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Corrosion studies of stainless steel and carbon steel in aqueous solutions of sodium glycinate used for CO_2 capture

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Abstract: Corrosion is a well-known and serious issue in the carbon dioxide (CO_2) absorption process, which causes high maintenance cost for the restoration of corroded equipment and pipelines. Aqueous sodium glycinate (SG) is a potential solvent for CO_2 capture. A corrosion study of SG solvent is very crucial for its practical applications, as such data are very limited in the open literature. Therefore, to address this significant gap, the corrosion rates of stainless steel (SS304) and carbon steel (CS1018) were investigated in this study by employing the weight loss method using SG solvent at three different temperatures (303.15, 313.15 and 333.15 K) and concentrations (0.10, 0.20 and 0.30 mass fraction) of industrial importance. The results revealed that SS304 showed negligible corrosion in SG solvent with marginal effects of temperature and concentration. However, significant effects of temperature and concentration were observed on the corrosion rate of CS1018 in SG solvent. At the highest studied temperature of 333.15 K and the highest concentration (0.30 mass fraction), the corrosion rates of SS304 and CS1018 in SG solvent were 3.291 and 32.203 mpy, respectively. Moreover, the corrosion rate of CS1018 in SG solvent was compared with methyldiethanolamine (MDEA), monoethanolamine (MEA) and diethanolamine (DEA). It was found that SG solvent showed lower corrosivity than various amine solvents. The findings of this study provide guidance for the practical application for SG solvent in the CO_2 capture process. Also, the data obtained

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could significantly help design engineers establish appropriate operating conditions for the CO_2 capture process to control corrosion.

Keywords: corrosion behavior; metallic materials; weight loss method; amino acids; CO_2 absorption.

INTRODUCTION

Corrosion is a well-known issue in acid gas (CO_2) removal operations, which is considered one of the most serious problems in CO_2 absorption. The corrosion of equipment, pipelines and other utilities in the CO_2 absorption process cause unscheduled downtime, loss of production; reduced equipment life and sometimes even fatal injuries. The production loss for a typical plant due to corrosion varies from 10,000 to 30,000 USD per day. Additionally, various management expenses are also incurred for the restoration of corroded systems and corrosion mitigation. Although it is virtually impossible to eliminate corrosion, however, it can be minimized and controlled. Chemical and design engineers always strive for the minimization of corrosion in CO_2 capture plants. To accomplish this, prior knowledge of chemical solvents, and the materials of construction for CO_2 capture plant fabrication is always important, especially when new chemical solvents are designed for CO_2 capture.[1–4] Therefore, in order to minimize and control corrosion in a CO_2 absorption plant, it is essential to evaluate the corrosion tendency of the new solvents to be used for the absorption of CO_2. Aqueous SG solvent shows promising CO_2 absorption characteristics. Various studies on SG solvent have been carried out, including studies on physical properties and CO_2 solubility.[5,6] However, these studies are not sufficient for commercial applications of SG solvent. It is crucial to investigate corrosion rate of stainless steel and carbon steel using SG solvent for its commercial applications. Based on a comprehensive literature review, such data are rarely available in the open literature. Therefore, in order to address this research gap, systematic corrosion studies on aqueous SG solvent have been carried out in this study. The corrosion data on the SG solvent are very useful for the selection of appropriate materials for the fabrication of plants and utilities. Besides, the evaluation of the corrosion tendency of SG solvent and its comparison with conventional amine solvents is also a key criterion for the commercial suitability of the SG solvent.

MATERIALS AND METHODS

In this study, the weight loss method was used for measuring the corrosion rate. The weight loss method is a simple and established technique for investigating general corrosion. This technique is used for long-term exposure of test metal in solutions. Weighed test specimens are immersed in the test solutions for a particular time, and then removed to determine the loss in weight of the specimen.

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Chemicals and gases

Various chemicals and gases were used in this work, such as glycine, sodium hydroxide, monoethanolamine, acetone and double-distilled water. These chemicals were supplied by Merck Sdn Bhd., Malaysia. Gases such as CO_2 and N_2 were supplied by Air Products Sdn Bhd. Malaysia. All the chemicals and gases were used without further purification. Double-distilled water was used for preparing the samples. The detailed specifications of the chemicals and gases used in this study are summarized in Table I.

