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Research Article

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Comparative Study on the Corrosion Behaviour of welded and un-welded Mild Steel in Agitated Media of Distilled Water 0.5mol, 0.3mol of Sodium Sulphate (Na_2SO_4) Solution

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Abstract
The research work was based on the comparative study of the corrosion bebaviour of the mild steel using agitated distilled water with 0.5 mol and 0.3 mol of Na_2SO_4 solution. The materials used for the research work are welded and un-welded mild steel. The mild steel materials were obtained at the Foundry shop of the Ajaokuta Steel Company Limited. The mild steel materials were analyzed using the SPECTRO Analytical Instruments at the Foundry shop of the company. These experiments were performed using 0.5mol and 0.3mol of Na_2SO_4 in different agitated media of distilled water .The samples used for general corrosion studies were 10mm and 4mm mild steel thickness. These materials were cut into specimen sizes to 2cm by 2cm). Twenty -eight (28) specimens each were prepared for the 10mm and 4mm mild steel materials the samples were ground and polished on the emery papers which removed rust particles on the test materials. The specimens were exposed for days for over fifty –four (54) days, with an interval of 3days. It was observed that welded materials have higher corrosion rate than the un-welded materials when subjected to experimental conditions. The corrosion rates values were used to plot graphs against time of exposure.

Keywords: Corrosion Behaviour, Welded, Un-welded, Mild Steel, Distilled Water, 0.5mol, 0.3mol, Na_2SO_4

Introduction
The corrosion of metals is electrochemical or chemical processes with its environments. It is an electrical circuit where the exchanges of electrons are conducted by chemical reactions in part of the circuit. The chemical reactions occur at the surface of the metal exposed to the electrolyte. Oxidation reactions occur at the surface of the anode and reduction reaction occurs at the surface of the cathode [1]. Metals corrode because they are used in an environment where they are chemically unstable. Only copper and the precious metals (gold, silver, platinum, etc.) are found in nature in their metallic state. All the other metals, to include iron-the metal most commonly used are processed from minerals or ores into metals that are inherently unstable in their environment [2].

Corrosion causes gradual decay and deterioration of pipes, both internally and externally. It can reduce the life of the pipe by corroding the wall thickness. Under certain conditions, the time for the decay causes the pipe to fail as short as five years [3].

Corrosion can also result in encrustation inside the pipes, reducing the carrying capacity of the pipes to a point that they have to be replaced to provide the flow needed [4].

However, like any engineering structure, the best-designed and maintained pipelines become defective as they progresses through design life. One of the major causes of pipeline defects around the world is corrosion [5]. Selection of pipes for particular situations is dependent on what will be passing through the pipes, which include pressure and temperature of the contents. Pipes are produced through the process of forming and fabrication from different material types to suit stringent needs and services desired. The most commonly used materials for petroleum pipelines is mild steel, because of its strength, ductility, weldability and it is amenable to heat treatment for varying mechanical properties [6]. However, mild steel corrodes easily because all common structural metals from surface oxide films when exposed to pure air but the oxide formed on mild steel is ready broken down, and in the presence of moisture, it is not repaired. [7].

However, despite the current level of industry knowledge, pipelines continue to experience modest but significant number of failure due to corrosion at its weld and entire point. The reason is that the corrosion behaviors of buried pipelines are much more complicated than that of piece steel in beaker salt water [8].

Pipelines play an extremely important role throughout the world as a means of transporting gases and liquid over long distances from their sources to the ultimate consumers. The public is not aware of the number of pipelines that are continually in services as primary means of transportation. Buried operating pipelines are rather unobtrusive and rarely make their presence which transport fluids are built with materials that are mild steel. This is because pipes must be strong enough to resist different conditions, which are mainly due to temperature, pressure and fluid [6].

Materials and Methods

Materials

The mild steel materials used in this study were obtained at the Foundry Shop of the Ajaokuta Steel Company Limited, Ajaokuta, Kogi. The chemical compositions of the samples were determined with the aid of SPECTRO Analytical Instruments at the Foundry shop of the Ajaokuta Steel Company Limited. The chemical compositions of the mild steel samples are shown in Tables 2.1 and 2.2

Table 2.1

	C	Si	Mn	P	S	Cr	Ni	Mo
	%	%	%	%	%	%	%	%
``x	0.133	0.307	0.82	0.006	0.008	0.08	0.102	0.038

	Al	Cu	Co	Ti	Nb	V	W	Pb
	%	%	%	%	%	%	%	%
``x	0.036	0.178	0.009	3E-04	0.005	0.002	<0.0001	<0.0001

	B	Sn	Zn	As	Bi	Ca	Ce	Zr
	%	%	%	%	%	%	%	%
``x	7E-04	0.006	0.004	5E-04	0.001	0.001	0.002	6E-04

	La	Fe
	%	%
``x	<0.0001	98.3

Table 2.2

	C	Si	,m	P	S	Cr	Ni	Mo
	%	%	%	%	%	%	%	%
``x	0.147	0.276	1.30	0.027	0.0043	0.015	0.036	<0.0001

	Al	Cu	Co	Ti	Nb	V	W	Pb
	%	%	%	%	%	%	%	%
``x	0.033	0.015	0.0013	0.0010	0.042	0.0007	<0.0001	<0.0001

	B	Sn	Zn	As	Bi	Ca	Ce	Zr
	%	%	%	%	%	%	%	%
``x	0.0006	0.0008	0.0021	<0.0001	0.0010	0.0018	0.0019	0.0002

	La	Fe
	%	%
``x	<0.0001	98.1 figure

Equipment

The equipment used in this study includes; table lathe machine, table vice, bench grinder, electric arc welding machine, polishing machine, digital weighing balance, digital multi-meter, pH meter.

