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Comparison of Corrosion Rate in an Environment of 10% Acid Solution with Different Deflection

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Abstract. That corrosion that occurs initially is pitting corrosion, so because pitting corrosion has occurred so that there is stress corrosion cracking. And the stress corrosion cracking event occurs due to the presence of sweet gas (for example H_2S and CO_2) in the pipelines, and if the stress corrosion cracking occurs it will be fatal, causing the pipe to break so that production will stop. And the corrosion test sample is API 5L-X65 carbon steel which is in the environment of 10% acid solution, then CO2 and H2S gas are injected with different deflection variations using the three-point loading method. Based on the figure (2.a) and figure (2.b) that the corrosion rate will increase with increasing exposure time, and the greater the stress that is given the corrosion rate increases according to the image (3.a) and image (3.b) then based on results of microstructural tests using optical microscopes, pitting corrosion occurs, and corrosion events occur are the stress corrosion cracking transgranular and intergranular based on figure 5.
Keywords: stress corrosion cracking , sweet gas, specimen three-point loading.

1. Introduction.

The research aims in this paper is to analyze the corrosion event of carbon steel pipe in laboratory scale on acid environment with the existence of sweet gas H_2O and CO_2 by using three points loading method. This research uses carbon steel pipe API 5L-X65 which stay in condensation environment of 7700 ml aquades, 250 ml acetic acid and 50 ml ammonia, then filled sweet gas CO_2 and H_2S in saturated state. Based on the test results of microstructure and microscope polarized, there is a phenomenon corrosion stress cracking, i.e transgranular stress cracking corrosion and intergranular stress cracking corrosion.[1]

From the results of the study that the samples with different deflections in the variation of exposure time, the corrosion rate is getting smaller because the corrosion material is not soluble in the solution so it inhibits the corrosion process as in table 1, table 2 and based on the figure 4 for deflection 1 cm or deflection 1.5 cm. And based on the microstructure result that the carbon steel pipe sample of API 5L-X65 occurs stress corrosion cracking either transgranular corrosion or intergranular corrosion as in figure 5[2].

The corrosion rate on the 5L-X65 API carbon steel pipe with the three poin loading method on acetic acid solution filled with CO_2 gas and H_2S in saturated state[13]. Analysis stress Corrosion Cracking on carbon steel pipe API 5L-X65 in Solution 7900 ml of Sea Water and 100 ml of Ammonia filled with CO_2 and H_2S Gases in Saturated Condition.[7].

The research process of the API 5L-X65 test sample as shown, and the test sample is in the holder using the three-point loading method as shown then stored in the corrosion test chamber.[2] Based on the results of the research data that the corrosion rate (mmpy) against the variation of deflection (cm) as in table 2, table 3 and based on figure 4, figure 5 both samples in acidic conditions or alkaline conditions that the corrosion rate (mmpy) will be greater when deflection (cm) given the greater. And based on the microstructure test results as shown in Figure 6, Figure 7 is good in the environment of acid conditions or alkaline conditions corrosion occurs transgranuar stress cracks and intergranular stress corrosion cracking.[3]

With the research using the three point loading method is the environment of CO_2 gas and saturated H_2S gas in a solution of 7900 ml of sea water and 100 ml ammonia, the corrosion phenomenon occurs. And the corrosion event that occurs, is stress corrosion cracking transgranular and intergranular based the results of microstructure test results and based the results of polarized microscopy test. The corrosion rate that occurs will increase with the deflection given to the larger test samples for the same exposure time, the corrosion rate that occurs will increase with the stress σ given to the test sample getting larger for the same exposure time and inside crack will get deeper with the deflection given to the test sample getting larger for thesame exposure time.[4]

Based on the results of the study data that the corrosion rate (mmpy) to the variation of deflection (cm) as in table 2, and based on figure 4 of the test sample in an acid environment that the corrosion rate will be greater as the exposure time is longer for the same deflection. And for the test sample in base solution as in table 3 and Figure 5, the corrosion rate will decrease over time exposures to the same deflection because of the presence of salt attached to the test sample. And based on the microstructure test results as shown in figure 6, figure 7 is good in the environment of acid conditions or base conditions occurs is stress corrosion cracking transgranuar and stress corrosion cracking intergranular.[5]

The population of the corrosion test samples of each time variation consisted of two test samples with 2 deflection variations, and either the weight of the test sample before the corrosion test and the sample weight after corrosion testing were weighed.[8]

2. Experimental Section

2.1.Tools and Materials

And the testing tool used is a tool for smoothing corrosion test samples, and optical microscopes. The materials used in this research is the glass, Plate of carbon steel API 5L-X65, acetic acid glacial (CH_3COOH), Iron(II) sulfide stick and aquadest.

