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Remaining Life Analysis using Ø 2 Inch Piping System Dehidration Gylcol Process in Gas Production

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Abstract. In the oil and gas industry, where there is a gas treatment process through a process of dehydration which is one of the most important processes in the process of CO2 Removal. This is a problem in the LNG plant if the CO2 content is still above 5%. The presence of CO2 and water content of the product will cause corrosion of the coating on the pipe where the pipe is used to distribute glycol of separator to the valve and frequent corrosion cause leaks. In this study, calculate the rate of corrosion and remaining life of the glycol dehydration process piping. This calculation uses the standard ASME B31.3 and API 570. In the analysis of the remaining life of 2-inch pipe B03 52 120 remaining life of the pipeline is lowest and the highest 3.83 years lifetime of the pipe is 6.9 years. The conclusion of this study determines that the output pipe valve separator heading shows the highest corrosion rate was 1.39 mm / year and the lowest was 0.81 mm / year. So which affect the rate of corrosion of pipes 2 inch diameter carbon steel material API 5L Grade A is the water content, pressure and temperature.

Keywords: Corrosion rate, remaining life, dehydration glycol, piping, API 5L Grade A.

1. Introduction

At this time in the oil and gas industry requires equipment that is very many, one of which is the production equipment. The production equipment is equipment that is essential in the production at the collecting station as well as to the process of separation in the oil and gas industry because of the components required to perform the production is separation equipment that support all other equipment [1], Then, the equipment is very important in the oil and gas industry is of pipe. Pipes is a path for the flow of fluid is needed in the world oil and gas industry [2].

Pipelines or pipe line is one component that serves to bring the fluid production (oil and gas) from a distribution point to other distribution points. Examples channelling of oil and gas in the offshore area (offshore) towards the area of land (onshore) using the system piping as oil or gas migration tool [3], Therefore, the integrity of a pressure vessel must be maintained over the remaining life.

This corrosion occurs because of chemical compounds such as CO2, H2S and chlorine compounds [4], This is certainly a problem and a big challenge to overcome the problem of corrosion in the transport pipeline. To reduce the level of repairs and cut repair time so that production and transportation of oil and gas is not impeded.Dehidration gycol or a glycol dehydration is a process for removing water contained in the feed gas, which if not removed would interfere with subsequent processes as well as damaging the equipment that will be passed along a feed gas [5].

2. Literature Review

2.1. Dehydration

Dehydration is the process of separation of water content in a gas stream. Interest Separation water content, in addition to preventing corrosion also prevent the formation of hydrate compounds and maximize the efficiency of the flow in the pipe [1], Glycol Dehydration of natural gas use triethylene glycol (TEG) or Diethylene Glycol (DEG) to remove water from the gas stream. The most commonly used glycol is triethylene glycol. Diethylene glycol and ethylene glycol can also be used in the application of dehydration. However, DEG and EG are often not taken into consideration because the requirements of the water content of dry gas. TEG has a higher degradation temperature and can be regenerated to a higher lean concentration with no modification to the standard regenerator reboiler. However, EG and DEG can meet the specifications of the moisture content when used with enhanced regeneration system. Increased regeneration is any system that promote the regeneration of glycol to achieve a leaner glycol solution or more concentrated. Increased regeneration may include stripping gas injection into the reboiler, azeotropic regeneration, or other proprietary processes. Costs associated with the use of EG or DEG will increase makeup glycol and some form of increased regeneration to obtain a more concentrated glycol to achieve the water content of dry gas.[6]

In analyzing and calculating the rate of corrosion and remaining lifespan can be calculated manually (hand calculation) with the formula of the standard ASME B31.3 (American Society of Mechanical Engineers) and API 570.

2.2. Corrosion on Gas Pipe Line

Corrosion is a quality deterioration caused by chemical reactions occurring on metallic materials with the elements - other elements found in nature [7], At a high corrosion resistance level at super martensitic carbon steel pipe is needed in the oil and gas industry, particularly in environments containing high levels of acidity. H2S will diffuse into the gaps in the metal structure which would then formed porous metal sulphide because it reacts on the metal surface, so that it will liberate hydrogen bonded with sulphur that can be absorbed and then the hydrogen contained in the solution of H2S indirectly cause a failure or corrosion [8]. Factors - factors that cause corrosion: Dissolved Gas Factor, temperature factor and Factors acidity (pH). Factors Reducing Bacteria or sulfuric acid reducing bacteria (SRB) [7].