Chemical Reagents

Chemical reagents used include sodium sulphate (Na_2SO_4) and Distilled water.

Preparation of Materials

The mild steel rod of length 20mm by 10mm thickness and length of 25mm by 4mm thickness were obtained from the Foundry Shop, of the Ajaokuta Steel Company Limited, Ajaokuta , Kogi State. The 10mm and 4mm thickness mild steel materials were cut into sizes a using cutting disc to 15mm x 15mm and was to 2cm x 2cm (21 numbers) each with the aid of a power hacksaw.

Preparation of Sample for Corrosion Test

The samples used for the studies were (10 and 4) mm thickness mild steel. These samples were ground and polished on the emery papers to remove the rust particles deposited on the test materials. Twenty- eight (28) specimens each were used in the experiments as shown in the table below.

Table 2.3: Shows the Identification and Description of Test Pieces in the solution of various Concentrations.

S/NO	SAMPLE	0.3mol,0.5molNa_2SO_4
1.	Parent material	➢
2.	weld assembly for gas welding	➢
3.	heat effected zone for gas welding	➢
4.	weld pool for gas welding	➢
5.	weld assembly for arc welding	➢
6.	weld pool for arc welding	➢
7.	heat affected zone arc welding	➢

2.5 Preparation of Solution for This Corrosion Test

The Na_2SO_4 solutions were prepared with the use of distilled water. The volumes of distilled water used were the same in the different agitated media. For all the preparation of 0.3mol and 0.5 mol of Na_2SO_4 solutions used were all diluted with 20ml of distilled water volume in conical flasks. These solutions were put into twenty-eight (28) small plastic beakers.

Fig 3.1: 0.5mol Na_2SO_4 welded specimen

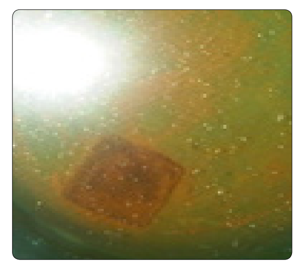


Fig 3.3: 0.3mol Na_2SO_4 welded specimen

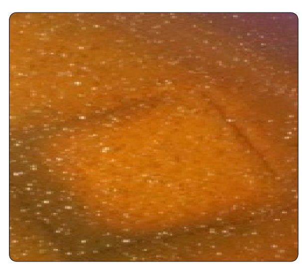


Fig 3.2: 0.5mol Na_2SO_4 un-welded specimen

Fig 3.4: 0.3mol Na_2SO_4 un-welded specimen

Corrosion Monitoring

(a) Weight Loss: the mass of the surface area of all the specimens used for these were measured before immersion into various solutions. The immersed samples were removed at every 3days interval. The samples were removed with the use of a spatula which was dipped into the solutions. The removed samples were thereafter cleaned with white rag in order to remove corrosion products that had contact with the test materials.

The specimens were weighted with digital weighing balance in order to obtain the loss in weight values as part of the readings of corrosion in the environment under study. The corrosion rates of the set up were calculated with this formula below.

$$\text{Corrosion rate} = \text{weight loss}.(\text{CR})\ (mg/mm^2/yr) = \frac{W}{A \times \frac{T}{365}} ----Equation\ (3.1)\ [12]$$

W = Weight loss (mg)

A = Total Surface area (mm²)

$\frac{T}{365}$ = Exposure time in days extrapolated to a year

A = 2Π²1

Where

L is the length (mm)

R = radius (mm)

(b) Weight Loss Measurement

The corrosion environments for experiments were done for the protection mechanism of the mild steel on welded joints samples (0.5mol and 0.3mol) Na_2SO_4 solutions for the duration of 54 days. The studies of the weight loss of the samples in the corrosive environments were for an interval of three (3) days. The samples were weighed using a digital weighing balance of model Electronic Scale –C & G GMbH Gielensto 65-69 41460 Neuss, Germany, at the Nigerian Liquefied Natural Gas (NLNG), Department of the Metallurgical and Materials Engineering, Faculty of Engineering, University of Nigeria, Nsukka. The values obtained were converted to saturated calomel electrode (SCE) values using the relation below

$E_m V(SCE) = E_{zin} - 1030$- - - - - -.Equation (3.2) [10] Constant value

Results and Discussion

Results

The results of the spark tests of as-received mild steel substrate used for this research works are presented in table 2.1and 2.2

Presentation of Data and Interpretation

Table 3.1 and figures 3.1 show the A2- 10mm samples welded immersed in (0.5m) Na_2SO_4 as a function of Corrosion rate g/cm²/yr with the No of days exposed.

Table 3.1: A2- 10mm samples welded immersed in (0.5m) Na_2SO_4

Nos. of days	Initial weights g	Final weights g	Weight loss g	Cumulative weight loss g	Corrosion rate g/cm2/yr	Potential (mV)	pH
1	27.78	27.78	2E-04	0.002	0	-676	7.35
4	27.78	27.77	0.006	0.008	0.298	-704	7.66
7	27.78	27.77	0.007	0.001	0.257	-567	7.89
10	27.77	27.76	0.012	0.026	0.168	-771	8.19
13	27.76	27.75	0.011	0.038	0.199	-650	7.45
16	27.75	27.74	0.01	0.047	0.144	-747	7.11
19	27.74	27.73	0.009	0.056	0.085	-675	7.31
21	27.73	27.72	0.009	0.064	0.053	-682	8.7
24	27.72	27.71	0.004	0.068	0.063	-610	7.8
27	27.71	27.71	0.007	0.075	0.073	-574	7.25
30	27.71	27.7	0.007	0.082	0.043	-721	7.1
33	27.7	27.7	0.013	0.094	0.035	-685	8.2
36	27.7	27.68	0.006	0.101	0.065	-745	8.1
39	27.68	27.68	0.013	0.113	0.048	-636	7.7
42	27.68	27.66	0.006	0.119	0.034	-621	8.1
45	27.66	27.66	0.006	0.125	0.057	-528	7.7
48	27.66	27.65	0.004	0.13	0.087	-760	7.65
51	27.65	27.65	0.013	0.142	0.063	-688	8.3
54	27.65	27.63	0.006	0.148	0.054	-786	9.1

