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# Feasibility Analysis Of Inactive Pipelines For Monetization Of Flare Gas Through Gas Production Facility Reactivation

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***Abstract:***
*This research will be used for analyzing feasibility of inactive pipeline for monetization of flaring gas through gas production facility reactivation. The produced gas from high pressure wells and gas from low pressure wells. High pressure gas can be sold directly after treatment, while gas from low pressure gas becomes flare gas. To support the government program for Zero Routine Flaring 2030 and* Ministry Regulation *no. 17 of 2021, gas from low pressure wells will be compressed so that it can penetrate the sales gas network pressure of around 450-500 Psi. To do this, we must reactivate the idle of gas production facilities. There are many activities that need to be done but this research is limited to analyzing the feasibility of a 14-inch pipe from the LP Separator to the Suction Scrubber Gas Compressor. After carrying out a series of analyzes which include checking, inspection, calculations and testing, it can be seen that the pipe is still feasible for reactivation. The advice that can be given are performing pipe maintenance, inspections, analyze gas composition periodically and follow up on inspection findings.*
***Keywords****: feasibility; pipeline; flare gas; Ministry Regulation; inspection.*

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## I. Introduction

Based on national energy policy, efforts are being made to increase oil production through drilling, well maintenance, well intervention and workovers so that there is an increase in oil and associated gas production. The gas produced is divided into 2, namely gas from high pressure wells and gas from low pressure wells. High pressure gas can be sold directly after treatment, while gas production from low pressure wells becomes flare gas.

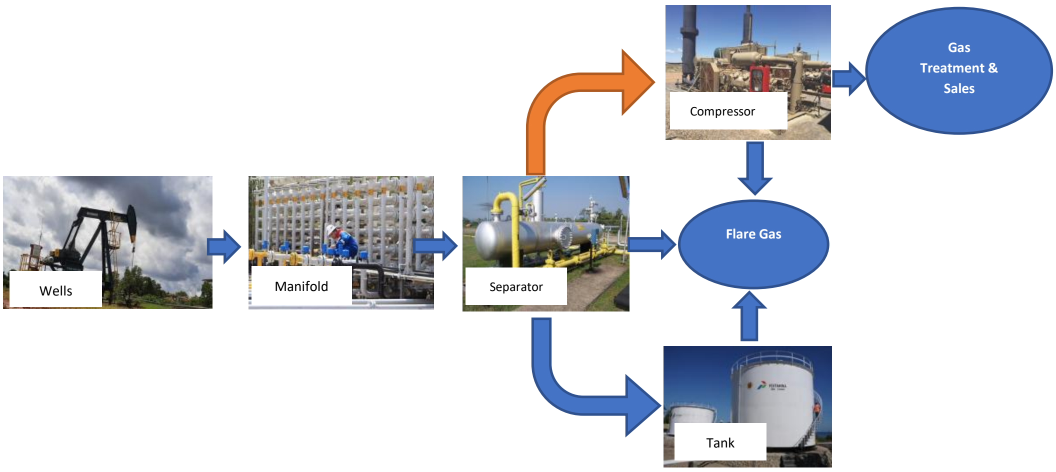


**Figure 1 Proses Flow Diagram for LP Separator**

Supporting the government program for Zero Routine Flaring 2030 and Ministry Regulation no. 17 year 2021, the low-pressure flare gas will be compressed so that it can penetrate the sales gas network pressure of around 450-500 Psi. To do this, reactivation is required for gas production facilities. There are many activities that need to be done for reactivating gas production facilities, but this research is limited to analyzing the feasibility of a 14-inch pipe from the LP Separator to the Suction Scrubber Gas Compressor so that it can be reactivated properly and safely.

## II. Methods

The research implementation refers to ASME 31.1 and API RP574 to carry out visual checks, wall thickness of pipeline inspections, calculations and tests.

**Visual Check:**

Direct observation of the outside and inside of components, connections and other easily accessible or visible piping elements before, during, or after manufacturing, fabrication, assembly, installation, inspection, or testing. This inspection includes verification of Code and engineering design requirements for materials, components, dimensions, joint preparation, alignment, welding, fastening, brazing, bolting, threading, or other methods of connection, support, assembly, and installation.