FIGURE 1. Corrosion on gas pipeline

2.3. Standard Piping

Standard on the piping itself has a standard set by ASME or the American Society of Mechanical Engineering. In a Process Plant, using the standard ASME B 31.3 piping in the process of doing a design and selection of components - components of the piping system. Process Plant is a system that aims to process a raw fluid into a fluid that can be used. Examples of the process plant is an oil refinery and gas refineries [9].

2.4. Absorption CO2 Removal Process

Tests that do not damage the ultrasonic aimed at detecting the presence or absence of defects in the test specimen prior to the test series. These defects can be shaped cracks (crack), porosity (blowhole), laminate (a congenital defect of the plant caused by the failure at the time of casting which is then roll for the manufacture of pipes) or incomplete penetration in pipe welding. The working principle of ultrasonic testing. Ultrasonic propagation wave generated by the transmitter (sender signal) which is directed at a specific part of the specimen to be examined, and the electromagnetic wave is reflected back by a certain section of the specimen captured by the receiver (receiver signal). [10]

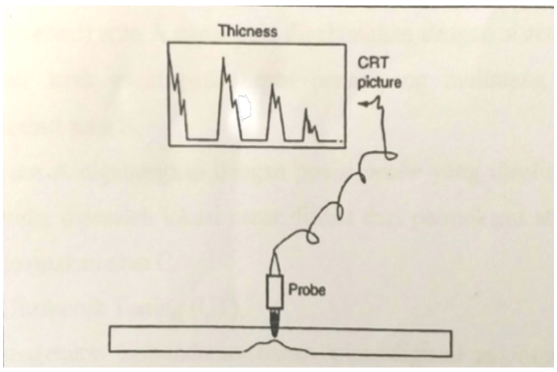

FIGURE 2. The working principle of ultrasonic measurement

2.5. Corrosion and Corrosion Rate

Corrosion is one of the forced destruction of substances such as metal and mineral building materials surrounding media, which are usually liquid (corrosive agents). It usually starts on the surface and is caused by chemical and in the case of metal electrochemical reactions [11]. While the rate of corrosion is the speed of propagation or speed of decline in quality of material with respect to time. In calculating the corrosion rate, the unit commonly used is mm / th (international standard) or mill / year (mpy, British standard). The level of resistance of a material to corrosion generally has a corrosion rate between 1-200 mpy [11]. The long-term corrosion rate (LT) must be calculated from the following formula:

$$Corrosian\ Rate\ (LT) = \frac{tinitial - tactual}{time\ between\ tinitial\ and\ tactual\ (years)} \quad (1)$$

Short-term corrosion rate (ST) can be calculated by the following formula:

$$Corrosion\ Rate\ (ST) = \frac{tprevious - tactual}{time\ between\ tprevious\ and\ tactual\ (years)} \quad (2)$$

where :
tinitial = Value of the measurement of the thickness of the material when the pressure vessel starts to corrode (mm)
previous = The value of the measurement of material thickness when the pressure vessel is examined beforehand (mm)
tactual = Value of the measurement of material thickness at the time of the last inspection (mm)

TABLE 1. Degree of resilience to corrosion by the corrosion rate [11].

Relative corrosion resistance	Approximate Metric Equivalent				
	mpy	**mm / yr**	**µm / yr**	**nm / yr**	**pm / sec**
	<1	**<0:02**	**<25**	**<2**	**<1**
Outstanding	1 -5	0.02 - 0.1	25-100	2-10	1-5
Excellent	5-20	0.02 - 0.1	25-100	2-10	1-5
Good	5-20	0.1 - 0.5	100-500	10-50	5-20
Fair	20-50	0.5 - 1	500 - 1000	50-100	20-50
Poor	50-100	1-4	1000 - 5000	100-500	50-200
Unacceptable	200+	5+	5000+	500+	200+