Procedure.

And the corrosion test research procedures with API 5L-X65 carbon steel samples in the holder are in a chamber containing 10% acid solution, then injected with CO2 gas and H2S gas in saturated conditions as stated in the journal.[2]

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That the carbon steel corrosion test sample API 5L-X65 is given a different stress load for each time of exposure. Before being put into the chamber that the test sample is weighed first, then after in accordance with the specified exposure time the sample is re-weighed.

The specimen holder in both ends of the specimen is bent / pressed with the screw (fitted with the ball), and the support is in the middle of the plane. The dimensions of the specimens used can be modified according to the specific needs (materials used), and to calculate the stress load given to the test sample using equations as in the journal.[2]

2.2.Methods used

And experimental flow charts in this study as in figure 1 below.

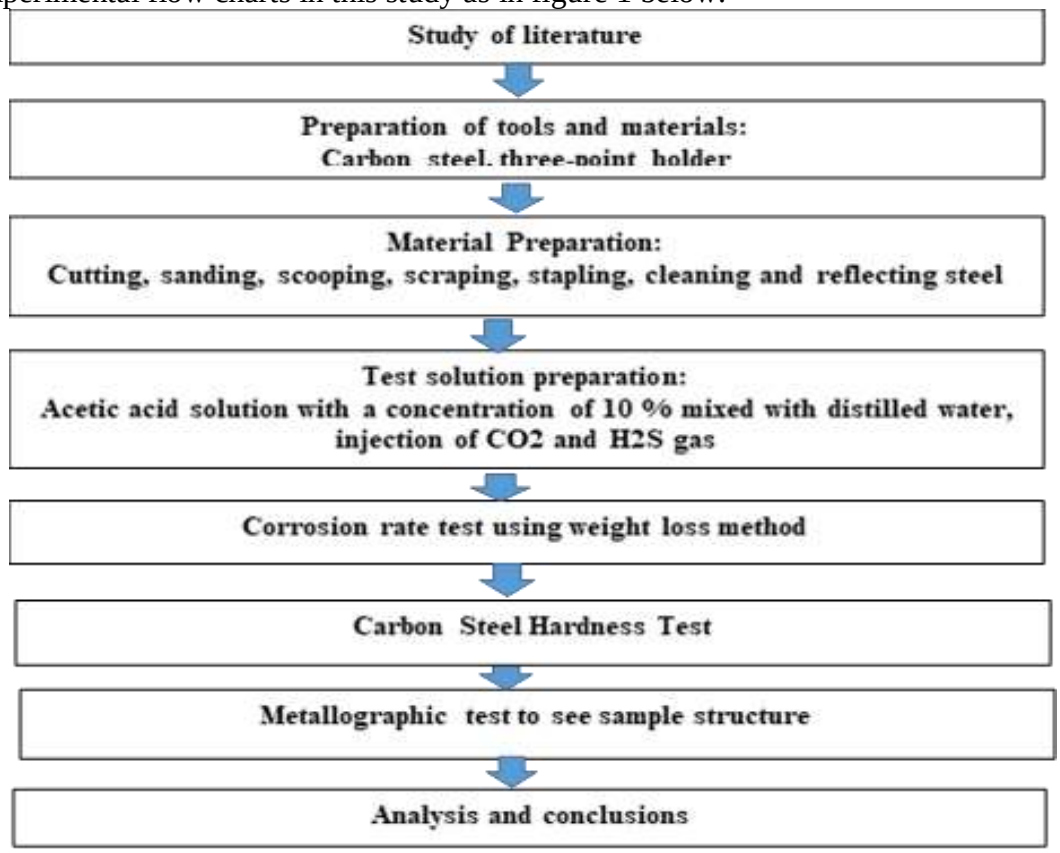

Figure 1: flow diagram of the research method.

3. Results and Discussion.

Based on research results from corrosion test samples as shown in the table 1, table 2 and table 3 for time variations and stress variations.

