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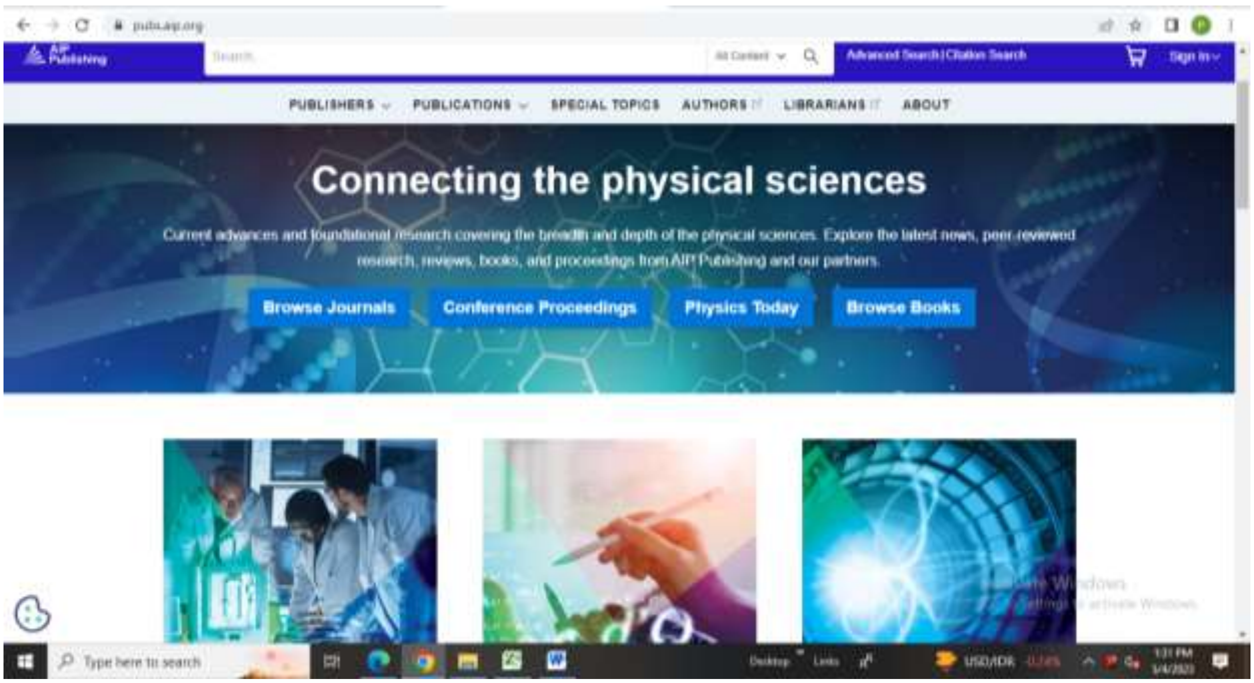

