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Evaluation of Aerated Drilling Effectivity on "BP" Well in Gbk Geothermal Field Use Guo-Ghalambor Method

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EVALUATION OF AERATED DRILLING EFFECTIVITY ON "BP"WELL IN GBK GEOTHERMAL FIELD USE GUO-GHALAMBOR METHOD

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Abstract

The formation of geothermal drilling usually is igneous rock. In general, many geothermal fields encountered fractures cause loss circulation zone in drilling. In drilling, overcome loss circulation zones make drilling more effective and efficient. Aeration drilling methods are known to reduce common problems in geothermal drilling such as loss circulation and stuck pipe. The principle drilling of aeration is to inject air into the fluid of the drilling fluid to reduce the bottom hole pressure on the borehole lower than formation pressure that make an underbalanced drilling. The conventional method of Aerated drilling is gas law method which is still not very accurate to analyze aeration drilling to prevent stuck pipe and loss circulation. So there are still many drilling problems such as stuck pipe and loss circulation despite using aerated drilling technique. The well profile and casing data on "BP" well is hole 26" use 20" casing to the depth of 405 meters, hole 17" use 13 $^3/_8$ casing to the depth of 1264 meters, hole 12 ¼" use 10 $^3/_4$ casing to depth of 1466 meters, and hole 9 $^7/_8$ use 8 $^5/_8$ casing to depth of 2016 meters. The method used in this research is Guo-Ghalambor method which is corrects aeration drilling and bottom hole pressure in the wells accurately because Guo-Ghalambor method corrects the two phase in drilling system called moody friction between the liquid phase of the drilling fluid and the gas phase for injection in the drilling fluid. This research analyze in route 12 ¼ and 9 $^7/_8$. In route 12 ¼ there is loss circulation problem in 1581 meters to overcome the problem it optimizes the gas injection of 1600 SCFM and 780 GPM mud rate. In route 9 $^7/_8$ there is loss circulation problem in 1800 meters to overcome the problem it optimizes the gas injection of 1600 SCFM gas and 740 GPM mud rate. Injection and analysis results drilling hydraulics output of Route 12 ¼ are ECD, ESD, Annular Static Pressure, and Annular Dynamic Pressure. The hydraulics output results less than formation pressure as well as on route 9 $^7/_8$ it makes underbalanced drilling in the well.

Optimization of aeration drilling is based on the limitations based on operation window of gas law method and gas liquid ratio window method. The gas liquid ratio window is more accurate and more preferably applied in the field when doing drilling operations because the parameters are simple than gas law method.
Keywords : Aerated Drilling, Geothermal, Drilling Evaluation.

1. Introduction

Aerated Drilling in geothermal wells is used for loss zone both partial loss and total loss. Aerated drilling fluid consist of two types: fresh water and aerated mud. The aerated mud injected by air, foam, or Corrosion Inhibitor. Aerated Drilling method is expected to overcome common problems that are often found in geothermal wells. Aerated Drilling method use Guo Ghalambor. The parameters considered in Aerated Drilling analysis are Equivalent Circulating Density (ECD), Equivalent Mud Weight (EMW), Annular Static Pressure, Annular Dynamic Pressure, Equivalent Static Density, Kinetic Energy. Guo Ghalambor method is better than other methods because it has the smallest error range in calculating Bottom Hole Pressure. Guo Ghalambor Method for Cutting Transport Analysis uses the minimum kinetic energy concept required to lift the cutting to surface. the minimum required Kinetic Energy is 3 lb / cuft.

2. Basic Theory

2.1. Aerated Drilling

Aerated Drilling or aeration drilling is a method of drilling by adding compressed air into the circulation fluid (drilling mud) to reduce the density of the fluid column in the annulus. Thus, the drilling fluid pressure present in the annulus (Hydrostatic Pressure) will be less than the formation pressure. the aeration drilling fluid comprises a gas phase (air) injected into a water-based sludge phase, in which the liquid fraction is over 25% and the aerated drilling mud weight has an effective density between 4-7 ppg. Aeration drilling in geothermal wells is commonly used when it penetrates a zone of loss of circulation (loss zone). Aeration drilling is expected to deliver good results in the drilling process. This aeration drilling method can not be used in any type of formation it is usually used in igneous rock formation.