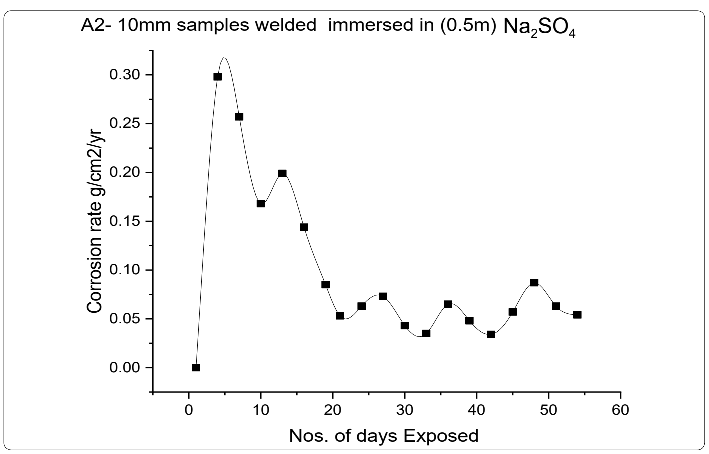


Figure 3.1: A2- 10mm samples welded immersed in (0.5m) Na_2SO_4

Table 3.2 and figures 3.2 show the B2- 4mm samples welded immersed in (0.5m) Na_2SO_4 as a function of Corrosion rate g/cm^2/yr with the No of days exposed.

Table 3.2: B2- 4mm samples welded immersed in (0.5m) Na_2SO_4

Nos. of days	Initial weights g	Final weights g	Weight loss (g)	Cumulative weight loss g	Corrosion rate g/cm2/yr	Potential (mV)	pH
1	30.04	30.04	0	0	0	-467	7.38
4	30.04	30.04	0.002	0.002	0.377	-684	7.25
7	30.04	30.03	0.005	0.007	0.122	-643	8.11
10	30.03	30.03	0.002	0.009	0.168	-567	8.64
13	30.03	30.02	0.007	0.016	0.144	-574	8.27
16	30.02	30.02	0.005	0.022	0.138	-456	7.25
19	30.02	30	0.01	0.032	0.023	-683	8
21	30	30	0.005	0.037	0.046	-783	8.11
24	30	30	0.003	0.039	0.038	-734	8.15
27	30	29.99	0.006	0.046	0.054	-763	8.45
30	29.99	29.99	0.004	0.049	0.032	-543	8.38
33	29.99	29.98	0.007	0.056	0.027	-794	7.6
36	29.98	29.97	0.006	0.062	0.044	-784	7
39	29.97	29.97	0.005	0.067	0.037	-664	8.25
42	29.97	29.97	0.004	0.071	0.027	-542	7.3
45	29.97	29.96	0.006	0.076	0.017	-683	8.11
48	29.96	29.96	0.004	0.08	0.046	-684	8.72
51	29.96	29.94	0.013	0.092	0.035	-456	7.95
54	29.94	29.94	0.009	0.101	0.056	-784	8.4

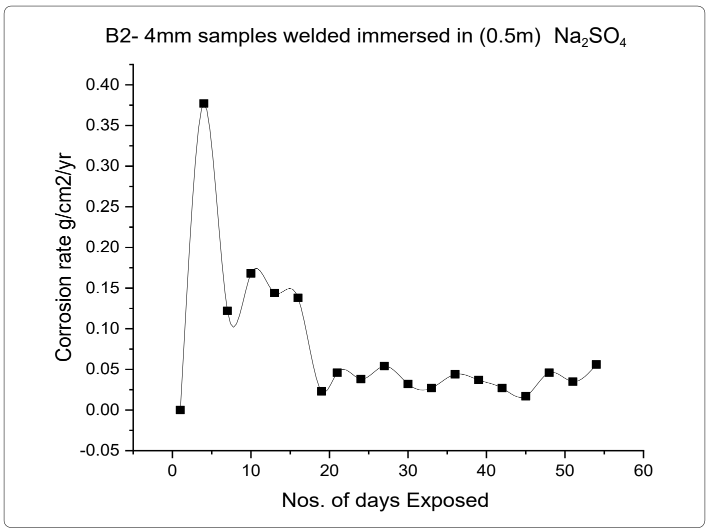


Figure 3.2: B2- 4mm samples welded immersed in (0.5m) Na_2SO_4

Table 3.3 and figures 3.3 show A2- 10mm samples un-welded immersed in (0.5m) Na_2SO_4 as a function of Corrosion rate g/cm^2/yr with the No of days exposed

Table 3.3: A2- 10mm samples un-welded immersed in (0.5m) Na_2SO_4

Nos. of days	Initial weights g	Final weights g	Weight loss g	Cumulative weight loss g	Corrosion rate g/cm2/yr	Potential (mV)	pH
1	13.2	13.2	0	0	0	-645	7.24
4	13.2	13.2	0.01	0.01	0.46	-347	7.34
7	13.2	13.2	0	0.02	0.22	-564	7.46
10	13.2	13.2	0.01	0.03	0.35	-567	7.29
13	13.2	13.2	0.01	0.05	0.16	-487	8.44
16	13.2	13.1	0.01	0.07	0.14	-576	8.36
19	13.1	13.1	0	0.07	0.05	-754	8.30
21	13.1	13.1	0.01	0.08	0.04	-568	8.26