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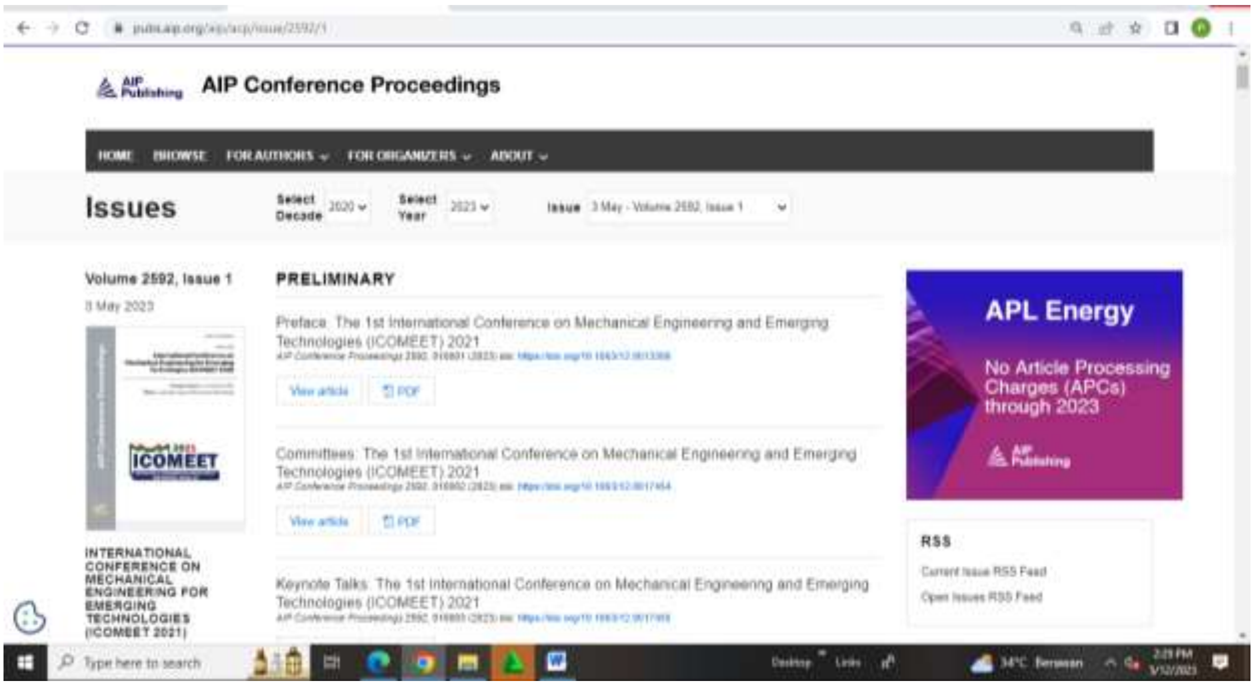

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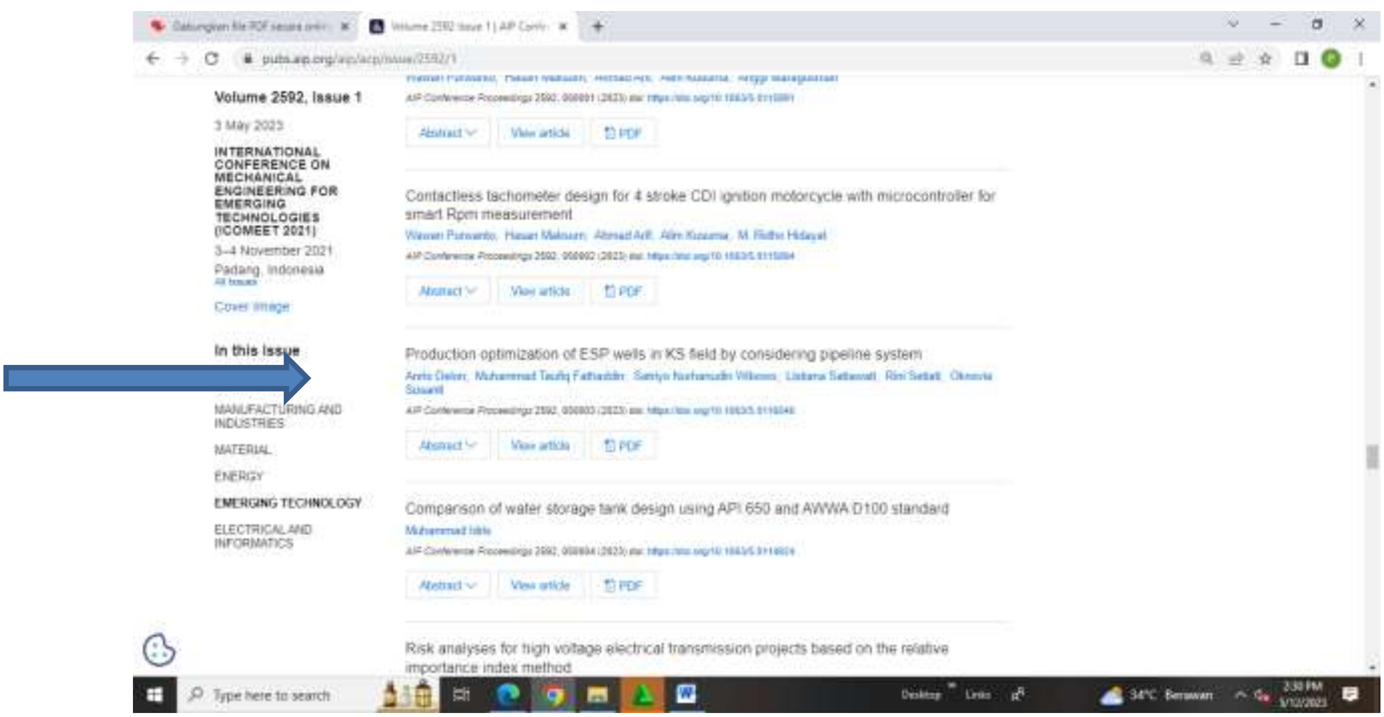

