Geometry Modified Square Edge Orifice Valve Study for Efficiency Gas Lift with Computational Fluid Dynamic (CFD) Method

(Studi Modifikasi Geometri Square Edge Orifice Valve Untuk Efisiensi Gas lift Dengan Menggunakan Metode Computational Fluid Dynamic)

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Abstract

The gas lift lifting system is widely used as an artificial lift on the X Field, with an average depth of gas lift production wells of 3,000-3,500 ft. Design of 3 to 5 Gas lift Valves (GLV) design with size of 1 inch is usually applied. While at the point of gas injection, the GLV square edge orifice is applied. The problem in the optimization of gas lift wells is the flow instability due to gas flow rate fluctuations, the limited volumetric gas injection and limited gas compressor pressure. With the limited compressor pressure, the flow lift and gas design speed is very dependent on the amount of pressure on the compressor, the production wells with limited injection pressure will result in a limited amount of gas injection, the square edge orifice requires a pressure difference of 40% to achieve the maximum gas flow rate. This study aims to find the modification of the GLV orifice geometry to improve the efficiency of the gas lift system so that it can get optimal production. This GLV design modification includes changing the GLV orifice geometry. Design studies using Computational Fluid Dynamic (CFD) simulations aim to analyze any changes in GLV geometry design to the performance of the gas flow rate in the orifice valve described in the valve performance curve. The design modification approach is in accordance with the GLV venturi orifice geometry and the availability of equipment for GLV modification. The CFD simulation results of the first modification geometry by increasing the orifice diameter from 0.25 to 0.5 inch with the condition of upstream 650 psig and downstream 625 psig pressure increasing the injection gas flow rate capacity by 355% and modifying the second geometry with the venturi orifice form by 280%. In modifying the shape of the orifice venturis to reach critical flow requires a pressure difference of 10%. Based on simulation results, the modified orifice application is able to increase production up to 44%.

Keywords: Gas Lift Valve, Orifice, Computational Fluid Dynamic

I. INTRODUCTION

Gas lift is one of the artificial lift methods used in X Field. The main focus in X Field is to maintain oil production. Continuous optimization of gas lifts is an effort to obtain optimal oil production. One of the problems that arise in gas lift systems is for wells...
with locations far from compressors, this results in a limited available pressure for the system in achieving the optimal gas lift injection flow rate. This greatly impacts gas lift wells which have a high productivity index. The use of orifice Gas Lift Valve (GLV) with a square edge shape has limitations to achieve maximal injection. It requires a high differential pressure (50% of the upstream orifice pressure). So that efforts are needed to increase the capacity of the optimal gas flow rate. To increase the optimal gas flow rate, GLV geometry authentication is needed, the analysis of GLV geometry modification using Computational Fluid Dynamic (CFD) software.

One obstacle in optimizing the increase in well oil production using the gas lift system is the limitation of casing head pressure, especially in gas lift wells that have a remote location with compressors due to high pressure drop. This condition is very influential on oil production wells that have a high injection rate and productivity index requirement, due to high flowing gradients (above 0.18 psig / ft) so that the pressure difference that can be generated on the GLV upstream orifice and down stream is only 10-20% which results in a limit of the gas flow rate at GLV.

Based on those problem this study aim to get solution about:

- How to modify GLV so that it can increase the capacity of the injection gas flow rate?
- What is the effect of GLV modification on gas lift well production performance?

The purpose of this research is to provide an optimal analysis of GLV modification design so that it can increase the gas flow rate in the gas lift system and oil production from gas lift wells. The purpose of this research is:

- Examine the performance of the GLV orifice that exists in the field using a CFD model simulation.
- Examining the relationship of modification of GLV geometry changes to the performance of injection gas flow rates on GLV, using CFD simulations.
- Simulate the performance of gas lift elevator production using GLV that has been modified.

The scope of this research is the geometry modeling of the Gas lift valve with the Computational Fluid Dynamic method and the modeling of well production performance with Nalal Analysis software. Research on efforts to optimize the production of oil production wells using the gas lift system by modifying GLV geometry, modifying analysis using CFD software tools, CFD software used to create valve performance curves that illustrate the relationship of injection flow rates with variable pressure differences on GLV.

The problem limits in this study are:

- This research was conducted using a numerical simulation method.
- The study was conducted on a 1 inch GLV, which was used on the X Field.

II. METHOD

The preparation before starting the research is to collect all the necessary field data related to GLV modification, namely detailed geometry and material from GLV (Figure 4), gas injection composition, casing head pressure data, well production data, gas lift design, PVP, reservoir data. After the data is ready, the systematic analysis sequence is as follows:

- Analyzing the performance of gas lift wells by using Nalal Analysis software, to obtain gas lift performance curves and limitations of conventional GLV.
- Analyze the simulation of gas flow through the initial GLV using CFD Software software.
- Simulation the GLV design with modification of the orifice size and variations in the size of the injection hole using CFD Software software.
- Simulation of the comparison between the venturi orice design and GLV that has been modified with CFD Software software.
- Analyzing the effects of GLV modification on oil well production using gas lifts,

Figure 1 shows the process of selecting candidate gas lift wells to be used as study cases. The criteria for the well to be chosen consider the following matters:

1. Wells with gas lift performance that are not optimal where indications of Total Gas Lift Ratio is less than 600 scf / stb
2. Wells that have a fairly good Productivity Index with a PI value more than 5.
3. Priority of wells with low WC in order to obtain a significant potential increase in production.

Figure 2 shows simulation flow chard while using software CFD.