2.6. Remaining Life (RL)

In the production process, an industry cannot be separated from the use of pressure vessel equipment, especially air receiver compressor tanks, such as the oil, chemical, food, power plant, etc. A pressure vessel must have a time of use until the pressure vessel cannot be reused [12] During the use of a pressure vessel, failure is likely to occur if no periodic control and maintenance is performed. Some causes of failure occur due to material fatigue, corrosion and other external factors. One of the controls to anticipate the failure of the pressure vessel is to analyze the thickness of the material from time to time so that it can be seen how much material reduction occurs due to corrosion [12].

$$Remaining\ Life\ (\mathrm{RL}) = \frac{tactual\ (ta) - trequired\ (tr)}{Corrotion\ Rate\ (CR)} \quad (3)$$

where :
tactual = The result of measuring material thickness at the time of last inspection (mm)
trequired = Minimum allowable thickness or design thickness (mm) for the top zone (mm)

The thickness required (requirement) for the shell is calculated based on the longitudinal stress with the formula 4 and circumferential stress with the formula:

$$tr = \frac{P \times D}{2 \times (S \times E + P \times Y)} \quad (4)$$

where :
tr = minimum shell thickness required, inches (mm)
P = internal design pressure, psi (kPa)
D = The outer diameter of the pipe (inch)
S = maximum allowable voltage, psi (kPa)
E = welding joint efficiency
Y = Temperature factor for stainless(ASME B31.3)

$$MAWP = \frac{2 \times (S \times E) \times ta}{D - (Y \times ta)} \quad (5)$$

where ;
MAWP = Maximum Allowable Working Pressure (psi)
S = Maximum permit voltage, psi (kPa)
ta = Minimum actual thickness (mm)
D = Outer pipe diameter (inch)
Y = Temperature factor for stainless (ASME B31.3)
E = Welding Joint Efficiency

3. Results and Analysis of Discussion

3.1. Calculation Data

Based on the results of field surveys and standards - standards that must be followed in order to analyze the rate of corrosion and remaining lifespan of the pipe diameter of 2 inches in the process of dehydration gylcol then be tested using ultrasonic test on the pipe wall at 5 locations: the location A, B, C, D and E-clockwise 12,3,6 and 9.

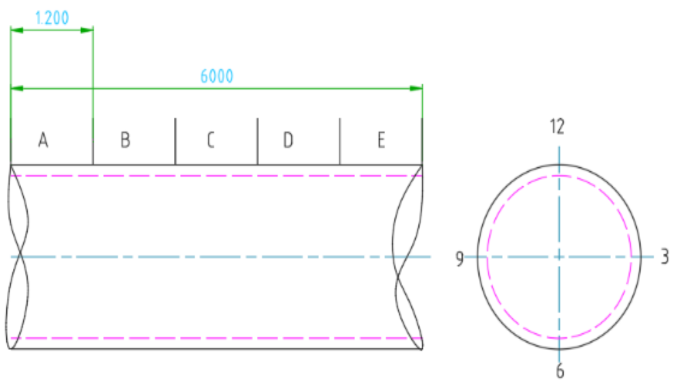

FIGURE 3. Point position and location of the measurement pipe

Pictured above addressing a measurement of pipe wall is conducted in the field with measurements in 5 different locations clockwise different. By measuring the thickness addressing each of these locations at any location on the wall of the pipe. Measurement of each location with a different clockwise was conducted to determine the actual thickness in order to analyze the rate of corrosion and remaining lifespan of the pipe.