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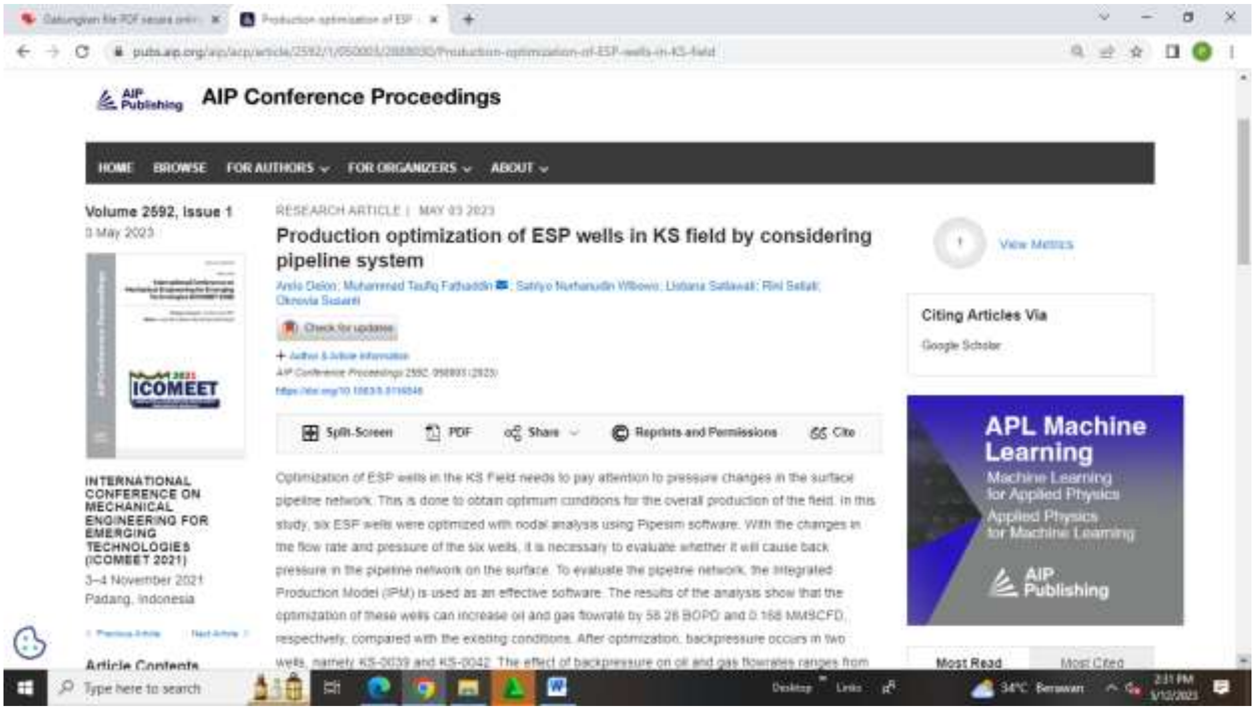

