Journal of Engineering in Industrial Research

2021, Volume2, Number 3

Original Article: Optimization of Corrosion Information in Oil and Gas Wells Using Electrochemical Experiments

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Citation: M. Akhtarian. Zand., Optimization of Corrosion Information in Oil and Gas Wells Using Electrochemical Experiments. *J. Eng. Indu. Res.* 2021; 2(3):149-155.

10.22034/jeires.2021.278003.1032

Article info:
Received: 20 January 2021
Accepted: 30 April 2021
Available Online: 03 May 2021
Checked for Plagiarism: Yes
Peer Reviewers Approved by:
Dr. Amir Samimi
Editor who Approved Publication:
Professor Dr. Mohammad Haghighi

Keywords:
Corrosion reactions, Interaction rate, Activation energy, Electrochemical data.

ABSTRACT

Corrosion reactions are often complex heterogeneous reactions that are accelerated by the interaction of factors such as: a) Ordinary kinetic considerations like as activation energy, b) the chemical composition of the electrolyte, c) the mass transfer between the electrolyte and the metal surface, and d) different surface effects such as surface adsorption, repellency and surface. The interactions between these factors make it difficult to reproduce electrochemical data or the exact conditions that cause a metal to be eaten. These are experimental factors that should be considered when testing corrosion, i.e. measurements, and test batteries. Ignoring these factors can produce data that do not provide the true corrosion behavior of the test metal under study. In this paper, the relationship between inherent corrosion measurement errors and suggestions on how to handle the variability of electro data A chemical solution was presented.

Introduction

Corrosion reactions are often complex heterogeneous reactions that are accelerated by the interaction of factors such as: a) Normal kinetic considerations like as activation energy, b) the chemical composition of the electrolyte, c) the mass transfer between the electrolyte and the metal surface, and d) different surface effects such as surface adsorption, repellency and surface. The interactions between these factors make it difficult to reproduce electrochemical data or the exact conditions that cause a metal to be eaten [1-5]. These are experimental factors that should be considered when designing corrosion tests, i.e. measurements, and test

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batteries. Ignoring these factors can produce data that do not provide the true corrosion behavior of the test metal under study. Ignoring the neutralization of solution resistance, for example, can produce an electrochemical corrosion rate that is below the actual velocity estimate and can lead to a metal structure whose thickness is not sufficient to prevent failure due to corrosion narrowing. Fortunately, errors in electrochemical corrosion measurements can be minimized by controlling several experimental factors [6-8].

Electrochemical experiments

Figure 1 shows an electrochemical corrosion test battery consisting of three electrodes immersed in an electrolyte. The volume of the specified acetate shows potential flow changes. Since the change in electrode potential from the open circuit potential is referred to as the formation of two poles, the electric current must be recovered simultaneously and symmetrically from a test electrode when current is provided, by the acetate potential, to the reverse electrode and vice versa to maintain electronic equipment and electrical neutrality. The two poles of the test electrode are measured as the potential difference between the reference and the test electrodes. No electric current flows between the acetate potential and the reference electrode, so it stays in its open circuit potential and provides a fixed reference point for corrosion measurements [9-11].

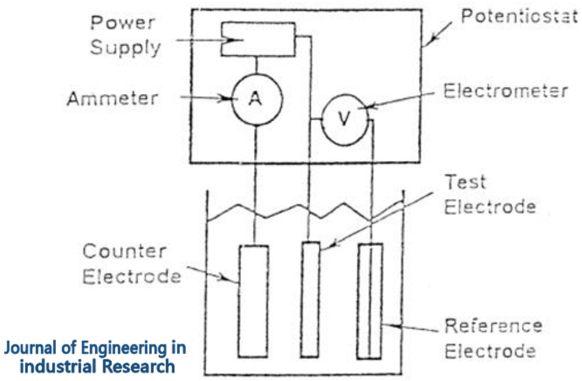

Figure 1. Schematic of a three-electrode test chamber

The reference electrode is also used to provide feedback for the acetate potential, so that the potential of the test electrode can be seen and adjusted to a desired level. The relationship between the electrode potential spectra and their associated electrical currents, or the range of voltage frequencies and apparent resistance values can be used to determine corrosion behavior, such as:

- If a metal turns ineffective (not eaten);
- If pitting corrosion occurs;
- If the coating protects against corrosion;
- If metal corrosion occurs despite the coating. Current data - potential or frequency - apparent resistance can be used to determine corrosion parameters;
- Electric capacitance of two electric layers;
- Corrosion rate; and,
- Corrosion resistance; and
- If the electrical capacity of the coating is effective and the resistance is up-to-date [12].