24	13.1	13.1	0.01	0.08	0.02	-758	7.97
27	13.1	13.1	0	0.09	0.05	-758	8.25
30	13.1	13.1	0.01	0.09	0.02	-567	8.23
33	13.1	13.1	0	0.1	0.03	-855	8.24
36	13.1	13.1	0.01	0.1	0.06	-575	8.00
39	13.1	14	0.01	0.01	0.04	-478	7.44
42	14	14	0.01	0.01	0.03	-586	7.49
45	14	14	0.01	0.01	0.03	-744	8.03
48	14	14	0.01	0.03	0.06	-574	8.09
51	13.96	13.95	0.01	0.03	0.05	-574	7.42
54	13.95	14	0.00	0.03	0.03	-567	7.37

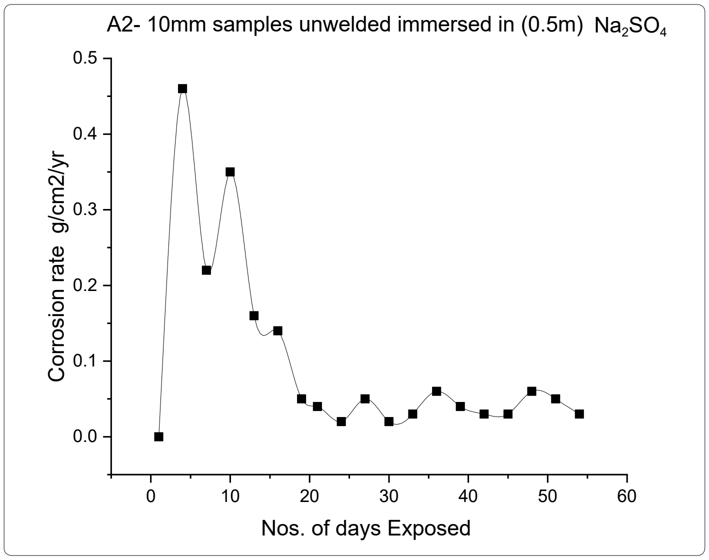


Figure 3.3: A2- 10mm samples un-welded immersed in (0.5m) Na_2SO_4

Table 3.4 and figures 3.4 show B2- 4mm samples un-welded immersed in (0.5m) Na_2SO_4 as a function of Corrosion rate g/cm^2/yr with the No of days exposed

Table 3.4: B2- 4mm samples un-welded immersed in (0.5m) Na_2SO_4

Nos of days	Initial weights g	Final weights g	Weight loss g	Cumulative weight loss g	Corrosion rate g/cm2/yr	Potential (mV)	pH
1	17.8	17.8	0	0	0	-467	7.41
4	17.8	17.8	0.01	0.01	0.23	-684	7.45
7	17.8	17.8	0	0.01	0.07	-643	7.54
10	17.8	17.8	0.01	0.02	0.14	-567	8.35
13	17.8	17.7	0.01	0.02	0.03	-574	8.48
16	17.7	17.7	0.01	0.03	0.09	-456	8.38
19	17.7	17.7	0	0.04	0.02	-683	8.33
21	17.7	17.7	0.01	0.04	0.07	-783	8.32
24	17.7	17.7	0.01	0.04	0.03	-734	8.03
27	17.7	17.7	0.01	0.05	0.04	-763	8.36
30	17.7	17.2	0.01	0.06	0.03	-543	8.03
33	17.7	17.7	0.01	0.07	0.03	-794	8.35
36	17.7	17.7	0.01	0.08	0.03	-784	8.04
39	17.7	17.7	0.01	0.08	0.02	-664	7.61
42	17.7	17.7	0.01	0.10	0.02	-542	7.47
45	17.66	17.7	0.00	0.10	0.02	-683	7.44
48	17.66	17.7	0.01	0.11	0.02	-684	8.49
51	17.65	17.65	0.00	0.11	0.02	-456	7.56
54	17.65	17.64	0.01	0.12	0.03	-784	7.36

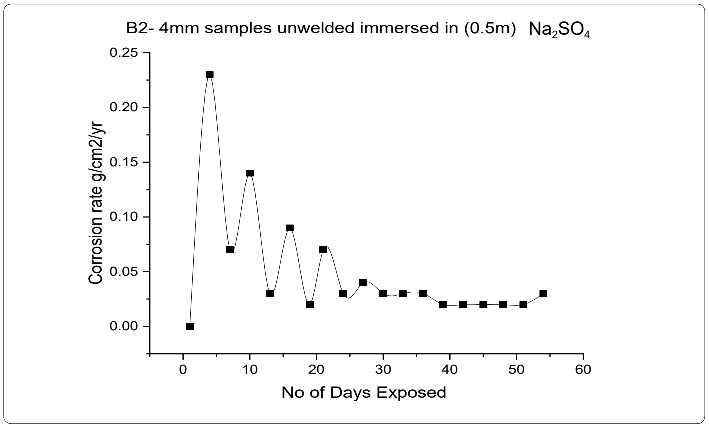


Figure 3.4: B2- 4mm samples un-welded immersed in (0.5m) Na_2SO_4

Table 3.5 and figures 3.5 show A2- 10mm samples welded immersed in (0.3m) Na_2SO_4 as a function of Corrosion rate g/cm^2/yr with the No of days exposed