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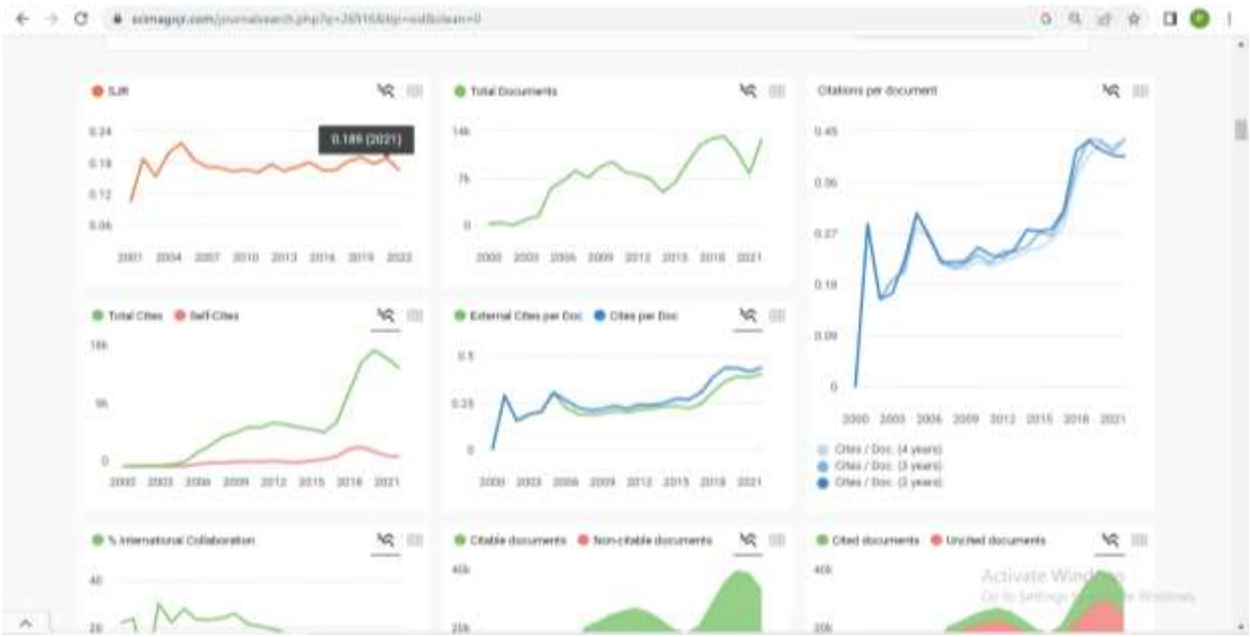

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Production Optimization of ESP Wells in KS Field by Considering Pipeline System

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Abstract. Optimization of ESP wells in the KS Field needs to pay attention to pressure changes in the surface pipeline network. This is done to obtain optimum conditions for the overall production of the field. In this study, six ESP wells were optimized with nodal analysis using Pipesim software. With the changes in the flow rate and pressure of the six wells, it is necessary to evaluate whether it will cause back pressure in the pipeline network on the surface. To evaluate the pipeline network, the Integrated Production Model (IPM) is used as an effective software. The results of the analysis show that the optimization of these wells can increase oil and gas flowrate by 58.28 BOPD and 0.168 MMSCFD, respectively, compared with the existing conditions. After optimization, backpressure occurs in two wells, namely KS-0039 and KS-0042. The effect of backpressure on oil and gas flowrates ranges from 0.44% to 1.70% and from 0.48% to 1.11%, respectively.