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Table 1. Corrosion rate data for samples of 1350 ml of aquades + 150 ml of acetic acid (10% acetic acid solution).[9]

10% acetis acid solution						
Sample	M initial (gram)	M final (gram)	σ (Mpa)	t (hours)	PH	CR (mmpy)
A1	49.73	44.92	264.8853	1440	3	1.176727
B1	48.66	43.37	284.5065	1440	3	1.279055
A2	48	36.32	264.8853	2160	3	1.919597
B2	48.65	36.26	284.5065	2160	3	2.036285
A3	50.01	33.09	264.8853	2880	4	2.062245
B3	48.41	30.48	284.5065	2880	4	2.18987

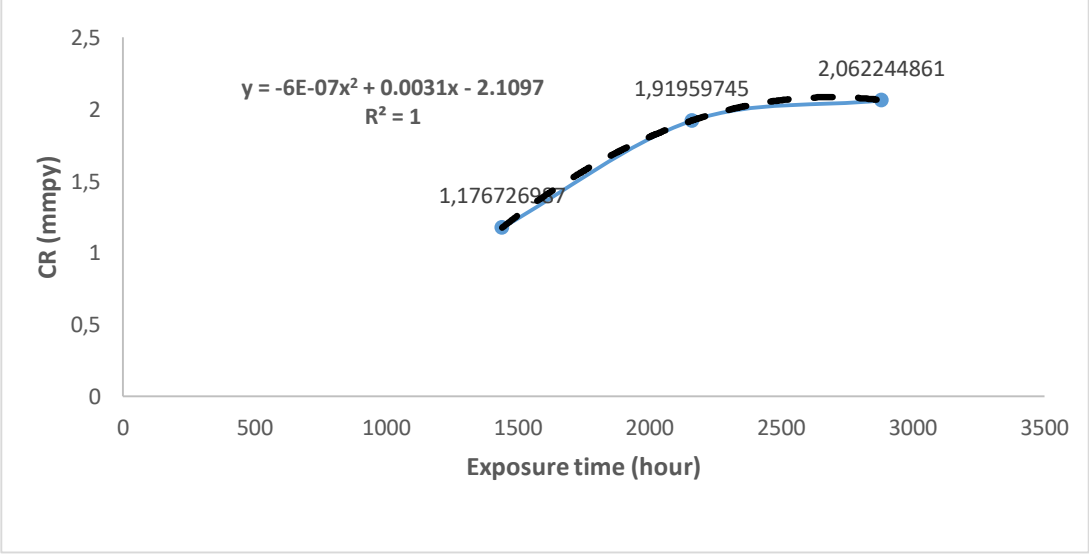
Table 2. Corrosion rate and exposure time data.

Sample	σ (Mpa)	CR (mmpy)
A1	264.885344	1.176727
A2	264.885344	1.919597
A3	264.885344	2.062245
B1	284.506481	1.279055
B2	284.506481	2.036285
B3	284.506481	2.18987

Table 3. Corrosion rate and stress data.

Sample	t (hours)	CR (mmpy)
A1	1440	1.176727
B1	1440	1.279055
A2	2160	1.919597
B2	2160	2.036285
A3	2880	2.062245
B3	2880	2.18987

And based on table 2, if plotted will be obtained as shown in figures (2.a) and (2.b) and based on table 3, if plotted, it will be obtained as shown in figures (3.a) and (3.b).