Table 3.5: A2- 10mm samples welded immersed in (0.3m) Na_2SO_4

Nos. of days	Initial weights g	Final weights g	Weight loss g	Cumulative weight loss g	Corrosion rate g/cm2/yr	Potential (mV)	pH
1	25.29	25.29	0	0	0	-528	8.27
4	25.29	25.29	0	0.0001	0.35	-678	7.15
7	25.29	25.28	0.01	0.109	0.23	-765	8.1
10	25.28	25.28	0	0.0116	0.27	-567	7.66
13	25.28	25.28	0	0.0129	0.17	-763	8.4
16	27.28	27.28	0	0.0141	0.2	-647	8.44
19	27.28	27.27	0	0.0159	0.03	-503	8.2
21	27.27	27.27	0	0.0162	0.05	-674	8.64
24	27.27	27.27	0	0.0181	0.02	-783	8.41
27	27.27	27.27	0	0.02	0.06	-573	8.72
30	27.27	27.27	0	0.0218	0.05	-564	8.53
33	27.27	27.27	0	0.0241	0.02	-673	8.22
36	27.27	27.26	0	0.0258	0.04	-764	7.51
39	27.26	27.26	0	0.0269	0.05	-863	7.35
42	27.26	27.26	0	0.0273	0.04	-673	7.89
45	27.26	27.26	0	0.0299	0.02	-753	8.43
48	27.26	27.26	0	0.0313	0.05	-573	8.27
51	27.26	27.25	0	0.0332	0.01	-792	8.11
54	27.25	27.25	0	0.0375	0.05	-783	7.35

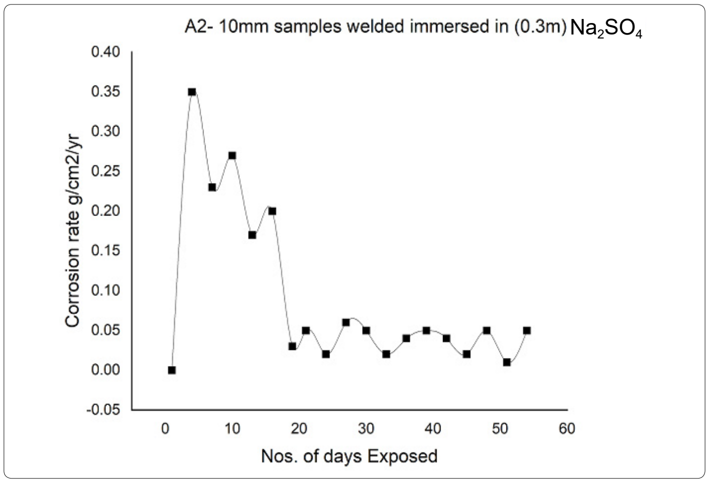


Figure 3.5: A2- 10mm samples welded immersed in (0.3m) Na_2SO_4

Table 3.6 and figures 3.6 show B2- 4mm samples welded immersed in (0.3m) Na_2SO_4 as a function of Corrosion rate g/cm^2/yr with the No of days exposed

Table 3.6: B2- 4mm samples welded immersed in (0.3m) Na_2SO_4

Nos. of days	Initial weights g	Final weights g	Weight loss g	Cumulative weight loss g	Corrosion rate g/cm2/yr	Potential (mV)	PH
1	21.4	21.4	0	0	0	-749	7.24
4	21.4	21.4	0	0	0.36	-648	7.22
7	21.4	21.4	0	0	0.15	-683	7.27
10	21.4	21.4	0	0.01	0.14	-793	7.42
13	21.4	21.4	0	0.01	0.17	-564	7.37
16	21.4	21.4	0	0.01	0.18	-658	7.2
19	21.4	21.4	0	0.02	0.09	-793	8.12
21	21.4	21.4	0	0.02	0.07	-634	8.13
24	21.4	21.4	0	0.02	0.06	-789	7.29
27	21.4	21.4	0	0.03	0.09	-793	8.25
30	21.4	21.4	0	0.03	0.05	-789	8.3
33	21.4	21.4	0	0.03	0.03	-793	8.36
36	21.4	21.4	0	0.04	0.02	-769	7.34
39	21.4	21.4	0	0.04	0.02	-674	8.11
42	21.4	21.4	0	0.04	0.02	-564	7.45
45	21.4	21.4	0.01	0.05	0.02	-488	7.36
48	21.4	21.3	0.01	0.06	0.02	-578	7.49
51	21.3	21.3	0	0.06	0.05	-785	8.09
54	21.3	21.3	0.01	0.07	0.06	-803	8.23

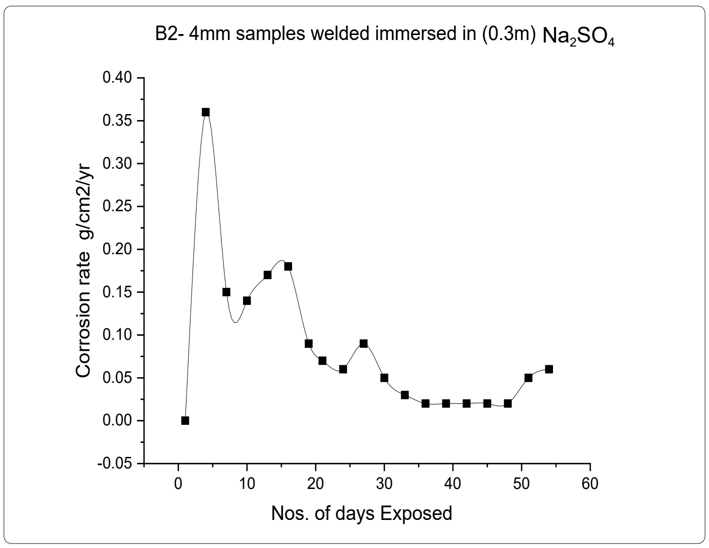


Figure 3.6: B2- 4mm samples welded immersed in (0.3m) Na_2SO_4

Table 3.7 and figures 3.7show A2- 10mm samples un-welded immersed in (0.3m) Na_2SO_4 as a function of Corrosion rate g/cm^2/yr with the No of days Exposed