INTRODUCTION

The production of oil wells from time to time has decreased along with the decrease in pressure in the reservoir. The oil produced when the perforation is first performed has a natural flow that can drain the fluid from the reservoir to the surface by itself. However, the reservoir drive will reach a point where the pressure in the reservoir will equal the pressure at the surface. Alternatives that can be done to lift the reserve can be done using an artificial lift. This method is generally carried out when the condition of the well is not able to lift the fluid to the surface by itself or when the well actually still has natural flow but the production rate is too small. So a pump is needed to increase the production of these wells.

In this study, the six electric submersible pump (ESP) wells will be optimized by increasing the frequency of the ESP pump. After that, an evaluation of the pipeline network was carried out using the Integrated Production Model (IPM). Surface networks and integrated production models are listed as one of the many answers to efficient and effective ways of managing certain fields [1, 2]. The analysis is carried out to determine the actual conditions in the field which will be affected by changes in flow rate and pressure in the surface pipe network system. In addition, there will be other factors such as backflow, backpressure, and pressure loss [3]. From the production side, it is related to the profit and efficiency that will be obtained as well as the optimal level of production.

PRODUCTION SYSTEM OVERVIEW

The KS field has nine flowing wells with six oil wells and three suspended wells. Modeling is done using Pipesim software. The production fluid flows from the well through the flowline to the cluster manifold, which collects all the production fluid from all the wells, and then flows through the trunkline to the field station. Figure 1 shows an illustration of networks and groupings. Well modeling has been analyzed in previous studies, where variations in well conditions are available through the network [4, 5]. The various conditions referred to are; vertical wells, deviation wells, and ESP installed wells. The ESP is a multistage centrifugal pump placed in an oil well to help bring liquid to

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the surface with an electric power source from the ESP pump part, namely the motor. The subsurface ESP pump series consists of a multi-stage centrifugal pump, intake or gas separator, shield or seal, and an electric motor. The pump circuit unit is immersed in the liquid and connected to the pipe circuit. The electric motor is connected by wires to the surface that is to the switchboard and transformer. The number of stages in the pump is adjusted to the condition of the well through pump design planning. Each stage consists of an impeller and a diffuser whose function is to apply pressure to the fluid and flow to the next stage. Figure 2 is an example of well KS-0039, where the well has deviation and installed ESP. After the network is built, optimization of the integrated production model can be done by increasing the ESP frequency. This is done to obtain optimal discharge from the integrated production model. The optimization is then followed by a back pressure analysis to check for a significant decrease in discharge in the optimized well [6].