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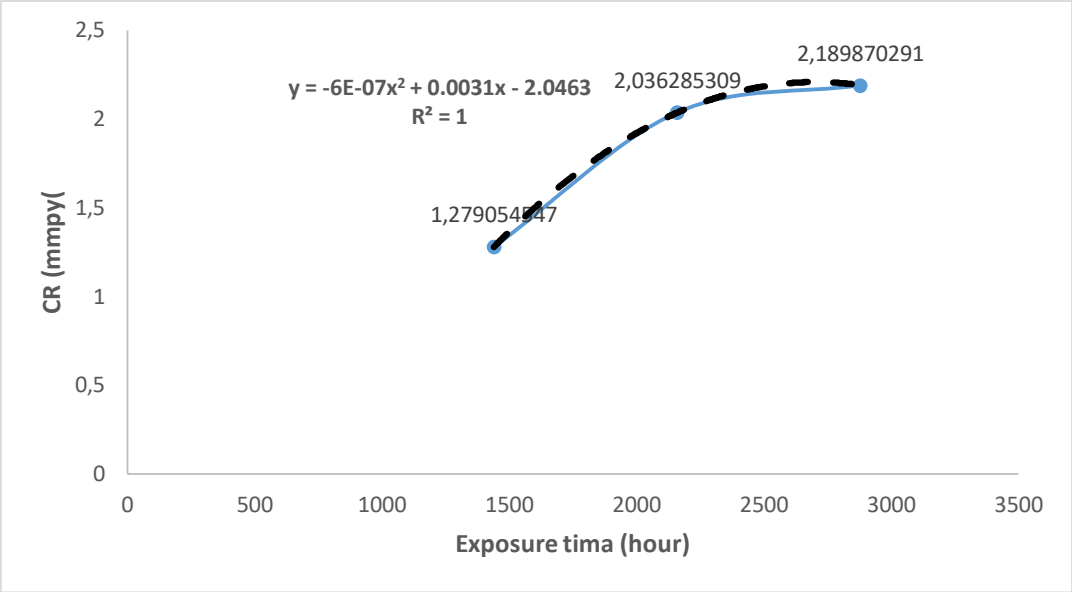
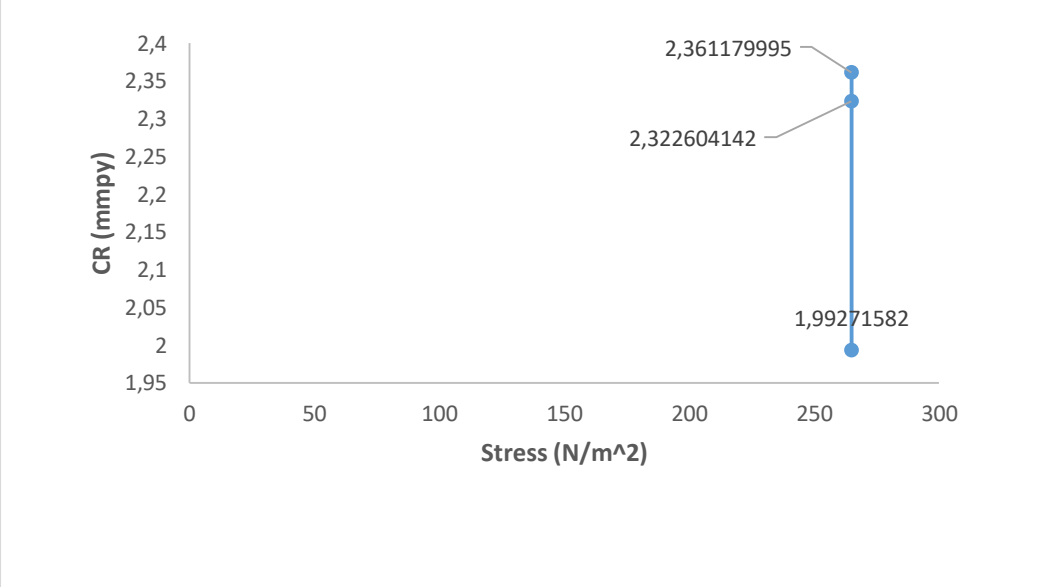
(a) Corrosion rate for stress 264.885388 MPa.



(b) Corrosion rate for stress 284.50648806MPa.

Figure 2 . Graph of corrosion rate and variation of exposure time for stress 264.885388 Mpa and stress 284.5064806 Mpa.