TABLE I. Specifications of chemicals and gases

Chemicals/gases	Chemical formula	Purity	Method of purification	Supplier
Glycine	H_2NCH_2COOH	≥ 99 %	None	Merck
Sodium hydroxide	NaOH	≥ 99 %	None	Merck
Monoethanolamine	C_2H_7NO	≥ 99 %	None	Merck
Water	H_2O	99 %	Double distillation	–
Acetone	C_3H_6O	≥ 99.5 %	None	Merck
Carbon dioxide	CO_2	99 %	None	Air Products
Nitrogen	N_2	99 %	None	Air Products

Preparation of solvent samples

Aqueous solutions of SG were prepared by neutralizing glycine dissolved in double-distilled water with an equimolar amount of sodium hydroxide. The solutions were stirred continuously until complete dissolution.[7] The concentrations of the solutions were expressed as mass fractions, denoted by w. An electronic analytical balance (Sartorius, model BSA-224S-CW) was used for all mass measurements with an accuracy of $\pm 1\times10^{-4}$ g. The solvent concentrations were 0.10, 0.20 and 0.30 mass fractions, which are relevant to commercial applications for the CO_2 removal process. Moreover, the selected concentration range represented the low, medium and high concentrations of amino acid salts, which are commonly used for systematic investigation of concentration effects on the corrosion rate and comparison with the literature. In addition, the purpose of selecting these solvent concentration ranges was to avoid solvent precipitation during CO_2 absorption.[8,9]

Specimen description and preparation

Two types of specimens were used in this work, stainless steel (SS304) and carbon steel (CS1018). These specimens are also called corrosion coupons. The coupons can be rectangular, cylindrical, or disc-shaped, with various dimensions. The dimensions of the test coupons are selected according to the conditions of the tests and the facilities available for corrosion testing. Carbon steel and stainless steel are selected in this study because they are widely used in the fabrication of equipment, accessories, and pipelines in CO_2 capture plants.[1] The corrosion coupons were purchased from Metals Samples Inc., USA. The coupons were shipped in individual vapor corrosion inhibition (VCI) bags to prevent vapor and atmospheric corrosion of the coupons. The coupons are rectangular, having dimensions of (1/16″ thick×1/2″ wide×3″ length). The coupons have 3/16″ diameter hole located 1/4″ from an end centered with 1/8″ radius corners. Besides, all the coupons were pre-weighed and stenciled with sequential numbers and alloy codes to avoid confusion during exposure. As an example, the coupons used in this study are shown in Fig. 1a (SS304) and b (CS1018). The chemical composition of the coupons SS304 and CS1018 is given in Table II.

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Fig. 1. Corrosion coupons.

TABLE II. Chemical composition (%) of corrosion coupons used in this study

Element	Sample	
	SS304	CS1018
Carbon	0.0575	0.1900
Manganese	1.6540	0.6700
Phosphorus	0.0330	0.0300
Sulfur	0.0010	0.0010
Chromium	18.1630	0.0300
Nickel	8.0340	0.0400
Copper	0.4700	0.0800
Molybdenum	0.3370	0.0200
Nitrogen	0.0650	0.0070
Iron	Balance	Balance

The specimens were prepared before use by grinding with silicon carbide waterproof abrasive papers with a grit range from 120 to 600, supplied by Saie Brand, China. The specimens were then cleaned with deionized water, degreased with acetone and dried with dry air. Finally, the prepared specimens were stored in a desiccator for corrosion experiments. The prepared specimens were handled carefully with gloves and tweezers to avoid contamination of the specimen surface. The method of preparing the specimens was performed according to ASTM G1-90.[10] The prepared specimens were used within 24 h of preparation.