3.2. Calculation of Corrosion Rate and Remaining Life of The Pipe

TABLE 1. Results of measurements of actual thickness and corrosion rate

POSISI	LOKASI									
	A		B		C		D		E	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
12	6,52	5,91	6,31	5,98	6,2	5,94	6,31	5,74	6,17	5,17
	Short Term		*Short Term*		*Short Term*		*Short Term*		*Short Term*	
Corrotion Rate	0,93		0,85		0,88		1,09		1,08	
Remaining Life	5,94		6,58		6,31		4,91		4,93	
MAWP	3.262,88		3.303,12		3.280,12		3.165,31		3.148,31	
POSISI	LOKASI									
	A		B		C		D		E	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
3	6,47	5,9	6,21	5,97	6,2	5,92	6,3	5,72	6,16	5,71
	Short Term		*Short Term*		*Short Term*		*Short Term*		*Short Term*	
Corrotion Rate	0,93		0,81		0,86		1,11		1,08	
Remaining Life	5,93		6,9		6,44		4,8		4,93	
MAWP	3.257,13		3.297,37		3.628,63		3.153,85		3.148,11	
POSISI	LOKASI									
	A		B		C		D		E	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
6	6,47	5,91	6,29	5,97	6,18	5,92	6,28	5,73	6,2	5,71
	Short Term		*Short Term*		*Short Term*		*Short Term*		*Short Term*	
Corrotion Rate	0,88		0,84		0,87		1,09		1,39	
Remaining Life	6,28		6,9		6,44		4,9		3,83	
MAWP	3.262,88		3.297,37		3.628,63		3.159,58		3.148,11	
POSISI	LOKASI									
	A		B		C		D		E	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
9	6,16	5,9	5,29	5,96	6,17	5,93	6,3	5,73	6,21	5,7
	Short Term		*Short Term*		*Short Term*		*Short Term*		*Short Term*	
Corrotion Rate	0,92		0,85		0,87		1,08		1,11	
Remaining Life	5,99		6,56		6,37		4,95		4,79	
MAWP	3.257,13		3.291,62		3.274,37		3.159,58		3.142,38	

3.3. Calculation of Corrosion Rate and Remaining Life of Pressure Vessels

a. In Area A position 12:

1. The rate of corrosion (Corrosion Rate)

- CRI = $\frac{ta1 - ta2}{time\ (years)\ between}$

$= \frac{27,10 - 26,39}{1}$

= 0.72 mm / year

2. *remaining Life* (RL)

- *tr* = $\frac{P \times D}{2 \times (S \times E + P \times Y)}$

$= \frac{203,053 \times 2,375}{2\,(16000 \times 1) + (203,053 \times 0,4)}$

= 0.015 inch = 0.381 mm

- RL = $\frac{ta - tr}{CR}$

$= \frac{5,91 - 0,381}{0,93}$

= 5.94 years

3. Maximum allowable working pressure (MAWP)

MAWP = $\frac{2 \times S \times E \times (\frac{ta}{25,4})}{D - Y \times (\frac{ta}{25,4})}$

$= \frac{2 \times 16000 \times 1 \times (\frac{5,91}{25,4})}{2,375 - 0,4 \times (\frac{5,91}{25,4})}$

= 3262.8 psi

(With the MAWP value meal can be concluded that the pipeline is feasible to operate because MAWP greater than the working pressure).

3.4. Analysis of Results of Discussion

After performing the calculation of the rate of corrosion and remaining lifespan on a 2 inch diameter pipe material API 5L Grade A is the output pipe separator to the valve, it can be discussed as follows:

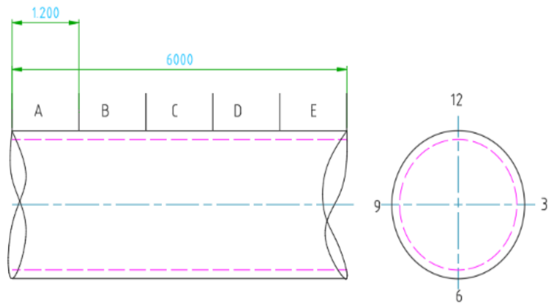

FIGURE 4. Location and position measurement wall pipe

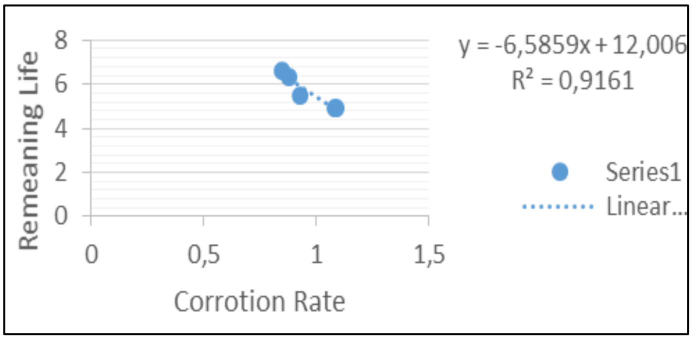

FIGURE 5. Comparison Chart Remaining Period Rate of Corrosion and Wear Pipe in Area A.