(a) Graph of the corrosion rate at a stress 264.885388 Mpa

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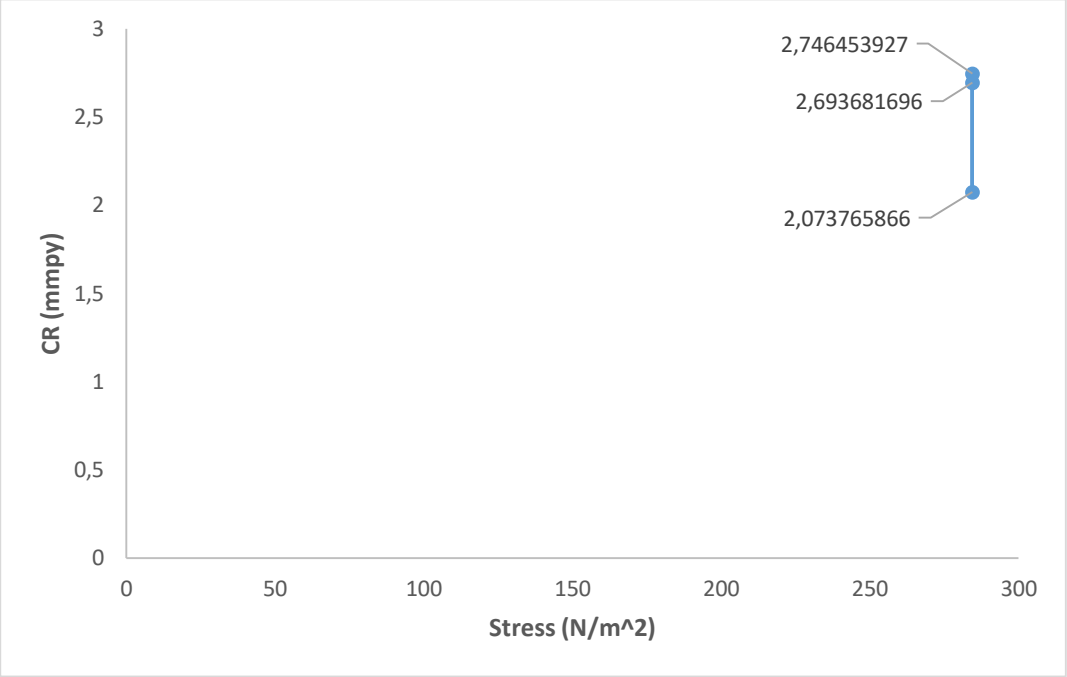

(b) Graph of the corrosion rate at a stress 284.5064806 Mpa

Figure 3. Graph of the corrosion rate at a stress of 264.885388 Mpa and stress 284.5064806.

Based on the test results of the corrosion test sample with an optical microscope as shown in Figure 4 and Figure 4.

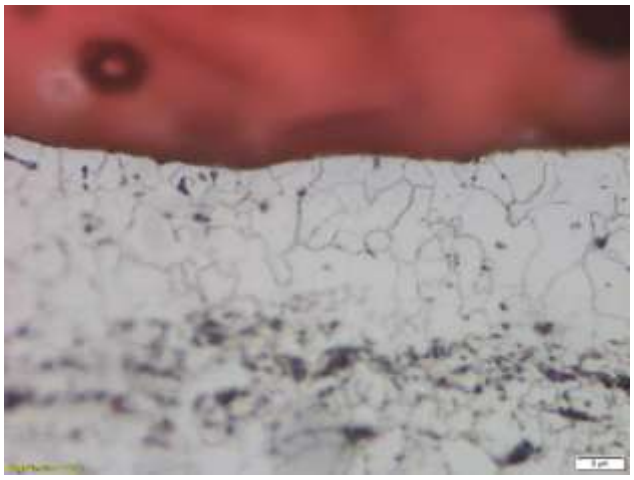

Figure 4. Microstructure test results with an optical microscope tool.

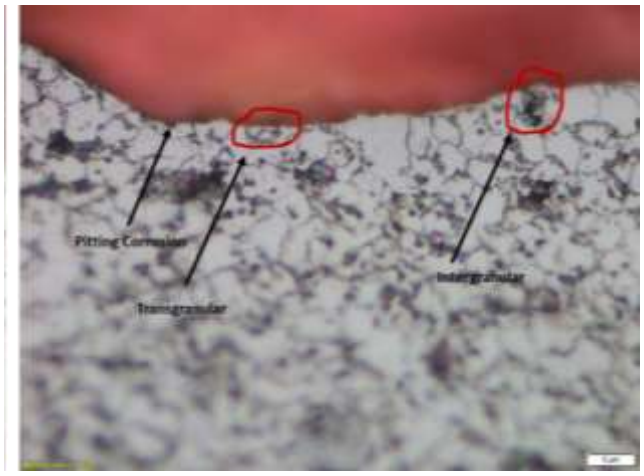

Figure 5 . Microstructure test results occur in Stress corrotion cracking transgranular and intergranular.

4. Conclusion

Based on the graph in figure (2.a) and figure (2.b) that the corrosion rate will increase with increasing exposure time. And the greater the stress given that the corrosion rate will increase based on the graphic figure (3.a) and graphic figure (3.b). Based on the results of the microstructure test of corrosion test samples using an optical microscope, which is a pitting corrosion event. Due to the occurrence of pitting corrosion events, it will trigger the occurrence as events stress corrosion cracking transgranular and intergranular in Figure 5.

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