Weight loss method for corrosion measurement

Corrosion testing using weight loss technique is the simplest and longest-established method to measure uniform corrosion. In this method, a weighed coupon of metal or alloy is immersed in the test solution under certain conditions (which var according to the objectives of the study) for a reasonable period, depending upon the experimental objectives and test design. Later, the coupons were removed and cleaned of all corrosion materials and reweighed. The weight loss of the metal was then used for the calculation of the corrosion rate.[11,12] In this study, the weight loss technique was used because it is widely used in laboratories and industries due to a number of attractive features.[12] The corrosion experiments are easy to conduct using the weight loss method because no sophisticated or complex instruments are required. The measurement is direct and does not require theoretical assumptions. This technique is applicable to all kinds of corrosion environments, which makes it versatile. Apart from these, it is a low-cost technique, flexible with respect to experimental facilities available in laboratories, and allows simultaneous evaluation of various materials and test solutions under various test conditions. Despite being the oldest method of corrosion measurement, the weight loss method remains widely used due to the versatile features described above.

Experimental procedure

The simple immersion corrosion method was used in this study, and the general corrosion rate was calculated using the weight loss method. The fundamental procedure of immersion

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corrosion tests was followed according to the guidelines of ASTM G-31-72 (Standard Practice for Laboratory Immersion Corrosion Testing of Metals),[11] The setup consisted of a corrosion bottle (250 mL, Schott Duran), nylon strings (0.45mm, No.2, Ofmer Company) for holding the corrosion coupon, a pH meter (SCHOTT instruments), and a heating system (hot plate/water bath/oven). In this study, an oven was used for heating. All the corrosion experiments were carried out at atmospheric pressure. The test solutions were prepared as described. The corrosion bottles filled with 250 mL of test solution were purged with CO_2 until saturation at ambient temperature. Later, before immersing the coupons in the test solution, the coupons were weighed using an electronic analytical balance (Sartorius, model BSA-224S-CW) with an accuracy of $\pm 1\times10^{-4}$ g. The corrosion coupons were immersed in the corrosion bottles by hanging them with a nylon string across the opening of the corrosion bottle. The coupons were suspended and positioned at the center of the corrosion bottle to ensure complete immersion of the coupons in the test solution and prevent them from touching the bottom of the bottles. The bottles were then firmly closed with the screw lid.[13] The corrosion bottle was labeled with the name of the test solution, identification of the coupons (type of alloy and coupon number), while the date, and time of immersion were recorded.[11,14,15] Finally, the corrosion bottle was placed in the preheated oven at 303.15 K for 240 h.[12,13,16] Similarly, other experiments were conducted at 313.15 and 333.15 K for the same exposure time. The temperature range (303.15, 313.15 and 333.15 K) was selected based on the practical range of absorption temperatures in CO_2 capture plants and to study systematic effect of temperature on the corrosion rate.[17,18] The time of exposure in these types of experiments can vary from 24 to 240 h.[19] A short exposure time may sometimes give erroneous results. It is recommended to use a longer exposure time (240 h) in order to get more realistic results.[11-13,18] The selected time duration of 240 h is sufficient and considered a long exposure time that produces a measurable corrosion rate and stable corrosion behavior[11-13,18] This exposure time is also suggested in ASTM G-31-72.[12] Each experiment was performed in triplicate to obtain reproducible results, and the average results were reported. The results were accurate within ±10 %.

Post-exposure cleaning of specimens

After completion of the test duration (240 h), the test bottles were removed from the oven and the specimens were withdrawn from the bottles. Before cleaning the coupons, their appearance was observed and recorded properly. The variation in the test solutions was also observed. Although these observations are qualitative, they can provide useful information during analysis of the corrosion results. Cleaning the coupons after a test is an important step in corrosion measurement. The procedure for post-cleaning of coupons was followed according to ASTM G1--90 standard.[10] The coupons were washed with running tap water, cleaned with a non-metallic brush and chemically washed. Later, the coupons were scraped with at least two different grit abrasives until the surfaces were free of the remaining corrosion products. The coupons were then washed with acetone, dried and weighed using an analytical balance. The cleaning cycles were repeated few times until the constant weight loss was obtained by plotting the number of cleaning cycles versus a mass.[8] During the post-cleaning, care should be taken to avoid the removal of base metal.

Calculation of corrosion rate

The corrosion rate of SS304 and CS1018 in the test solutions was calculated according to ASTM G1-90 (Standard Practice for Preparing, Cleaning and Evaluation Corrosion Test Specimen). Since the weight loss method was used in this study, the initial and final weights of the

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specimen were used for estimating the corrosion rate. The following equation was used to calculate the corrosion rate:[9,10]

$$CR = \frac{KW}{ATD} \tag{1}$$

where CR is the corrosion rate in mpy, K is the constant factor (5.34×10^5), W is the mass loss in g, A is the area (3.38 square inches), T is the time of exposure (240) in h and D is the density of the alloy (SS304: 7.94; CS1018: 7.87) in $g\cdot cm^{-3}$.

