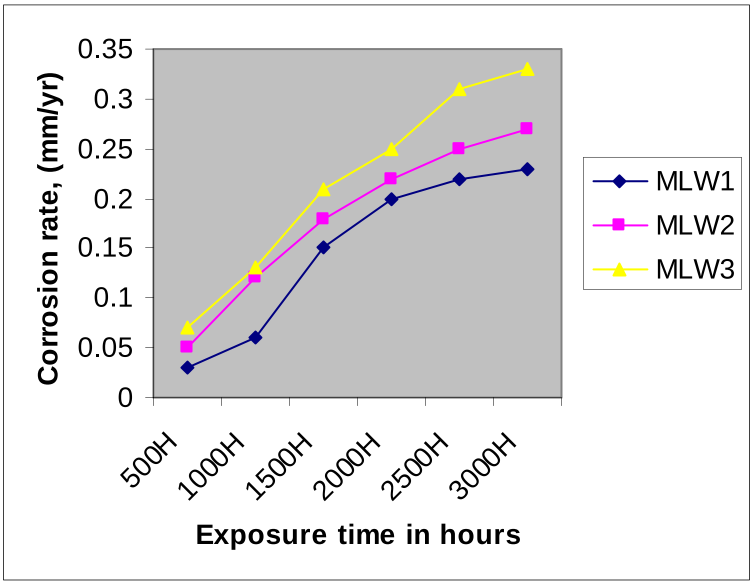

Figure 3: Corrosion rate of galvanized steel against exposure time in moving liquid waste samples collected within the core city.

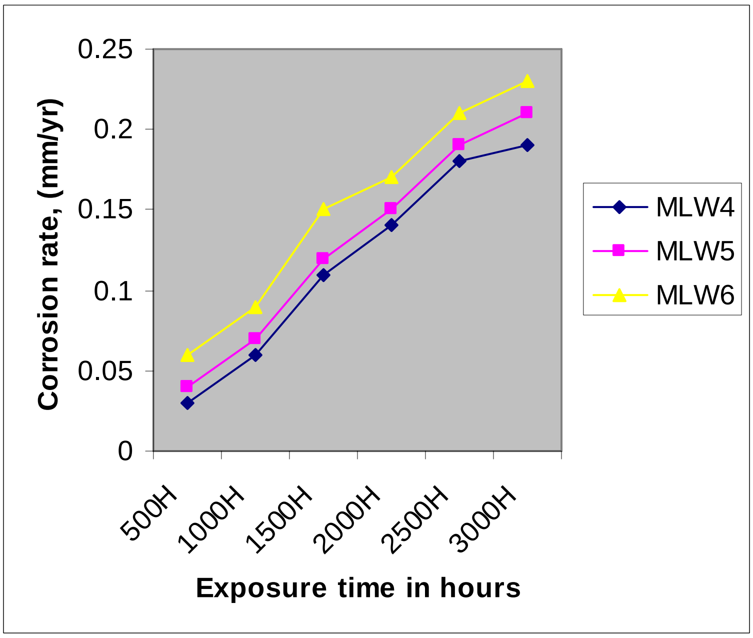

Figure 4: Corrosion rate of galvanized steel against exposure time in moving liquid waste samples collected outside the core city.

CONCLUSION

From the results of the investigation carried out the following deductions can be inferred:

1. The rate of corrosion of galvanized steel in municipal liquid wastes increases with increase time of exposure and after 2500 hours it starts to reduced, with the formation of adherent passive films on the galvanized steel surface. Therefore, their is need to predict the lifetime expectancy of each steel pipe supplying water to the city, because not all the pipe have the same standard.

2. The present of some inhibiting ions, (e.g. chloride) stabilized the corrosion rate of galvanized steel corrosion to a certain level.
3. Galvanized steel pipe used in supplying the municipal city with pipe borne water should always be checked to avoid supplying contaminated water to the municipal city.

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