**Wall Thickness of pipeline Inspection:**

Measurements are taken in four (4) corners with 0° in the top position clockwise. In critical areas of pipes such as elbows, tees. The thickness tool used is ultrasonic thickness.

**Calculation:**

In carrying out the calculations we will consider mechanical data of pipe to find out MAWP, Minimum wall thickness ($t_{min}$), Minimum Requirement Wall Thickness ($t_{min\ req}$), corrosion rate and hydrostatic leak test pressure.

Mechanical data of pipe consist of Design pressure (P) Stress value (S), Joint Efficiency Shell (E), Weld Joint Factor (W), Coefficient (y), Outside Diameter (D), Thickness Actual ($t_{actual}$), Thickness Initial ($t_{initial}$), Corrosion Allowance (Ca).

Formula for Maximum Allowable Working Pressure (MAWP)

$$\mathrm{MAWP} = \frac{2SE(t - Ca)}{D - 2y\,(t - Ca)}$$

Formula for Minimum Wall thickness ($t_{min}$)

$$t\ min = \frac{PD}{2\,(SEW + PY)}$$

Formula for Minimum Requirement Wall Thickness $t\ min.req. = t\ min - Ca$ and formula for Hydrostatic Leak Test Pressure P test = 1.5 P

Formula for corrosion rate

$$C_{rate} = \frac{t_{initial} - t_{actual}}{year_{actual} - year_{initial}}$$

## III. Result

**Visual Check:**

Observations were made by checking the 14-inch pipe route and recording the variables listed in table below:

**Tabel 1 Visual Check Result**

| Description | Remarks |
|---|---|
| Object | Piping System from Separator to Scrubber |
| Size | 14 inches |
| Material | API 5 L Grade B |
| Safety Devices | Gate Valve 14-inch class 150 |
| Protection | Painting |
| Year of installation | 1998 |
| Status | Inactive |
| Pipe Position | Above 97% and Underground 3% for road crossing |
| Pipe support | Yes |
| External pipe condition | Good and need minor repair for repainting |

PHOTOGRAPH

PHOTOGRAPH

PHOTOGRAPH

Based on visual check result shows that external part of pipelines is still in good condition and suitable to be reactivated without modification.