III. RESULTS AND DISCUSSION

In order to get the optimal production of Wells A, B and C, a simulation of gas lift injection performance at the injection point is made, from the
simulation results to achieve an optimal gas flow rate of 700-800 kscfd (Figure 5, Figure 6 and Figure 7). The maximum available head pressure casing cannot reach optimal conditions injection flow rate is not possible. To achieve the optimal gas injection flow rate can be done by modifying the geometry of the orifice in order to reduce the pressure loss in the orifice by increasing the area of the orifice so that with the same pressure difference the injection gas delivery capacity can be increased.

In model 1 (Figure 8) with a 650 psig upstream pressure and 625 psig downstream pressure with a pressure difference of 25 psig the injection gas flow rate is 360 Mscfd. To get the optimal gas flow rate for Wells A, Wells B and Wells c of 700 Mscfd a pressure difference of 150 psig is needed, so that with limited casing head pressure on Wells A, Wells B and Wells c by using the orifice ¼ " the optimal gas flow rate is not can be achieved. In the Model 1 graph (Figure 8) it can be seen that the pressure difference of 50 psig gas flow rate of 455 Mscfd and flow at a pressure difference of 250 psig gas flow rate of 869 Mscfd, this trend is consistent with the results in the reference paper, where a pressure difference above 40% to get the maximum gas flow rate. And from the graph seen in the range of pressure difference of 25-250 psig / P downstream 400-625 psig with changes in downstream pressure will result in a significant change in gas flow rate so that it influences the flow rate of well production, this affects the stability of gas lift well production

In the model 2 (Figure 9) with a 650 psig upstream pressure and 625 psig downstream pressure with a pressure difference of 25 psig the injection gas flow rate is 1258 Mscfd. To get the optimal gas flow rate for Wells A, Wells B and Wells c of 700 Mscfd with limited casing head pressure on Wells A, Wells B and Wells c the flow rate can be achieved using the orifice ½ " according to the results found in the reference paper, where a pressure difference above 40% to get the maximum gas flow rate. And from the graph seen in the range of pressure difference of 25-250 psig / P downstream 400-625 psig with changes in downstream pressure will result in a significant change in gas flow rate so that it influences the flow rate of well production, this affects the stability of gas lift well production

In the model 3 (Figure 10) with a 650 psig upstream pressure and 625 psig downstream pressure with a pressure difference of 25 psig the injection gas flow rate is 912 Mscfd. To get the optimal gas flow rate for Wells A, Wells B and Wells c for 700 Mscfd with limited casing head pressure on Wells A, Wells B and Wells c the flow rate can be achieved using venturi orifice, with modified geometry from orifice ¼ " to venturi there is a very significant increase in gas from 360 Mscfd to 912 Mscfd for a pressure difference of 25 psig. In the Model 3 graph it can be seen from the pressure difference of 250 psig the injection gas flow rate of 1081 Mscfd. From the trend of gas flow rate only with a pressure difference of 10%, the maximum gas flow rate can be obtained. In addition, from the graph in the range of pressure difference of 25-250 psig / P downstream 400-625 psig with changes in downstream pressure does not result in a significant change in gas injection flow rate so that it does not affect the flow rate of well production, this affects the stability of gas well production.

The geometry modification of model 3 will be very effective on wells that have limited head pressure casing so that the pressure difference of 10% will get the optimal injection gas flow rate.

**IV. CONCLUSIONS**

The conclusions of this research are:

1. From the simulation results of Square Edge Orifice performance CFD with GLV upstream pressure of 650 psig and 25 psig pressure difference of 325 Mscfd gas flow rate, and with a pressure difference of 250 psig at 869 gas flow rate Mscfd.
2. Changes in model 2 geometry by increasing the bore diameter of the square edge orifice from ¾" to ½" with a GLV 650 psig upstream pressure and a 25 psig pressure difference can increase the capacity of the flow rate from 325 Mscfd to 1258 Mscfd (387%) and with a pressure difference of 250 psig the flow rate is 3.093 Mscfd (355%).
3. Change in geometry of model 3 by modifying the square edge orifice shape to the venturi orifice with a GLV 650 psig pressure upward and a 25 psig pressure difference can increase the capacity of the flow rate from 325 Mscfd to 912 Mscfd (280%) and with a 250 psig pressure difference of 1081 Mscfd (120%). Critical flow is obtained with a pressure difference of less than 10% from upstream pressure.
4. From the simulation results with the implementation of modification of model 2 and the model 3 wells A, B, and C has the potential to increase production by an average of 44%.
REFERENCES
Simulation of Gas flow through existing valve (orifice ¼"")

Simulation of Gas flow through orifice with greater diameter

Simulation of Gas flow through venturi orifice

Simulation of various pressure drops to flow rate through injection valve

Analysis of various geometry shapes of valve to gas lift efficiency

Simulation & analysis of well production increment due to gas lift valve modification

Is there production increase?

End

Figure 2. Simulation Flow Chart
Figure 3. Study of Ventury GLV Orifice Geometry

Figure 4. Geometry Modification (A) Gas Lift Valve Initial Geometry (B) Gas lift Valve Modification by increase bore hole to ½” (C) Gas Lift Valve Modification Ventury Orifice
Figure 5. Potential of A Well

Figure 6. Potential of B Well
Figure 7. Potential of C Well

Figure 8. CFD Simulation Result of Model 1
Figure 9. CFD Simulation Result of Model 2

Figure 10. CFD Simulation Result of Model 3