What happens when current flows between the test and reverse electrodes?

The formation of two poles of the test electrode is controlled by a potentiostat that provides electrons for the reverse electrode or test, such as cars leaving the highway every hour and controlled by the number of cars entering the highway every hour. But everyone knows that the number of cars entering the highway per hour does not always control the number of cars leaving each hour. Other factors such as the number of open roads, weather, road conditions, accidents, slow cars and the number of cars on the highway can affect the number of cars leaving each hour. Similarly, there are many factors other than the potential acetate current that can control the amount of contrast between the two electrode poles. Examples of these factors are:

- The chemical composition of the test electrode,
- Test and reverse electrode surface condition,
- Geometric shapes of test and reverse electrodes,
- Inverted electrode size,
- The chemical composition of the electrical double layers, and
- The chemical composition of the electrolyte [13-16].

Contradiction of the two electrode poles causes certain processes in the electrolyte to occur that can limit the electric current during the measurement of electrochemical corrosion, such as traffic congestion hours or road conditions that can create conditions in which the number of cars leaving per hour restricts the highway. Figure 1 shows the outline of an experimental battery in which a reference electrode is ejected to allow space to show the various processes that take place during two-pole opposition. Visualized ions (machines on the highway) respond to electrode polarization (traffic congestion time) by moving between the reverse electrodes and the test (input and output paths, respectively) in order to maintain the electrical neutrality of the electrodes and the electrolyte [17-19].

Electrochemically, the active species move in the opposite electrode and react with electrons provided by the acetate potential. The acetate potential in Figure 2 provides electrons for the reverse electrode, which causes positive ions (cations) to move toward the reverse electrode. The acetate potential discharges the electrons from the test electrode and the negative ions move towards the test electrode [20].

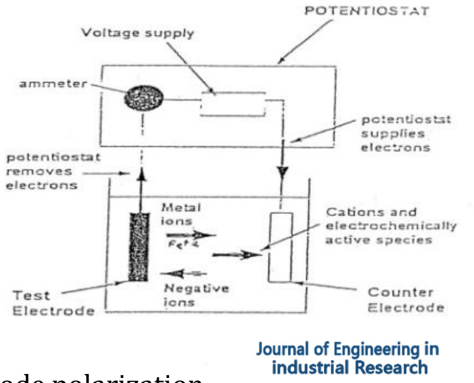

Figure 2. Fluid flow during electrode polarization

There are situations where corrosion data do not reflect actual corrosion because one or more of the processes shown in Figure 2 do not behave ideally. For example, if the metal of the test electrode is able to lose 2,000,000 electrons per second (visualizing the output road on routes longer than the highway), but the reverse electrode can only lose 1,000 electrons per second to reduce electrode types. The acetate potential will then only be able to dissipate 1000 electrons per second from the test electrode, even if it can dissipate twice the number of electrons per second. The next section discusses how the properties of an electrolyte can reduce the current velocity expelled from the test electrode by an acetate potential, thereby discussing electrochemical data and its relationship to actual corrosion behavior and velocity [21].

How solution resistance affects corrosion data

Imagine a slow-moving car slowing down other cars stuck in heavy traffic, thus reducing the number of cars entering and exiting the highway every second. Slow-moving ions, like slow-moving machines, can limit the amount of electric current flowing from the electrode. In open circulation, ion potentials need to move at short distances between the cathode and anode locations on the rusting metal surface to maintain the metal's electrical neutrality, so ion motion has little or no corrosion effect.

But during electrode polarization, ions often travel longer distances along current paths established by an electrical strand between the test and reverse electrodes in an electrolyte. The velocity of the ion along these flow paths is determined by the dynamics of the ion. The ideal electrolyte ions move along the current paths so fast that the ion motion does not limit the electric current of the acetate potential. True electrolyte ions can hardly be used along current paths to the potential to move ions between electrodes instead of polarizing the test electrons provided [22].

Consequently, the potential used is different from the polarization potential, and a method must be used to ensure that the potentials of the tested electrodes are at the desired level. Therefore, there is a need for a reference electrode to see and provide feedback to match the potential of the test electrode. The best and most ideal way to measure the potential of the test electrode during polarization is to place the reference electrode on the surface of the test electrode. However, placing the reference electrode on the surface of the test electrode blocks the movement of the ionic current to the test electrode at the point of contact and can lead to hole-type corrosion. Subsequently, the reference electrode should be spaced as far as the diameter of the two reference electrodes from the surface of the test electrode to prevent blocking of the test electrode. Unfortunately, separating the reference and experimental electrodes can create a potential difference between them, referred to as IR-drop, which prevents the true polarization of the electrode from being measured. The electrical resistance associated with IR-drop is referred to as the resistance of the neutralized solution, and the mathematical expression of the resistance of the neutralized solution is as follows: The resistance of the neutralized solution is ohm, d is the distance between the test and reference electrodes in centimeters the specific resistance of the solution is in ohms per centimeter, and A is the area of the electrode in square centimeters.