Table 3.7: A2- 10mm samples un-welded immersed in (0.3m) Na_2SO_4

No of days	Initial weights (g)	Final weights (g)	Weight loss (g)	Cumulative weight loss (g)	Corrosion rate g/cm2/yr	Potential (mV)	PH
1	15.6	15.6	0	0	0	0	7.7
4	15.6	15.6	0	0.0036	0.47	304	7.1
7	15.6	15.6	0.01	0.0101	0.28	405	8.1
10	15.6	15.6	0.01	0.0198	0.29	290	8.5
13	15.6	15.6	0.01	0.0248	0.11	327	7.45
16	15.6	15.6	0.01	0.0316	0.13	344	7.31
19	15.6	15.6	0.01	0.039	0.12	498	8.2

21	15.6	15.6	0	0.0432	0.06	410	7.35
24	15.6	15.6	0	0.0468	0.04	527	8.07
27	15.6	15.6	0	0.0513	0.05	463	9.14
30	15.6	15.6	0.01	0.0601	0.09	326	9.1
33	15.6	15.6	0.01	0.0654	0.05	348	8.8
36	15.6	15.6	0.01	0.0718	0.05	385	8.45
39	15.6	15.6	0.01	0.0784	0.07	455	9.2
42	15.6	15.6	0.01	0.084	0.04	320	9.18
45	15.6	15.6	0.01	0.0901	0.04	292	8.41
48	15.6	15.5	0.01	0.0966	0.04	274	7.92
51	15.5	15.5	0.01	0.1025	0.03	355	8.42
54	15.5379	15.5300	0.0079	0.1104	0.04	475	7.45

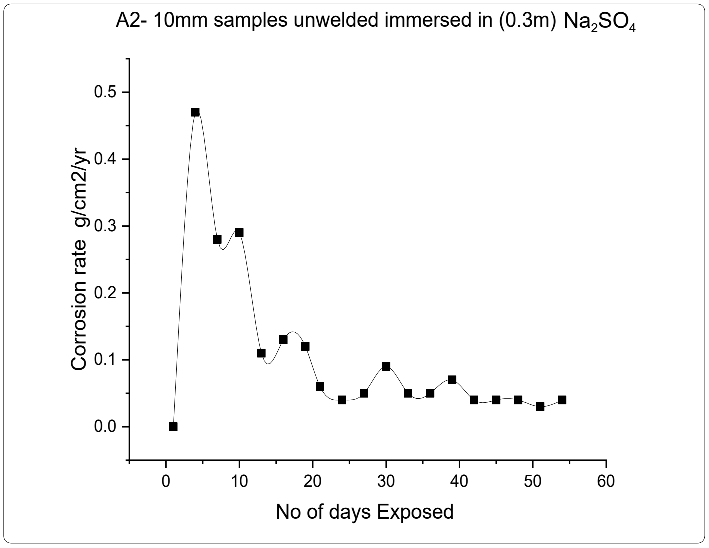


Figure 3.7: A2- 10mm samples un-welded immersed in (0.3m) Na_2SO_4

Table 3.8 and figures 3.8 show B2- 4mm samples un-welded immersed in (0.3mol) Na_2SO_4 as a function of Corrosion rate g/cm^2/yr with the No of days exposed

Table 3.8: B2- 4mm samples un-welded immersed in (0.3m) Na_2SO_4

Nos. of days	Initial weights (g)	Final weights (g)	Weight loss (g)	Cumulative weight loss (g)	Corrosion rate g/cm2/yr	Potential (mV)	pH
1	14.6	14.6	0	0	0	-632	7.1
4	14.6	14.6	0	0.0004	0.43	-747	7.08
7	14.6	14.6	0.01	0.0068	0.16	-375	7.17
10	14.6	14.6	0	0.0113	0.17	-564	8.17
13	14.6	14.6	0.01	0.0174	0.06	-781	7.23
16	14.6	14.6	0.01	0.0225	0.12	-640	8.01
19	14.6	14.6	0	0.0269	0.07	-672	8
21	14.6	14.6	0.01	0.0033	0.08	-723	7.91
24	14.6	14.6	0.01	0.0386	0.05	-605	8.31
27	14.6	14.6	0.01	0.0458	0.08	-757	7.31
30	14.6	14.6	0.01	0.0517	0.04	-490	7.47
33	14.6	14.6	0.01	0.0571	0.05	-560	8.23
36	14.6	14.6	0	0.0613	0.01	-628	7.48
39	14.6	14.5	0.01	0.0664	0.04	-380	8.25
42	14.5	14.5	0	0.0702	0.04	-740	8
45	14.5	14.5	0.01	0.0776	0.05	-660	8.18
48	14.5	14.5	0.01	0.0822	0.05	-651	7.48
51	14.5	14.5	0.01	0.089	0.02	-582	7.43
54	14.5	14.5	0.01	0.0967	0.05	-580	8.16

