Investigation of Adding Ethylene Diamine Tetra Acetic Acid (EDTA) as an Inhibitor of Calcium Carbonate (CaCO3)

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Abstract: The oil and gas industry requires scale inhibitors due to the inability to control scale formation which can cause many operational and economic problems. When oil and gas flow through a pipeline system, especially at certain temperature and pressure conditions, scale can form as a result of chemical reactions between minerals in the pipe walls. Decreased flow, increased pressure, or even equipment damage can be caused by this scale. The use of scale inhibitors is very important to stop scale formation, optimize the performance of production infrastructure, and maintain operational sustainability in the gas and oil industry. To overcome this, in this study ethylene diamine tetra acetic acid (EDTA) was used as a calcium carbonate (CaCO3) scale inhibitor using a method without the addition of crystal seeds (unseeded experiment) at a temperature of 90oC with variations in the concentration of the growth solution of 0,05; 0,075 and 0,1 M and inhibitor variations of 5,15,25,35, and 45%. The most effective percent effectiveness value obtained at a growth solution concentration of 0,05 M and an inhibitor concentration of 5% was 86.9%. The use of EDTA as a CaCO3 scale inhibitor using the unseeded experiment method can be considered as a solution as a scale inhibitor whose application can be used in the oil and gas industry.

1 INTRODUCTION

The oil and gas industry is an economic sector that plays an important role in the world economy. Oil and natural gas are valuable natural resources and are used to meet world energy needs and as raw materials for many products. Since the discovery of the first oil well in the 19th century, the oil and gas industry has developed rapidly. This industry involves the exploration, production, refining, and distribution of oil and natural gas to various countries around the world. Conveyance pipes are used in the oil and gas industry to convey crude oil, natural gas, and related products from production sources to processing or marketing facilities. Distribution pipes in this industry have an important role in maintaining the smooth production and distribution of energy resources (Rahman, 2015). One of the problems that often occurs in oil and gas industrial pipes is the reduction in pipe diameter which occurs due to the formation of salt deposits which accumulate along the flow and form a crust or scale (Ariyanto, 2013).

Scale is a hard layer that forms on the surface of an object due to the oxidation or burning process. Usually, scale forms when chemicals such as metals or minerals oxidize or react with other elements in the air or surrounding environment. The process of scale formation often involves the buildup of substances that form a hard layer that covers the surface of an object (Skinner et al., 2016). Scale that sticks to the pipe walls causes the diameter of the pipe to decrease, thereby inhibiting fluid flow so that the temperature

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and pressure increase and can cause the pipe to rupture (Ariyanto, 2013). This statement is in line with the research results of Suharso et al. (2014) who stated that scale formed on industrial equipment pipes is very disruptive and hampers the production process, causing time and financial inefficiencies.

In this research, a study will be conducted on effectiveness An inhibitor of ethylene diamine tetra acetic acid (EDTA) has been used by Wang et al. (2016) as an effective scale inhibitor to inhibit scale formation in the industrial sector.

2 MATERIALS AND METHOD

The materials used in this study were CaCl2 anhydrous, Na2CO3, distilled water, and Ethylenediaminetetraacetic Acid (EDTA). The tools used in this study were glassware that is often used in laboratories,water bath Thermoscientific brand AC 200/S21 from the United States, plastic cups, magnetic stirrer, spinbar, oven Innotech brand from China, analytical balance Arshwoth AA−160 brand from Japan.

2.1. Preparation of EDTA Acid Inhibitor

In the research, EDTA acid was used with varying concentrations of 5, 15, 25, 35, and 45%. Making an inhibitor solution with a concentration of 5% is done by taking 5 grams of EDTA, then diluting it with distilled water in a 100 mL volumetric flask, then homogenizing. The same treatment was carried out to prepare inhibitor solutions with concentrations of 15, 25, 35, and 45%.