2.2. Guo-Ghalambor Method

Aerated Drilling aim is to balance the pressure on the hole with the formation pressure, the drilling fluid density needs to be reduced by adding compressed air into the drilling fluid. Calculation of hydraulics using the method of Guo-Ghalambor, this method is better than other methods because it has the smallest error range in determining the bottom hole pressure. Guo-Ghalambor creates a hydraulic equation that is carried out on the multiphase drill fluid in directed drilling.

3. Methodology

Flowchart procedure of this research is the input drilling parameters which are the flow rate of mud, gas injection, and temperature to produce hydraulic pressure from friction pressure and dynamic flow pressure. These output results are annular pressure output, ECD, and ESD where for successful aeration drilling techniques should be less than formation pressure. If the hydraulic output has been less than formation pressure then this research is in accordance with the planned flow diagram.

3.1 Literature Study

The literature study is to find reference theory related to the case or problems in the research. The reference contains:

1. Geothermal drilling system in general
2. Aerated drilling equipment applied in the field
3. Hydraulics of geothermal drilling
4. Guo-Ghalambor method for geothermal drilling

These references can be found in journals, books, articles, and websites on the internet. The output of this literature study is correction of references relevant to the problem. The goal is to strengthen the problem solution as well as the theoretical basis in conducting the study and also become the basic for evaluation on aerated drilling of “BP” well in GBK geothermal field.

3.2. Data Collection

The data is collect as secondary data that required to complete this research are in the following below:

1. Gas injection on drilling
2. Rate the mud required on drilling
3. Data reservoir wells
4. Drilling parameters at wells

The data is obtained by literature studies and readings on well data. The results of data collection are used to analyze aeration drilling on “BP” well by looking at the output parameters generated from the data on the well.

4. Case Study

4.1. Case 1

In the 12 ¼” trajectory there is still an ECD that exceeds the pore pressures as seen in Fig. 2 where there is still a circulation loss use 1400 SCFM gas injection and the 820 GPM mud flow rate. It can makes ineffective drilling and it is necessary to process the optimization for gas injection and mud flow rate with guo-ghalambor method.

4.2. Case 2

the case 2 is in 9 7/8” trajectory there is still an overbalanced pressure that is ECD value above pore pressure which can be seen in figure 4 where it indicates that there is still loss circulation with gas injection 1600 SCFM and 805 GPM mud flow rate used in drilling operation. In case to avoid problems that occur in the drilling is is important to correct gas injection optimization and mud flow rate based on guo-ghalambor method.

The problems due to loss circulation then the optimization is doing with gas injection of 1600 SCFM and 750 GPM mud flow rate as can be seen in figure 5 that the ECD value is less than pore pressure so that loss circulation can be prevented on gas injection optimization and mud flow rate purpose getting drilling results are good and efficient so it can save the company's operating costs caused by problems that occur due to loss circulation.

The successful criteria for aeration drilling based in several aspects and paradigms of dynamic pressure, static pressure, and kinetic energy. Dynamic pressure and static pressure to correct the pressure value expressed in the ECD between the two phases inside the annulus while the kinetic energy is how much energy the mud needs to move the cutting as the cutting carrying out aerated mud aeration analysis of the lifting of the cutting to the surface. From the results in the field shows that the problem of stuck pipe and loss circulation can be overcome by guo-ghalambor method.

5. Result and Discussion

5.1. Case 1

Optimization for aeration drilling parameters in case 1 is based on recommended injection limits on liquid gas ratio window so we can determine how effective the gas injection and mud rate are based on good working area. In the operation window of the gas liquid ratio window there are limits of mud rate and gas injection that can results the formation become collapse, loss circulation, and poor cutting transport as seen in figure 3 below.

After the optimization to prevent loss circulation with gas injection of 1600 SCFM and 780 GPM mud rate as can be seen in Figure 3 that the ECD value is less than pore pressure so *loss circulation* can be prevented to reduce the drilling problem caused by loss circulation.

5.2. Case 2

The problems due to loss circulation then the optimization is doing with gas injection of 1600 SCFM and 750 GPM mud flow rate as can be seen in figure 5 that the ECD value is less than pore pressure so that loss circulation can be prevented on gas injection optimization and mud flow rate purpose getting drilling results are good and efficient so it can save the company's operating costs caused by problems that occur due to loss circulation.