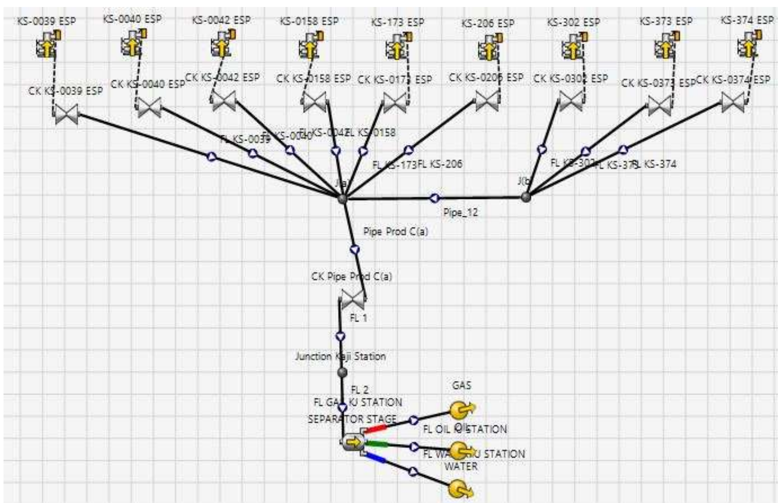

FIGURE 1. Integrated production model of KS Field

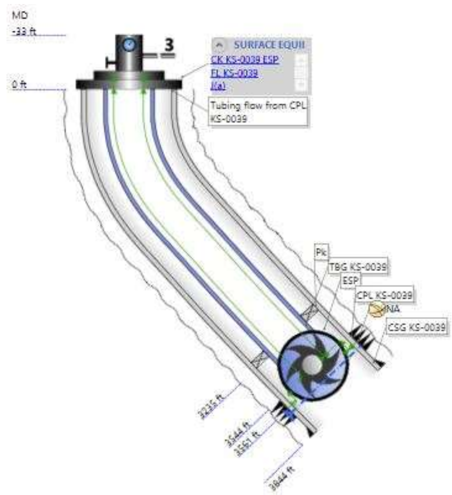

FIGURE 2. Example of well modeling in KS-0039

METHODOLOGY

The research procedure begins by conducting a literature study on related topics including reservoirs, production, artificial lift, and pipelines. After that, the actual data collection was carried out. Data collection is the most important step for building a model. Because the field is unique with a certain structure, dynamic environment, model development and validation must be carried out by matching the model results [7].

The data collected is related to well design, namely PVP data, well data, and pipe network data. PVP data includes gas-oil ratio, water cut, gas specific gravity, water density, and oil API. And well data includes perforation depth, tubing diameter, casing diameter, well deviation, and well test data. With these data, a well model is constructed.

The second data collected is related to pipelines. Pipe network data includes flow length, flow diameter, height, choke bean size, and network scheme. After this data is collected, network simulation is carried out to achieve conditions similar to the actual network field conditions. Once the matching is complete, the integrated production model optimization scenario can be performed. This optimization is intended to increase the ESP frequency. The optimization is then continued with an analysis of the presence of backpressure in the optimized well [8-10]. Figure 3 shows the research flowchart.

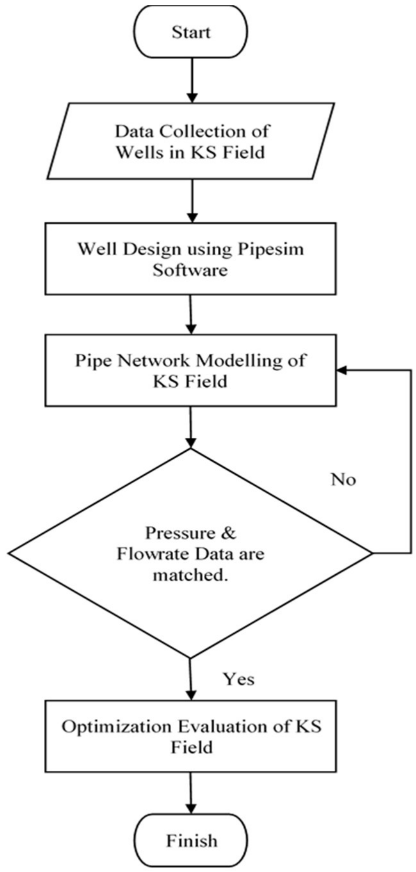

FIGURE 3. Flowchart of the research done

RESULT AND DISCUSSION

Simulation results are given in Tables 1 to 8. Tables 1 to 3 show the validation results of the Integrated Production Model. The tables show that model has a good agreement with the data since the deviations of the model from the actual data is less than 10 percent. After the network simulation is matched, the optimization is carried out. With the results given in Tables 4 to 8, it can be seen that the best scenario carried out has an increase in production rate and changes in pressure between networks. After the optimization is done in an integrated production model, there are pressures and changes in production in all clusters. Tables 4 and 5 explain the change in pressure and production of the best scenario. The changes of upstream pressure and downstream pressure range from 2 to 48 psig and from 3 to 39 psig, respectively. While the change in oil and gas flowrates range from -1 to 19 BOPD and from -0.002 to 0.109 MMSCFD, respectively. The total increase of oil production rate and the gas production rate is 52 BOPD and of 1.13 MMSCFD as given in Table 6.