From the graph above in Figure 5 can be explained or showed that the rate of corrosion and remaining lifespan of the pipe in position A is obtained correlation values R^2 at 0.9161. From these results, it is found that the pipeline suffered corrosion rate (corrosion rate) A site at the position of 0.93 mm / year with the remaining useful life of 5.94 years. If the rate of corrosion that occurs on the pipe bigger then it indicates residual lifespan of the pipe is getting smaller due to the erosion of the material.

By entering the data table Corrosion Rate Calculation and Remaining Life 3 position in each location or the location of inspection are obtained graph the comparison rate of corrosion and remaining lifespan of the pipe as follows:

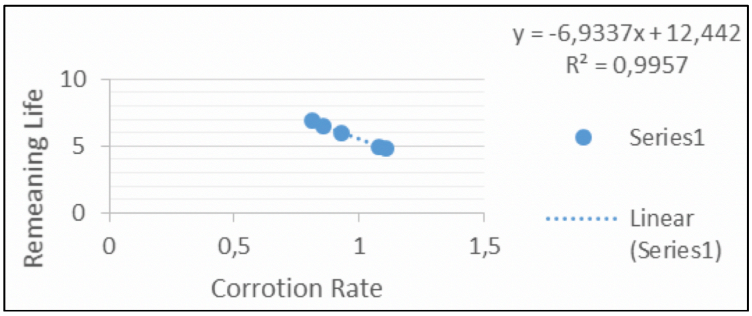

FIGURE 6. Corrosion rate comparison charts and residual lifespan on the pipe at the location A.

From the graph 6 above can be explained that the linearity shows that y = -6,9337x + 12.442 where the value of -6,9337x slope showed a decline accelerated remaining life (remaining life) of -6,9337x and constants (b) of 12.442, which means factor the corrosion rate (CR) was not affected by RL & CR amounted to 12.442 which is due to other influences such as material defects, lamination / segregation, welding defects and defects caused by third parties (sabotage).

RL = -6.9337 (CR) + 12.442

RL = Remaining Life (Years)
CR = Corrosion Rate (mm / year)

TABLE 2. Correlation value of CO2 in the pipe

Position	Linearity	A (Slope)	B (Constanta)	R²	R
12	y = -6,5859x + 12.006	-6,5859x	12.006	0.916	0.957
3	y = -6,9337x + 12.442	-6,9337x	12.442	0.995	0.997
6	y = -5,3535x + 11.098	-5,3535x	11.098	0.959	0.979
9	y = -6,7321x + 12.235	-6,7321x	12.235	0.997	0.998

From the above data it can be seen the R value of each position and location of the inspection. The highest R value has a correlation coefficient of the relationship between the rate of corrosion and remaining lifespan of the pressure vessel that mendekatai 1 is 0.9988. With these results explain that persesntase tertinggo residual service life (life remaning) at the time in the pipeline is at 90% this means that influenced the rate of dehydration gylcol corrosion caused by temperature, pressure, water content (H2S), and the material of the pipe.

4. Conclusions

From the above calculation, the conclusions can be drawn are as follows:

1) Overall a 2 inch pipe material API 5L Grade A still have remaining service life. In the analysis of the remaining life of the separator to the valve output pipe is 2-inch pipe that is 3.83 year lows located at position E clockwise 6 and the highest pipe shelf life period is 6.9 years in the position B clockwise 3. This analysis determines that the pipeline after leaving the separator and into the valve shows the highest corrosion rate was 1.39 mm / year at locations A clockwise 12 and the lowest corrosion rate was 0.81 mm / year in the position B clockwise 3.
2) The magnitude of the rate of corrosion of pipes is not the same in every location and position, it is due to potential corrosion products uneven acceleration of corrosion, the top position and the side affected by the flow rate and erosion, as well as the effect of other changes to the pipe wall, in the down position for their precipitation.

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