2.2. Determination of CaCO3 Growth Rate by Adding EDTA Acid Inhibitor at Different Growth Solution Concentrations Using the Unseeded Experiment Method

The growth solution was made from anhydrous 0.05 M CaCl2 solution and 0.1 M Na2CO3 solution each with a total volume of 300 mL of EDTA acid with a predetermined concentration. Each solution was put into a beaker and stirred using a magnetic stirrer for 15 minutes at a temperature of 90°C to homogenize the solution. Then the 0.1 M anhydrous CaCl2 solution and 0.1 M Na2CO3 solution were mixed and stirred using a magnetic stirrer for 15 minutes at a temperature of 90°C to form a CaCO3 scale. The CaCO3 solution formed was put into 5 plastic cups of 50 mL each. After that, it was placed in a water bath at 90°C for 15 minutes to reach equilibrium. Observations were carried out for 60 minutes, in the first 20 minutes one glass was taken, then filtered using weighed filter paper, then dried using an oven at 105°C for 3-4 hours. Then the glass is taken again every 10 minutes until the last glass is reached. This experiment was repeated with varying concentrations of CaCl2 and Na2CO3 solutions of 0.075 and 0.1 M as well as varying concentrations of EDTA acid.

3 RESULT

Data from experiments carried out calculated the percentage of effectiveness and the data was input into Microsoft Excel. To determine the effectiveness of inhibitors in inhibiting the rate of formation of CaCO3 deposits, you can use the equation proposed by Patel (1999) as below:

$$\text{Inhibitor Effectiveness (\%)} = 100\% \times \frac{(Ca - Cb)}{(Cc - Cb)}$$

Where:

Ca = CaCO3 concentration after adding the inhibitor at equilibrium (g/L) Cb = CaCO3 concentration without inhibitor at equilibrium (g/L)

Cc = Initial CaCO3 concentration (g/L)

The results of the research showed that the 0.05 M growth solution had the highest percentage of effectiveness with the 5% inhibitor, namely 86.9%.

No.	Adding of Inhibitor (%)	Effectiveness of Inhibitor (%)
1	5	86.9
2	15	84.5
3	25	82.8
4	35	82.3
5	45	81.9

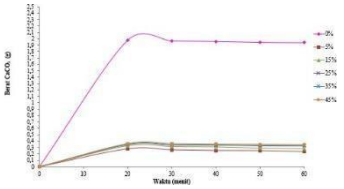

Fig 1. Data and Graphs Determination of CaCO3 Crystal Growth with Variation of Inhibitor Concentration in 0,05 M Growth Solution

In the 0.075 M growth solution the results that had the highest percentage of effectiveness werewith the 5% inhibitor, namely 64.1%.

No.	Adding of Inhibitor (%)	Effectiveness of Inhibitor (%)
1	5	69.8
2	15	67.3
3	25	65.7
4	35	64.6
5	45	64.1

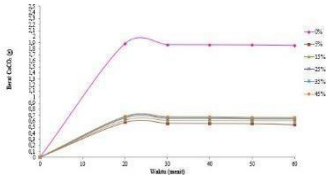

Fig 2. Data and Graphs Determination of CaCO3 Crystal Growth with Variation of Inhibitor Concentration in 0,075 M Growth Solution

In the 0.1 M growth solution the results that had the highest percentage of effectiveness werewith the 5% inhibitor, namely 61%.

No.	Adding of Inhibitor (%)	Effectiveness of Inhibitor (%)
1	5	69.8
2	15	67.3
3	25	65.7
4	35	64.6
5	45	64.1

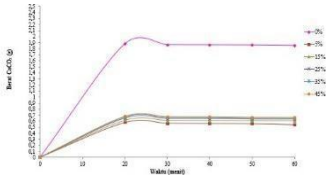

Fig 3. Data and Graphs Determination of CaCO3 Crystal Growth with Variation of Inhibitor Concentration in 0,1 M Growth Solution

4 CONCLUSIONS

Based on the results obtained in the study, it can be concluded as follows:

1. The ability of EDTA acid to inhibit the formation of calcium carbonate (CaCO3) scale was most effective in growth solution unseeded experiment with a concentration of 0,05 M and at concentration of 5% inhibitor with an effectiveness percentage value of 86,9 %.
2. The higher the variation in concentration and molarity, the effectiveness of the EDTA acid inhibitor decreases.

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