RESULT AND DISCUSSION

Comparison of corrosion rate of monoethanolamine with the literature

The corrosion rate of MEA at a mass fraction of 0.30 was measured at various temperatures (303.15, 313.15 and 333.15 K) in order to compare the results with literature. The corrosion rate of MEA at 313.15 K was compared with previous work,[20] since the data are not available in the literature at other temperatures. The comparison is shown in Fig. 2. The experimental values of the corrosion rate at 313.15 K are in the range of those reported in the literature for MEA at a mass fraction of 0.30 at 313.15 K.[20]

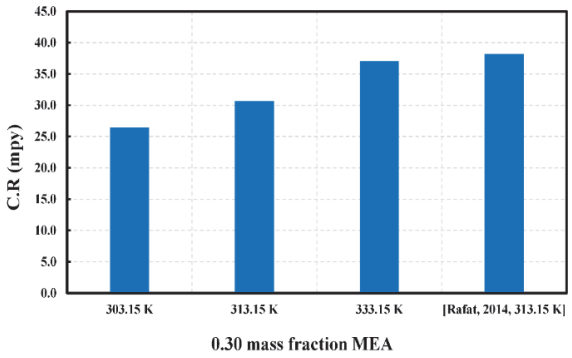

Fig. 2. Corrosion rate of 0.30 mass fraction MEA and comparison with the literature.

Corrosion rate of aqueous SG solutions

The corrosion rate of SS304 and CS1018 in aqueous SG solutions was measured by weight loss technique at three different temperatures (303.15, 313.15 and 333.15 K) and at various mass fractions (0.10, 0.20 and 0.30). Each experiment was conducted three times, and the average results were reported. The process parameters of interest in this study for corrosion measurement are temperature, concentration and type of metal. Therefore, the effects of these parameters on the corrosion rate were studied using the weight loss technique.

Effect of temperature on corrosion rate

Temperature is an essential parameter that influences the rate of corrosion. Therefore, in this study, the effect of temperature on the corrosion rate of SS304

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and CS1018 was investigated at the three different temperatures mentioned above. From the analysis of the corrosion results, it was found that temperature has a significant influence on the corrosion rate of both SS304 and CS1018 in aqueous SG solutions. The rate of corrosion increases with an increase in the system temperature, as shown in Fig. 3a and b. This suggests that increasing the solution temperature increases the kinetic energy of the species, thereby accelerating the iron dissolution and thus enhancing the corrosion rate.[21,22] The corrosion reaction (iron dissolution) is:

$$\mathrm{Fe{+}HCO_3^-} \rightarrow \mathrm{FeCO_3} + \mathrm{H^+} + 2\mathrm{e^-} \tag{2}$$

Moreover, increasing the temperature increases the mobility of reacting species by increasing the diffusion of ions of the reactive species to the metal surface, thereby increasing the corrosion rate.[4,24] Moreover, passive oxide films may become unstable and more porous at elevated temperatures, thereby accelerating the iron dissolution process.[21–23] Similar trends have been observed for various amine solutions.[3,4,24,25] By further investigating the effect of temperature on the corrosion rate, it was observed from Fig. 3a and b that the effect of temperature from 303.15 to 313.15 K is smaller than that from 313.15 to 333.15 K for both metals and at various concentrations. The corrosion rate increased significantly from 313.15 to 333.15 K, which suggests that the corrosion process is dependent on temperature. This trend could be due to increase in corrosion reaction kinetics at high temperatures. These trends are the same as those reported in the literature for various solvents used for CO_2 capture.[3,4,24,25] Moreover, the effect of temperature on the corrosion rate of SS304 is smaller than that on CS1018 for aqueous SG solutions. This could be due to the fact that SS304 is significantly less susceptible to corrosion than CS1018. Therefore, an increase in temperature does not greatly affect the corrosion of SS304 in aqueous SG solutions. At the highest studied temperature (333.15 K) and the highest concentration (0.30 mass fraction), the corrosion rate of SS304 in aqueous SG solutions was 3.291 mpy. Similarly, the corrosion rate of CS1018 under the same conditions was 32.203 mpy in aqueous SG solutions.