Correction of electrochemical corrosion data for neutralized solution resistance

Current cut-off method

The current cut-off method emphasizes the fact that the volume is zero when a current is not provided by the acetate potential, equal to the acetate potential current multiplied by time, and the means of determining how much the acetate potential is due to the resistance of the neutral solution that is not provided. The acetate potential is programmed to cut off the acetate potential current at short intervals, a few nanoseconds, and subsequently measure the potential of the test electrode while the current is zero. The acetate potential programs are to adjust the applied voltage to the value, thus neutralizing the resistance of the neutralized solution, and the acetate potential resumes or decreases the polarization of the test electrode from the data set [23].

There are situations where the resistance of the solution and the potential flow of the acetate are so low that it is negligible and there is no need for a current cut-off method to correct the potential used. Using a current cut-off in this example can generate a lot of electronic noise in the current-potential data, as shown in the rotational polarization curve in Figure 1. The streaks seen in the upper curve are electrical noise caused by the power outage process. Keep in mind that the noise level is lower for the upper curve when the currents are 6-10 amps per square centimeter or more. The lower curve in Figure 1 shows what a non-intermittent curve looks like. Notice how much smoother the lower curve is when there is no power outage. In Figure 1 noise is generated by current cut-off when solution resistance and electric current are low [24].

Test Electrode Area

The corresponding equation (Equation 1) shows that the resistance of the solution can be reduced by increasing the electrode area, reducing the distance between the electrodes, and reduction of specific resistance of the solution.

The specific strength of the solution can be reduced by adding aqueous solution, mineral salts. There is a limit to how a reference electrode can be placed close to the surface of the test electrode. Therefore, reducing the reference electrode-test distance does not completely eliminate the resistance of the neutralized solution. As for reverse electrode area, imagine how close the slopes of the entrance can reduce the number of cars entering the highway per hour and consequently the number of cars leaving each hour. Using a small reverse electrode is similar to approaching downhill routes at the highway entrance. Reducing the area of the reverse electrode, or reducing access to the surface of the reverse electrode, reduces the room for electrochemically reduced types of electrons by electrons and limits the electric current of the acetate potential discharged from the test electrode. often used to reduce the current limitation with the electrode area. A reverse electrode whose geometric area is at least twice the area of the test electrode that is often used when it is not practical to use reverse platinum electrodes.

Geometric shape of the test electrode

The electrical neutrality of the polarized electrode is maintained by the movement of positive and negative ions along the current paths established by an electrical strand between the test and reverse polarized electrodes in an electrolyte. Electrochemically active species can also move along current paths, especially when ions resemble hydrogen ions.

Statistical tests without parameters to compare the data set

Non-parametric statistical tests can be used to determine whether the results obtained from two variables are the same without having to a) specify what kind of statistical distribution is for the data, or b) use A large number of iterations (for example, up to 100) until normal statistical tests (e.g., t-test) can be applied to the data. For example, the man-Whitney test can determine whether the corrosion currents for 304 and 316 stainless steels are statistically the same when the number of repetitive measurements for each grade is small (e.g., 5 repetitions). Normal statistical tests (eg t-test) require more patterns for the same determination. Reference numbers 23 and 24 at the end of this chapter include discussions on how to use non-parametric statistics, such as rank, degree, and chi field experiments.

Conclusion

Reverse analysis (often referred to as curve fit) is the most common type of statistical analysis used for corrosion data. Reversal analysis should always be accompanied by analysis of variance and residual analysis. The reported return equations (models) without these two statistics are not properly validated and should be viewed with suspicion. This brief discussion of statistics involves two reasons:

1- To strengthen the need for corrosion scientists and engineers to perform repetitive electrochemical corrosion measurements;

2- To encourage engineers and scientists to use appropriate statistical analysis techniques. In this article, first the radiographic image of the tube was introduced as input to the software and after performing various processing, the software output was an image that detected deposits and corrosions up to 1.5 mm high.

3- The type of image determined how the content software treats the data for each pixel, as corresponding gray levels. These four types are: binary, indexed, gray, and RGB images. A gray image is a matrix whose values represent light intensities in the range 0 to 255 (by default, the value is 0 in black and the value is 255 belongs to white).

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