6. Conclusion

From this research about aeration drilling in well "BP" geothermal field of GBK this can be drawn the conclusion are:

1. Gas injection and mud rate are very influential on aerated drilling analysis carried out in the loss circulation zone is at 1581 mMD depth trajectory 12 ¼" and 1800 mMD depth in 9 7/8" trajectory.
2. Gas injection 1600 SCFM and mud rate 780 GPM aeration drilling parameters at a depth of 1581 mMD 12 ¼" trajectory does not exceed pore pressure it makes column pressure under formation pressure resulting in underbalanced drilling
3. With 1600 SCFM gas injection and 740 GPM mud aeration drilling parameters at the depth of 2016 mMD 9 7/8 " trajectory does not exceed pore pressure it makes column pressure under formation pressure resulting in underbalanced drilling
4. Cutting will be perfectly lifted to the surface with a minimum kinetic energy of 3 lb / cuft at a depth of 1581 mMD in route of 12 ¼ the kinetic energy generated is 17.7 lb / cuft it exceeds the minimum value after optimization
5. Cutting will be perfectly lifted to the surface with minimum kinetic energy of 3 lb / cuft at a depth of 1800 mMD in route of 9 7/8 the kinetic energy is 102.2 lb / cuft it exceeds the minimum value after optimization

7. Recommendation

The following are suggestions from the authors, hopefully useful and can assist in the development of aeration drilling and overcome the problems found in geothermal drilling wells with the methods that have been carried out in the writing of this research so that it can help companies improve the efficiency of operations and drilling management:

1. To optimize geothermal drilling operations because many fractures are found in their forms which can cause loss circulation it is recommended to use aeration drilling techniques. Aeration drilling reduces the problem of geothermal drilling so that it is expected that the increase in

drilling efficiency will be faster and the costs incurred are not large to overcome the problem of geothermal drilling such as stuck pipes which take a lot of cost and a long time.

2. In using aeration drilling use the Guo-Ghalambor optimization method which is more efficient because the correction of bottom hole temperature is accurate and precise.

3. The need for injecting gas and mud flow rates are right for optimization by looking at the operating window.

8. Acknowledgement

The author would like to express the gratitude as much as possible to the family and friends who always give support and to Ir. Sugiatmo Kasmungin, M.T., P.hD. and Ir. Bambang Kustono as mentors in this research by providing direction, guidance and useful advice for the completion of this research. Good luck always for all who have helped the preparation of this research. I hope this research can be useful for the progress of the nation and the State and contribute to the progress of science and education in Indonesia.

9. References

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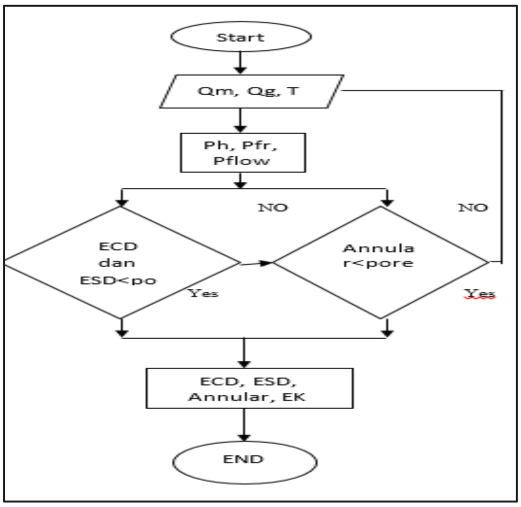