Furthermore, the effect of temperature on the corrosion rate of SS304 and CS1018 followed Arrhenius behavior:

$$\log C.R = \log A - \left(\frac{E_\mathrm{a}}{2.303RT} \right) \tag{3}$$

where $C.R$ is the corrosion rate (mpy), A is the Arrhenius pre-exponential factor, $E_\mathrm{a}/2.303R$ is the slope of the equation, in which E_a is the activation energy (J/mol), R is the universal gas constant (J/(K mol)), and T is the temperature in K. From Eq. (3), the plot of log $C.R$ *versus* $1/T$ gives straight lines, as shown in Fig. 3a and b. From the Arrhenius plots, the effect of temperature on the corrosion rate of SS304 and CS1018 in aqueous solutions of SG is more obvious.

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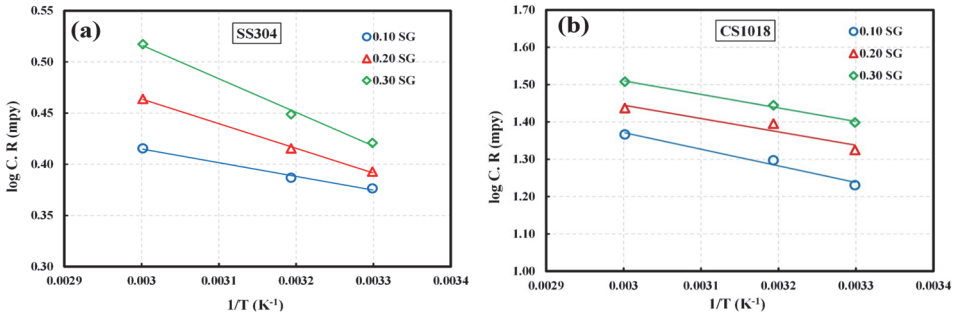

Fig. 3. Arrhenius plot for corrosion rate of: a) SS304 and b) CS1018 in aqueous SG solutions at various concentrations.

Moreover, the Arrhenius equation given above can also be used for the prediction of the corrosion rate of SS304 and CS1018 in aqueous SG solutions. Therefore, for the validation of experimental results, the corrosion rate data of the studied solvent were also predicted using Eq. (3) and its coefficients. The validity of experimental and predicted data was assessed statistically by estimating the deviation between the two datasets. The values of Arrhenius pre-exponential factors (A), slopes of the lines ($E_a/(2.303R)$, R^2 and SD are given in Table III for aqueous SG solutions.

TABLE III. Corrosion rate correlation parameters for aqueous SG solutions

w(SG)	$E_a/2.303R$	A	R^2	SD
		SS304		
0.10	133.72	6.547869	0.9909	0.0088
0.20	240.73	15.34264	0.9984	0.0071
0.30	328.45	31.75411	0.9948	0.0188
		CS1018		
0.10	445.82	511.564	0.9762	0.3802
0.20	357.74	329.6856	0.9048	0.7842
0.30	362.91	397.1001	0.994	0.2195

Effect of concentration on corrosion rate

It is essential to study the effect of the concentration of SG on the corrosion rate of SS304 and CS1018. Different concentrations of the solvent give different corrosion rates of both metals. Therefore, in this study, the corrosion rate of SS304 and CS1018 in aqueous SG solutions was measured at different concentrations (0.10, 0.20 and 0.30 mass fractions). The graphical representation of the effect of concentration on the corrosion rate of SS304 and CS1018 in aqueous SG solutions at various temperatures is shown in Fig. 4a and 4b.