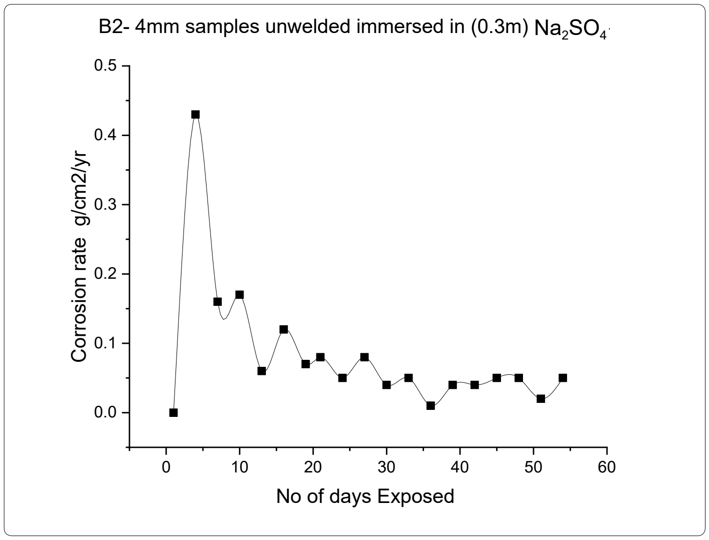
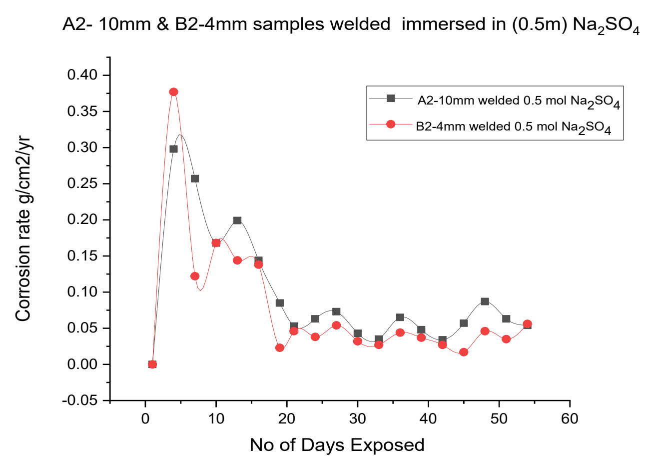


Figure 3.8: B2- 4mm samples un-welded immersed in (0.3m) Na_2SO_4



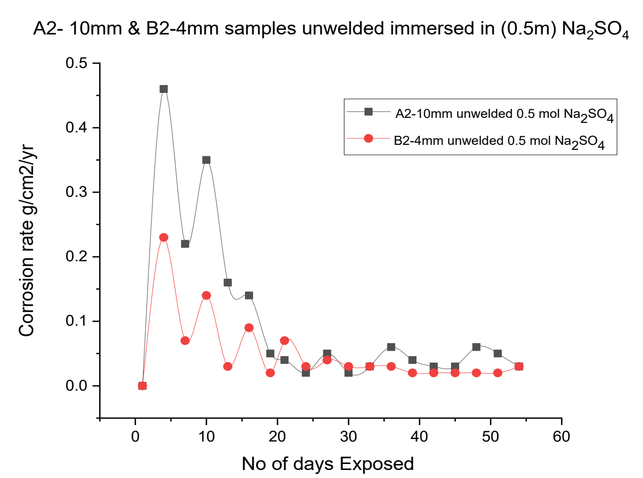
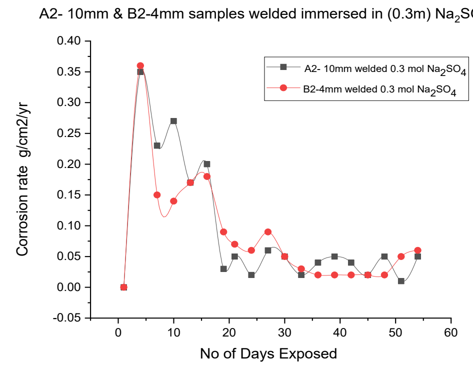


Figure 3.9: A2-10mm & B2- 4mm samples welded immersed in (0.5m) Na_2SO_4 Figure 3.10: A2 -10mm & B2- 4mm samples un-welded immersed in (0.5m) Na_2SO_4



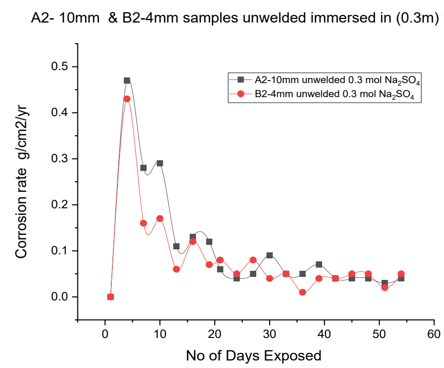
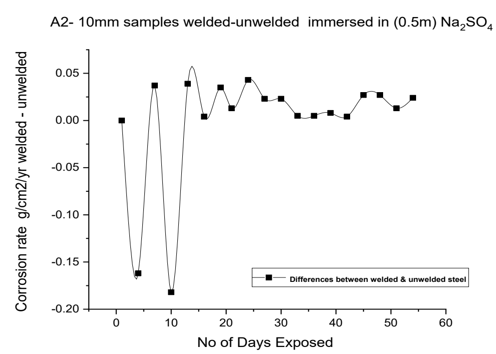


Figure 3.11: B2- 4mm samples welded immersed in (0.3m) Na_2SO_4 Figure 3.12: B2- 4mm samples un-welded immersed in (0.3m) Na_2SO_4



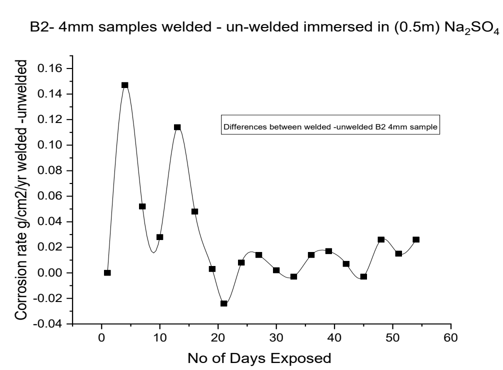
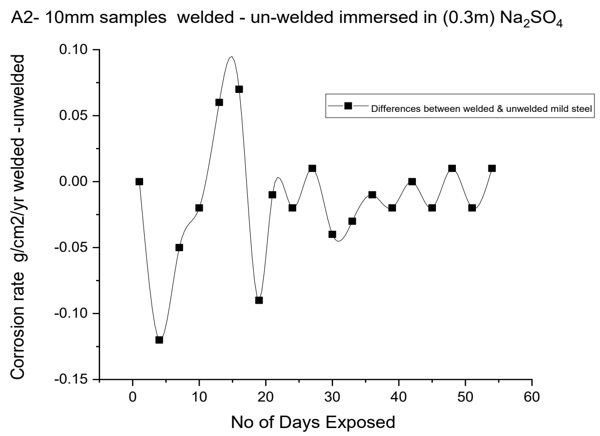