In the best scenario, back pressure is found in two optimized wells. The wells are KS-0039 and KS-0042. Both wells show significant increases in upstream and downstream pressure. Table 7 explains the change in pressure.

It can be seen that backpressure can be indicated by increasing upstream and downstream pressure of the choke. Upstream and downstream here are indicated by the position of the choke. Tables 3 and 8 shows that the backpressure effect is ranging from 0.44% to 1.70% for oil flowrate and from 0.48% to 1.11% for gas rate.

TABLE 1. Upstream and downstream pressure matching

Well	Data		Simulation		Deviation	
	Pressure					
	Upstream (psig)	Downstream (psig)	Upstream (psig)	Downstrem (psig)	Upstream (%)	Downstream (%)
KS-0039	70	65	67	62	4.73	4.88
KS-0040	60	55	62	60	2.97	9.01
KS-0042	170	100	156	105	7.96	4.65
KS-0158	150	60	137	61	8.54	0.84
KS-0302	150	56	152	59	1.53	6.77
KS-0373	70	55	69	59	1.76	8.25

TABLE 2. Liquid and water flowrate matching

Well	Data		Simulation		Deviation	
	QL (BFPD)	QW (BFPD)	QL (BFPD)	QW (BFPD)	QL (%)	QW (%)
KS-0039	483	420	484	421	0.22%	0.22
KS-0040	783	742	826	784	5.34%	5.77
KS-0042	1646	1630	1653	1636	0.41%	0.41
KS-0158	1619	1587	1577	1546	2.58%	7.65
KS-0302	1232	1117	1182	1076	7.15%	3.73
KS-0373	1828	1737	1862	1769	1.87%	1.87

TABLE 3. Oil and gas flowrate matching

Well	Data		Simulation		Deviation	
	Qo (BFPD)	Qg (MMSFCD)	Qo (BFPD)	Qg (MMSFCD)	Qo (%)	Qg (%)
KS-0039	63	0.09	63	0.09	0.22	0.92
KS-0040	41	0.00	41	0.00	5.77	0.00
KS-0042	16	0.42	17	0.43	0.41	1.85
KS-0158	32	0.55	32	0.51	2.58	7.65
KS-0302	115	0.00	106	0.00	3.78	0.00
KS-0373	91	0.00	93	0.00	1.87	0.00

TABLE 4. Pressure alterations of the best scenario

Well	ΔP Upstream (psig)	ΔP Downstream (psig)
KS-0039	4	4
KS-0040	8	6
KS-0042	2	3
KS-0158	34	6
KS-0302	48	39
KS-0373	8	6

TABLE 5. Oil and gas flowrate alterations of the best scenario

Well	ΔQo (BOPD)	ΔQg (MMSCFD)
KS-0039	-1	-0.001
KS-0040	19	0.000
KS-0042	0	-0.002
KS-0158	7	0.109
KS-0302	14	0.000
KS-0373	13	0.000

TABLE 6. Estimated rate gain of the best scenario

Well	Qo (BOPD)	Qg (MMSCFD)
Estimated rate gain	52	1.13

TABLE 7. Backpressure pressure analysis of the best scenario

Well	ΔP-Upstream (psig)	Δ P-Downstream (psig)
KS-0039	3.96	4.34
KS-0043	1.92	3.22

TABLE 8. Backpressure flowrate analysis of the best scenario

Well	ΔQo (BOPD)	Δ Qg (MMSCFD)
KS-0039	-1.07	-0.001
KS-0043	-0.07	-0.002

CONCLUSIONS

Based on the analysis and discussion presented above, several conclusions have been obtained as follows:

1. The best scenario has an increase in oil flowrate of 58.28 BOPD and gas flowrate of 0.168 MMSCFD.
2. The change in oil and gas flowrates range from -1 to 19 BOPD and from -0.002 to 0.109 MMSCFD, respectively.
3. The effect of backpressure ranges from 0.44% to 1.70% for oil flowrate and from 0.48% to 1.11% for gas rate.

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