From the analysis of corrosion results, it was found that the corrosion rate increases with increasing concentration of SG in the solution. This trend is due to

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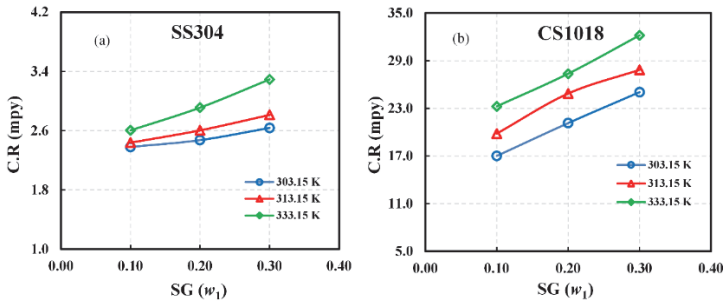

Fig. 4. Effect of concentration on the corrosion rate of: a) SS304 and b) CS1018 in aqueous SG solutions at various temperatures.

the fact that when the concentration increases, the absolute amount of CO_2 absorbed increases, which results in a higher number of bicarbonate ions and protonated amines. The increasing number of bicarbonates and protonated amines causes a greater rate of iron dissolution and hence increases the corrosion rate. Moreover, a higher concentration also increases the ionic strength and electrical conductivity, thus facilitating the charge transfer and increasing the iron dissolution. Additionally, the increased concentration of amino acid salts helps to form metal–amino acid complexes. The formation of these complexes restricts the development of protective layers on the metal surface, thereby exposing the metal to the reacting species and increasing corrosion.[26,27] The same trend has been observed in the literature for various amines.[20,24] Moreover, the effect of concentration on the corrosion rate of SS304 is much lower than that on CS1018. This may be due to the fact that SS304 is significantly less susceptible to corrosion than CS1018. However, the trend still shows an increasing tendency similar to that observed for CS1018. On further analyzing the results, it was observed that at a fixed temperature (303.15 K), the corrosion rate of SS304 in aqueous SG solution increased from 2.379 to 2.636 mpy (10.80 % increase) when the concentration was increased from 0.10 to 0.30 mass fraction. However, the effect of concentration on the corrosion of CS1018 in SG solution is significantly higher than that observed for SS304. At a fixed temperature (303.15 K), an increase of about 47.26 % in the corrosion rate of CS1018 in aqueous SG solution was observed when increasing the concentration from 0.10 to 0.30 mass fraction. From the above facts, it is quite apparent that corrosion rate of CS1018 is largely influenced by the concentration of aqueous SG solutions. On average, the corrosion rate increased by almost 40 % when the concentration increased from 0.10 to 0.30 mass fraction. These results suggest that SS304 is corrosion resistant even at high concentrations, while CS1018 is significantly susceptible to corrosion at high SG concentrations. These results could significantly aid the selection of appropriate materials of construction for CO_2 capture plants. Moreover, the results also provide significant guidance for selecting

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the appropriate solvent concentration for the CO_2 capture process, so that the corrosion problem could be minimized.

Effect of the type of metal on corrosion rate

The appropriate material selection for a CO_2 absorption column is essential because it affects the capital and operational costs of the CO_2 capture process.[28] In general, two types of metals, SS304 and CS1018, are widely used for the fabrication of CO_2 capture plants.[1,2,4] For every new solvent, it is very important to investigate the corrosion rate of these two materials in the new solvent prior to solvent selection.[29] Therefore, in this study, the corrosion rate of SS304 and CS1018 in aqueous solutions of SG was investigated at three different temperatures (303.15, 313.15 and 333.15 K) and at various concentrations. The comparison of corrosion rate data of SS304 and CS1018 at various temperatures and concentrations is presented in Fig. 5 for aqueous SG solutions.

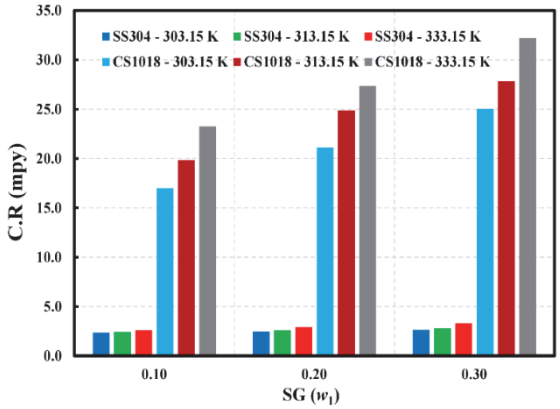

Fig. 5. Comparison of the corrosion rates of SS304 and CS1018 in aqueous SG solutions at various temperatures.