**Inspection:**
Figure and Recording result of inspection listed in table below:

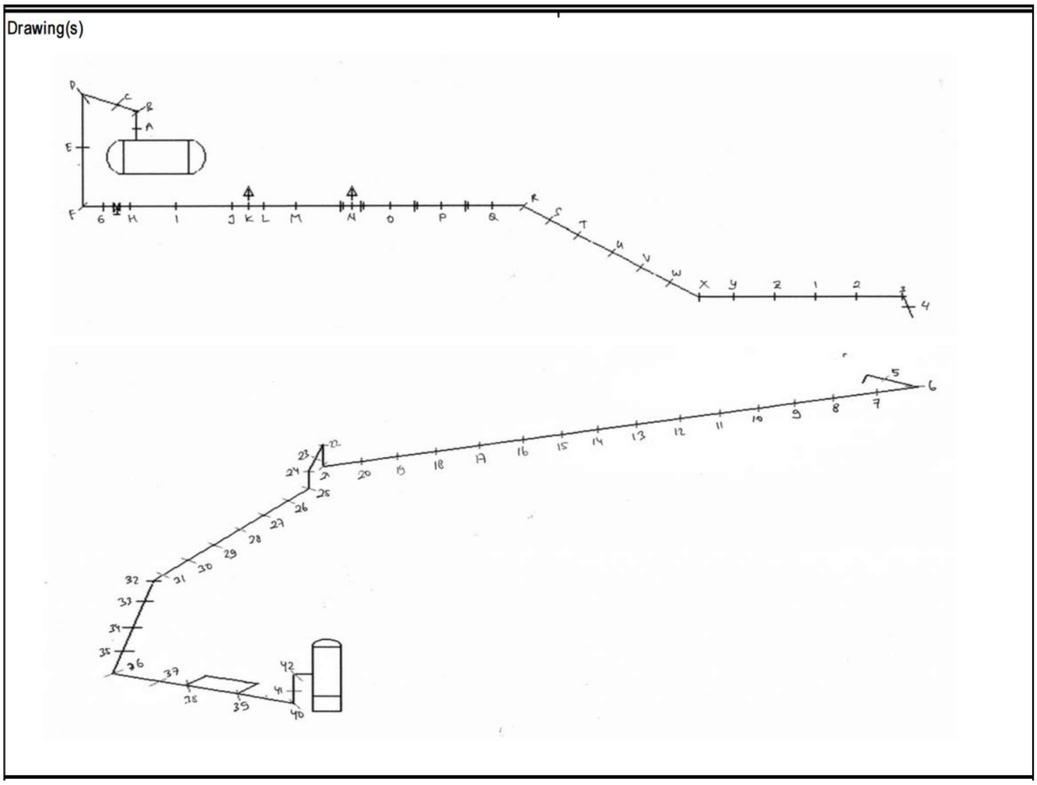


**Figure 2 Pipeline Schematic and point of inspection.**

**Tabel 2 UT Wall Thickness Result**

| Part | Spot Location | Actual Thickness (mm) | | | | Min. Thick. (mm) | Max Thick. (mm) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | 0° | 90° | 180° | 270° | | | |
| A | Pipe | 11.46 | 12.01 | 11.80 | 11.54 | 11.46 | 12.01 | |
| B | Elbow | 12.10 | 12.91 | 12.76 | 12.42 | 12.10 | 12.91 | |
| C | Pipe | 10.91 | 11.45 | 11.21 | 11.05 | 10.91 | 11.45 | |
| D | Elbow | 12.02 | 12.41 | 12.32 | 12.37 | 12.02 | 12.41 | |
| E | Pipe | 11.47 | 11.33 | 11.45 | 11.24 | 11.24 | 11.47 | |
| F | Elbow | 12.64 | 12.38 | 12.41 | 12.31 | 12.31 | 12.64 | |
| G | Pipe | 11.64 | 11.51 | 11.63 | 11.44 | 11.44 | 11.64 | |
| H | Pipe | 11.75 | 11.31 | 11.65 | 11.48 | 11.31 | 11.75 | |
| I | Pipe | 11.77 | 11.28 | 11.65 | 11.34 | 11.28 | 11.77 | |
| J | Pipe | 11.36 | 11.24 | 11.43 | 11.29 | 11.24 | 11.43 | |