Figure 3.13: A2- 10mm samples welded –unwelded immersed in (0.5m) Na_2SO_4 Figure 3.14: B2- 4mm samples welded -un-welded immersed in (0.5m) Na_2SO_4



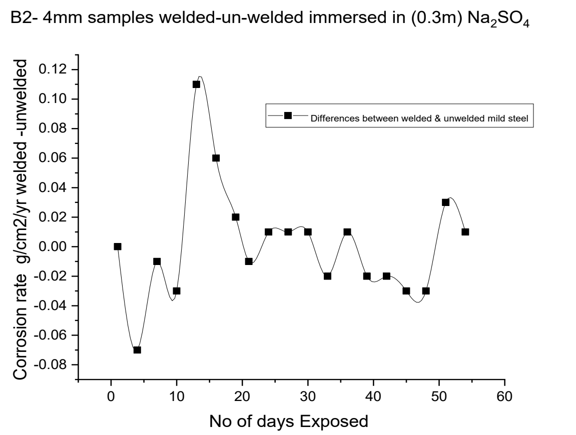


Figure 3.15: A2- 10 mm samples welded-unwelded immersed in (0.3m) Na_2SO_4 Figure 3.16: B2- 4mm sample welded - un-welded immersed in (0.3m) Na_2SO_4

Discussion

Results obtained from the experiments showed that at 54 days, which was the highest number of days allowed for the experiments, the sample of A2- 10mm of welded mild steel specimen immersed in (0.5m) Na_2SO_4 had a corresponding value of Corrosion rate g/cm^2/yr as 0.054. The Corrosion rate g/cm^2/yr of sample A2- 10mm specimen of un-welded mild steel immersed in (0.5m) Na_2SO_4 for 54 days and the corresponding value was 0.03. Therefore, it was observed that the difference between the corrosion rate g/cm^2/yr stood at 0.024. By implication, it shows that the corrosion rate is higher in the welded mild steel than the un-welded mild steel. These results are further represented in figure 3.13.

Similar trend was also observed when B2- 4mm samples welded immersed in (0.5m) Na_2SO_4 for 54 days and had a corresponding value of 0.056, while that B2- 4mm samples of un-welded sample immersed in (0.5m) Na_2SO_4 for the same 54 days had a corresponding value of 0.03 as the Corrosion rate g/cm^2/yr. The difference therefore between the welded and un-welded specimen was 0.026 as the corrosion rate g/cm^2/yr. These results was represented in a graph as shown in figure 3.14.

A2- 10mm samples of welded mild steel was immersed in (0.3m) Na_2SO_4 as was exposed for 54 days and had a corresponding value of 0.05 as the corrosion rate g/cm^2/yr, while the A2- 10mm samples of un-welded specimen immersed in (0.3m) Na_2SO_4 exposed for 54 days had a corresponding value of 0.04 corrosion rate g/cm^2/yr. The difference between the welded and un-welded specimen was 0.01. Meaning that the welded specimen has a higher corrosion rate g/cm^2/yr than that of the un-welded specimen. These results were represented in a graph shown in figure 3.15.

A Similar trend was also observed when B2- 4mm samples of welded mild steel was immersed in (0.3m) Na_2SO_4 for 54 days, which had a corresponding value of 0.06 as the corrosion rate g/cm^2/yr, while the A2- 10mm samples of un-welded immersed in (0.3m) Na_2SO_4 for 54 days had a corresponding value of 0.05. By implication, the difference between the welded and un-welded mild steel was 0.01 corrosion rate g/cm^2/yr. These results indicate that the welded mild steel sample has a higher corrosion rate g/cm^2/yr than that of the un-welded mild steel. These values were used to plot graph as shown in figure 3.16.

Conclusion

The research was performed on the comparative study of the corrosion behaviour of welded and un-welded mild steel in agitated media of distilled water 0.5mol, 0.3mol of Na_2SO_4 Solutions. Having investigated the effects of corrosion on both welded and un-welded mild steel materials carried out with 0.5mol and 0.3mol Na_2SO_4 environment the following conclusion were arrived at:

(i) That the corrosion rate g/cm^2/yr in welded mild steel is higher than that of the un-welded mild steel in all the agitated media deployed in this research work.

(ii) That in the 0.5mol of Na_2SO_4 solution, the A2, 10mm welded of 0.5mol has the highest resistance

(iii) In Na_2SO_4, solutions for all the samples have similar trend where all the welded mild steel were higher than all the un-welded mild steel at all levels.

(iv) The increase corrosion rate of the weld assembly was attributed to the formation of galvanic cells in the welded material since the corrosion characteristics of different phases make up the weld assembly different

Recommendations

a) The research performed is not exhaustive; more studies be carried out using materials that have a higher carbon content while they could also be tested in different concentration of salt solutions.

b) This project work should be used to solve problems of selection of welding parameters for mild steel substrate intending for services in sodium sulphate (Na_2SO_4) environments.

c) More studies should be carried out on the corrosion behaviour / resistance of mild steel.

d) More exposed time should be used to check the corrosion resistance of mild steel in sodium sulphate environments.

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