From the analysis of the data, it was found that SS304 is significantly less susceptible to corrosion than CS1018, as is evident from Fig. 5, at various temperatures and concentrations. The highest corrosion rate of SS304 at the highest temperature (333.15 K) and the highest concentration (0.30 mass fraction) was 3.291 mpy in aqueous SG solutions. This corrosion rate of SS304 is considered negligible.[24] In other words, it can be said that the corrosion rate of SS304 in aqueous solutions of SG is negligible and can be neglected. This evidence suggests that SS304 is a highly corrosion-resistant material in aqueous SG solutions. On the other hand, CS1018 is more susceptible to corrosion than SS304. Moreover, the highest corrosion rate of CS1018 at the highest temperature (333.15 K) and the highest concentration (0.30 mass fraction) was 32.203 mpy in aqueous SG solutions. Based on this comparative analysis of the two metals, SS304 can be a better

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material for the construction and fabrication of a CO_2 absorption plant than CS1018.[30,31]

The higher corrosion resistance of SS304 can be attributed to the fact that under the test conditions of this study, SS304 did not significantly undergo active dissolution process, whereas CS1018 was in the active dissolution state. Alloys such as SS304 can easily form passive films (chromium oxide), which provide corrosion protection.[24] Initially, during the immersion of corrosion coupon specimens in the test solutions, these specimens were clean and film-free and exposing these fresh test specimens with more anodic and cathodic sites to the aqueous SG solution favored the corrosion process.[24] Since the passive film layer on the SS304 surface forms more readily, no severe dissolution occurred even after long immersion time. The formation of passive films suppressed the iron dissolution process, thereby reducing the corrosion rate.[32–34] In the case of CS1018, the active dissolution process continued for some time, and passive films did not form readily, resulting in greater dissolution and a higher corrosion rate of CS1018. This suggests that passive film formation plays a crucial role in corrosion protection.[32,34,35] In this study, passive films on CS1018 did not form; therefore, a higher corrosion rate was observed for CS1018. Similar trends in the corrosion behavior of SS304 and CS1018 in aqueous amine solvents have been observed and reported elsewhere.[17,18] The above findings indicate that SS304 is the superior and preferred material of construction for the fabrication of CO_2 capture plant and accessories compared with CS1018.

Comparison of corrosion rate of the solvents

The corrosion rates of various solvents studied in this work are compared in terms of their performance in corrosion protection. It is crucial to analyze and compare the corrosion tendency of various solvents to be used for CO_2 capture. Since an alloy like SS304 is considered slightly corrosive, the comparison is only made for the corrosion rate of CS1018 in solvents such as SG, MEA, MDEA and DEA. Moreover, since the data on the corrosion rate of CS1018 in amine solvents are also very scarce and scattered, a possible comparison of the corrosion rate in the solvents studied in this work is made with amine solvents at 313.15 K. Fig. 6 shows the comparison of corrosion rates among various solvents. The concentration of the solvents expressed as a mass fraction. From Fig. 6, it is apparent that the solution of SG is less corrosive than amine-based solvents. Among the amines, DEA has lower corrosion rate than other amines, however, it is still higher than that of amino acid salts. Aqueous SG solution has a lower corrosion rate than MEA and DEA. From the above observations, the corrosion rate of the solvents shown in Fig. 6. follows the order MDEA > MEA > DEA > SG. These results suggest that aqueous amino acid salts could potentially be used for CO_2 capture from various gas streams. The comparative analysis of the corrosion data of different solvents will

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design engineers and corrosion consultants in the selection of an appropriate material of construction for the fabrication of a CO_2 absorption plant and accessories.

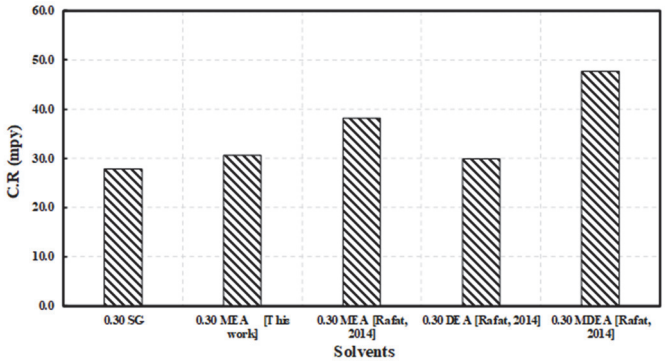

Fig. 6. Comparison of corrosion rates of different solvents at 313.15 K.