| Part | Spot Location | Actual Thickness (mm) | | | | Min. Thick. (mm) | Max Thick. (mm) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | 0° | 90° | 180° | 270° | | | |
| K | Tee | 12.98 | 13.05 | 13.42 | 13.23 | 12.98 | 13.42 | |
| L | Pipe | 11.34 | 11.81 | 11.78 | 11.67 | 11.34 | 11.81 | |
| M | Pipe | 11.56 | 11.57 | 11.84 | 11.71 | 11.56 | 11.84 | |
| N | Tee | 18.34 | 19.11 | 18.21 | 18.33 | 18.21 | 19.11 | |
| O | Pipe | 6.09 | 6.38 | 6.12 | 6.19 | 6.09 | 6.38 | |
| P | Pipe | 7.67 | 6.78 | 7.05 | 6.98 | 6.78 | 7.67 | |
| Q | Pipe | 13.72 | 13.50 | 13.42 | 13.21 | 13.21 | 13.72 | |
| R | Elbow | 13.52 | 12.54 | 12.43 | 12.61 | 12.43 | 13.52 | |
| S | Pipe | 11.21 | 11.24 | 11.46 | 11.29 | 11.21 | 11.46 | |
| T | Pipe | 11.38 | 11.59 | 11.66 | 11.51 | 11.38 | 11.66 | |
| U | Pipe | 11.10 | 11.36 | 11.21 | 11.19 | 11.10 | 11.36 | |
| V | Pipe | 11.54 | 11.32 | 11.13 | 11.19 | 11.13 | 11.54 | |
| W | Pipe | 11.36 | 11.62 | 11.18 | 11.33 | 11.18 | 11.62 | |
| X | Elbow | 13.06 | 12.89 | 12.26 | 12.31 | 12.26 | 13.06 | |
| Y | Pipe | 10.98 | 11.49 | 10.67 | 10.91 | 10.67 | 11.49 | |
| Z | Pipe | 11.17 | 11.32 | 11.21 | 11.23 | 11.17 | 11.32 | |
| 1 | Pipe | 11.34 | 11.08 | 11.21 | 11.15 | 11.08 | 11.34 | |
| 2 | Pipe | 11.22 | 11.31 | 11.58 | 11.36 | 11.22 | 11.58 | |
| 3 | Elbow | 12.61 | 13.46 | 12.17 | 12.59 | 12.17 | 13.46 | |
| 4 | Pipe | 11.51 | 11.77 | 11.35 | 11.63 | 11.35 | 11.77 | |
| 5 | Pipe | 11.63 | 10.95 | - | 11.21 | 10.95 | 11.63 | |
| 6 | Elbow | 11.84 | 12.09 | - | 12.11 | 11.84 | 12.11 | |
| 7 | Pipe | 11.34 | 11.28 | - | 11.22 | 11.22 | 11.34 | |
| 8 | Pipe | 10.85 | 10.81 | - | 10.89 | 10.81 | 10.89 | |
| 9 | Pipe | 10.93 | 10.95 | - | 10.88 | 10.88 | 10.95 | |
| 10 | Pipe | 10.98 | 10.75 | - | 10.91 | 10.75 | 10.98 | |
| 11 | Pipe | 11.07 | 10.99 | - | 11.02 | 10.99 | 11.07 | |
| 12 | Pipe | 11.05 | 10.97 | - | 10.94 | 10.94 | 11.05 | |
| 13 | Pipe | 10.97 | 11.02 | - | 11.05 | 10.97 | 11.05 | |
| 14 | Pipe | 10.90 | 10.78 | - | 10.98 | 10.78 | 10.98 | |
| 15 | Pipe | 11.20 | 11.08 | - | 11.03 | 11.03 | 11.20 | |
| 16 | Pipe | 10.98 | 11.01 | - | 10.78 | 10.78 | 11.01 | |
| 17 | Pipe | 10.87 | 10.92 | - | 10.89 | 10.87 | 10.92 | |
| 18 | Pipe | 10.96 | 10.85 | - | 10.76 | 10.76 | 10.96 | |
| 19 | Pipe | 11.10 | 11.02 | - | 10.96 | 10.96 | 11.10 | |
| 20 | Pipe | 11.17 | 11.31 | - | 11.11 | 11.11 | 11.31 | |
| 21 | Elbow | 11.84 | 12.77 | 12.93 | 12.18 | 11.84 | 12.93 | |
| 22 | Elbow | 11.51 | 12.56 | 11.97 | 12.13 | 11.51 | 12.56 | |
| 23 | Pipe | 10.93 | 10.88 | 10.91 | 10.87 | 10.87 | 10.93 | |
| 24 | Elbow | 12.55 | 12.17 | 12.50 | 12.62 | 12.17 | 12.62 | |
| 25 | Elbow | 13.04 | 12.82 | 12.51 | 12.81 | 12.51 | 13.04 | |

Based on the results of pipe wall thickness measurements, it is known that segments O and P have the lowest pipe wall thickness, so new pipes are inserted. By making this insertion, the lowest pipe wall thickness is 10.59 mm.

**Calculation:**

**Tabel 3 Operation and Mechanical Data**

| Description | Remarks |
|---|---|
| Design Pressure | 360 psi |
| Design Temperature | 200 °F |
| Shell material Specification | API 5L Gr B |
| Stress value (S) | 20000.00 psi |
| Joint Efficiency Shell (E) | 0.85 |
| Weld Joint Factor (W) | 1.00 |
| Coefficient (y) | 0.40 |
| Type | pipe |
| Outside Diameter (OD) | 14.00 inch = 355.6 mm |
| Outside Radius | 7.00 inch = 177.80 mm |
| Thickness Actual ($t_{actual}$) | 0.417 inch = 10.590 mm |
| Thickness Initial ($t_{initial}$) | 0.750 inch = 19.050 mm |
| Corrosion Allowance (Ca) | 0.000 inch |

**Maximum Allowable Working Pressure (MAWP)**

$$\mathrm{MAWP} = \frac{2SE(t - Ca)}{D - 2y\,(t - Ca)} = 1076.67006 \ \mathrm{Psi}$$

then it is known that the MAWP is 1076.67006 Psi or equal to 75.69922 Kg/Cm2.