Figure 1. Research flow chart

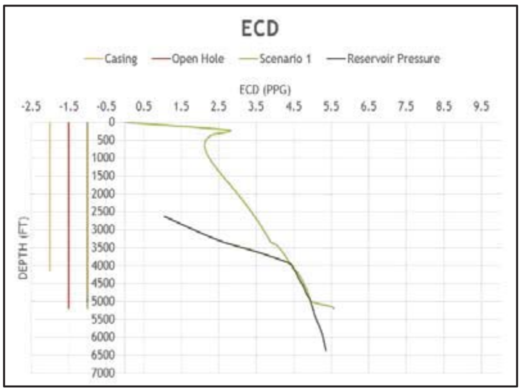

Figure 2. ECD graph in 12 ¼ trajectory before optimization

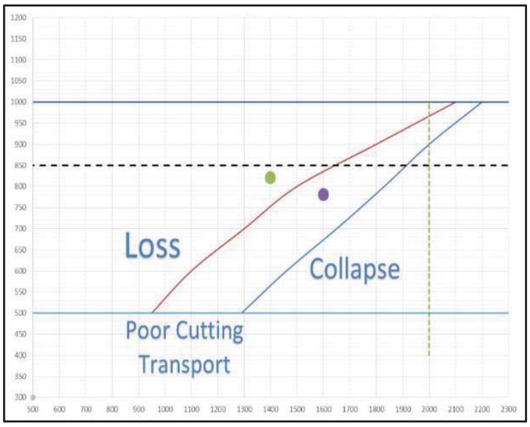

Figure 3. Operating window of case 1

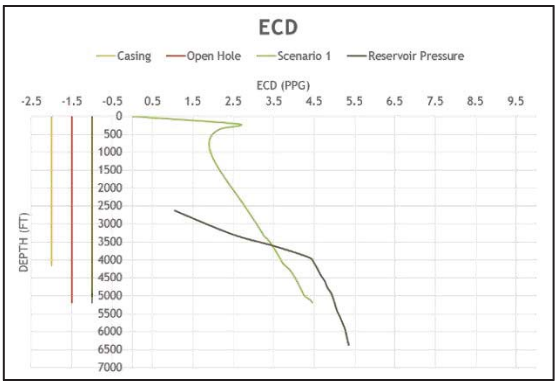

Figure 4. ECD graph in 12 ¼” trajectory after optimization

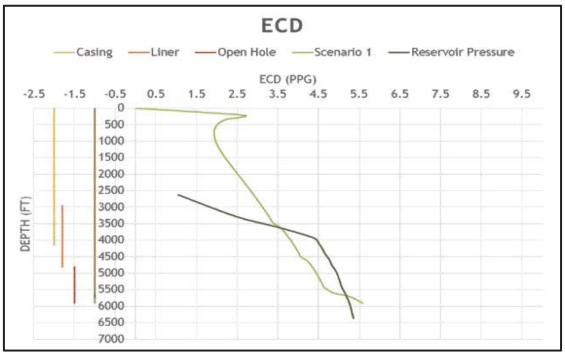

Figure 5. ECD graph in 9 $^7/_8$ " Trajectory before optimization

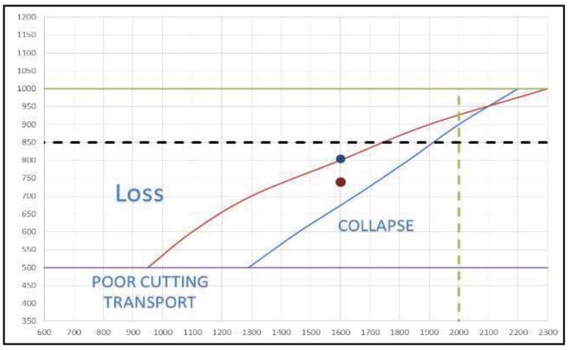

Figure 6. Operating window of case 2

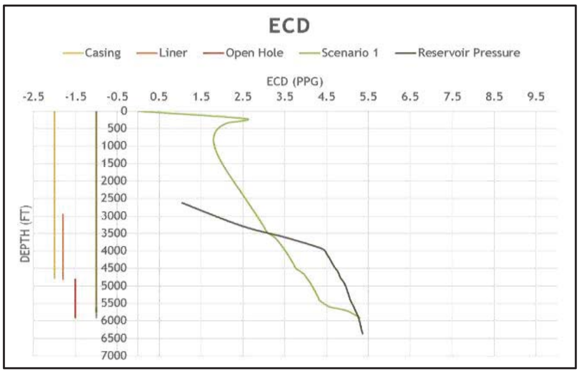

Figure 7. ECD Graph in 9 $^7/_8$ " trajectory after optimization

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Table 1. Aerated Drilling successful criteria

No	Parameter	Explanation
1.	Dynamic pressure (*Pflow*)	Pflow < Pres; ∆P ≤ 200 psia
2.	Static pressure (*Pstatic*)	Pstatic < Pres; ∆P ≤ 200 psia
3.	Kinetic energy (Ek)	Ek > Ek_{min} ; Ek_{min}=3 lb/cuft
4.	ECD	ECD > ESD