CONCLUSION

The corrosion study of two metals, SS304 and CS1018, in aqueous SG solutions was carried out at different temperatures (303.15 K, 313.15 K and 333.15 K) and concentrations (0.10, 0.20 and 0.30 mass fractions). The measured corrosion rates of SS304 and CS1018 in aqueous SG solutions showed an increasing trend with increasing temperature and concentration. The effect of temperature on the corrosion rate of SS304 was marginal; however, this effect was significant for CS1018. Similar to the temperature effect, the concentration effect on SS304 was also trivial, but significant in the case of CS1018. The corrosion rate data of aqueous SG solutions were correlated by an Arrhenius type equation, and good agreement was found between the predicted and experimental data, as shown by low values of the estimated standard deviation (*SD*). Therefore, the Arrhenius type correlation can be used for the prediction of the corrosion rate of SS304 and CS1018 in various solvents. Moreover, it is worth mentioning that SS304 much less susceptible to corrosion; hence, SS304 can be considered non-corrosive. However, CS1018 was considerably more susceptible to corrosion in the studied solvents. The corrosion rates of various solvents were compared and followed the order MDEA > MEA > > DEA > SG. Overall, solvents studied in this work showed a lower corrosion rate than the amine solvents. Therefore, these solvents could potentially be used for commercial applications in CO_2 removal. Additionally, the corrosion rate data obtained in this study can be used for the appropriate selection of solvents for CO_2 capture, and materials of construction for the fabrication of a CO_2 absorption plant and accessories. An additional notable contribution of the present work is the investigation of the corrosion rate of metals in aqueous SG solution using SS304 and CS1018 at various temperatures. This provides a large corrosion database, which would help design engineers and corrosion consultants in the selection of

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an appropriate material of construction for the fabrication of a CO_2 absorption plant and accessories. Moreover, the reported experimental data on the corrosion rate will also guide the selection of an appropriate solvent for CO_2 capture.

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ИЗВОД

СТУДИЈЕ КОРОЗИЈЕ НЕРЂАЈУЋЕГ ЧЕЛИКА И УГЉЕНИЧНОГ ЧЕЛИКА У ВОДЕНИМ РАСТВОРИМА НАТРИЈУМ-ГЛИЦИНАТА КОЈИ СЕ КОРИСТЕ ЗА ВЕЗИВАЊЕ CO_2

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Корозија је добро познат и озбиљан проблем у процесу апсорпције угљен-диоксида (CO_2), што узрокује огромне трошкове одржавања за санацију кородиране опреме и цевовода. Водени раствор натријум-глицината (SG) је потенцијални растварач за хватање CO_2. Студија корозије SG растварача је веома важна за његову практичну примену, јер су такви подаци веома ограничени у доступној литератури. Стога, да би се решио овај значајан јаз, у овој студији су испитане брзине корозије нерђајућег челика (SS-304) и угљеничног челика (CS-1018) применом методе губитка тежине коришћењем SG растварача на три различите температуре (303,15, 313,15 и 333,15 K) и концентрације од индустријског значаја (масени удео од 0,10, 0,20 и 0,30). Резултати су показали да је SS304 показао занемарљиву корозију у НГ растварачу са маргиналним утицајем температуре и концентрације. Међутим, значајан утицај температуре и концентрације је примећен на брзину корозије CS1018 у SG растварачу. На највишој проучаваној температури од 333,15 K и високој концентрацији (0,30 масени удео), брзина корозије SS304 и CS1018 у SG растварачу је 3,291 и 32,203 mpy, редом. Штавише, брзина корозије CS1018 у SG растварачу је упоређена са метилдиетаноламином (MDEA), моноетаноламином (MEA) и диетаноламином (DEA). Утврђено је да SG растварач показује мању корозивност од различитих аминских растварача. Резултати ове студије пружају смернице за практичну примену SG растварача у процесу хватања CO_2. Такође, добијени подаци би могли значајно помоћи инжењерима пројектантима да успоставе одговарајуће радне услове процеса хватања CO_2 како би се контролисала корозија.

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