**Minimum Wall thickness ($t_{min}$)**

$$t \min = \frac{PD}{2\,(SEW + PY)} = 0.14699 \ \mathrm{inchi}$$

then it is known that $t \min$ is 0.14699 inch or equivalent to 3.73 mm

**Minimum Requirement Wall Thickness ($t_{min\ req}$)**

$$t\ min.req. = t \min - Ca = 0.14699 \ \mathrm{inchi}$$

then it is known that minimum requirement wall thickness (t min. req.) is 0.14699 inch or equivalent to 3.730 mm. By considering that the actual minimum thickness (t act) is 10,590 mm which is greater than the required minimum pipe wall thickness (t min. req.) which is 3,730 mm. Based on wall thickness of pipe can be declared suitable for reactivation.

**Corrosion rate was happened since 1998 until 2021.**

$$C_{rate} = \frac{t_{initial} - t_{actual}}{year_{actual} - year_{initial}} = 0.368 \ (mm)/year$$

then it is known that corrosion was happened 0.368 mm/year

**Hydrostatic Leak Test**

The test pressure is 1.5 times the design pressure so that the test pressure is 540 Psi. The pressure was increased gradually until it reached 540 Psi and then held for 2 hours. If the pressure is maintained, monitoring is carried out along the pipeline and monitoring of pressure reading devices. The observed results show that there is no indication of leakage in the pipe, therefore the pipe can be declared suitable for reactivation.

## IV. Discussion

**Tabel 4 Analysis Result**

| No | Analysis Decription | Result | |
|---|---|---|---|
| | | Feasible | Not Feasible |
| 1 | Visual Check | Yes | |
| 2 | Measurement & Calculation | Yes | |
| 3 | Hydrostatic Leak Test | Yes | |
| | Conclusion | Yes | |

Based on table 3, it is known that all stages of analysis show that the pipe is suitable for reactivation as a gas distribution pipe.

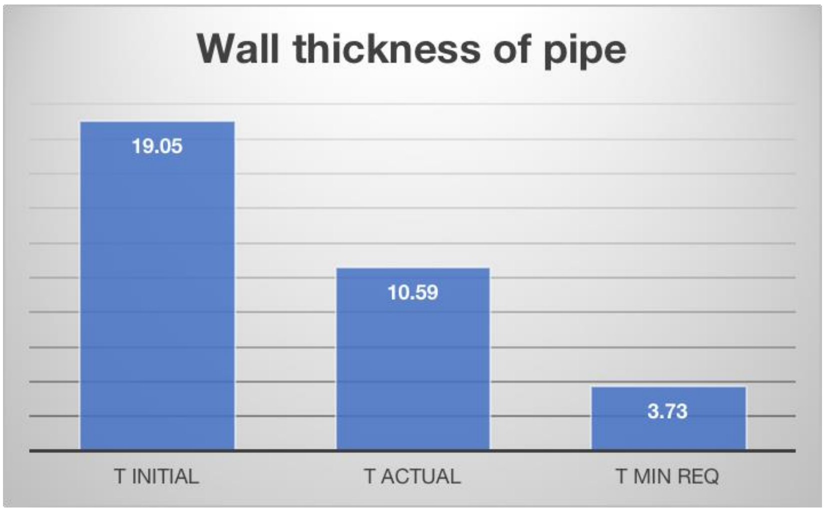


**Figure 3 Graphic of wall thickness**

Based on Figure 3, it is known that the actual pipe thickness ($t_{act}$) is 284% thicker than the minimum required pipe thickness ($t_{min\ req}$). And if we look at the corrosion rate that occurred over 23 years, it is known that there was a reduction in pipe thickness of 0.368 mm/year. To be able to control the rate of corrosion in pipes, carry out maintenance, measure the thickness of the pipe and analyze the composition of the flowing gas periodically so that recommendations can be identified that need to be carried out in the maintenance process.

## V. Conclusion

Based on the results of analysis, it is known that 14-inch pipes from LP Separator to Suction Scrubber Compressor is feasible for reactivation to distribute associated gas which has operating pressure around of 50-60 psi. Recommendations to keep feasibility of pipe are performing maintenance, inspection and analyze gas composition periodically.

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