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Determining Wells Candidates For Hole Cleaning in Kamojang Geothermal Field

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ABSTRACT

During the generation for more than 40 years, Kamojang wells have experienced decline in production. It directly affects steam supply to the power plant. The most important program to resolve steam availability is to drilling makeup well. Limited access and unsuccessful drilling makeup well as expected in the last 10 years becomes a problem in order to maintain long term production. Fetkovich Method has been used as guideline to simulate gas/geothermal well production performance. It has been used widely and give an accurate model of production performance. But, there is a weakness in Fetkovich Method, which is it's difficult to understand the change of parameter stabilization production coefficient and deliverability exponent with their correlation in wellbore or reservoir. Acuna and Pasaribu (2008) can handle this problem with anaylitical method through parameter of friction coefficient inwellbore and productivity index in reservoir. In this case, hole cleaning aims to dissolve scaling that cause decline of production. As result total of seven wells experienced increase in production after hole cleaning. It gains approximately 8 MW. In addition, the advantages of this jetwash are reduction in cost and time as well compared.

Keywords: decline analysis; hole cleaning; jetwash; scaling

I. INTRODUCTION

The primary problem that occurs in Kamojang field is how to maintain steam supply to the power plant. It is indicated with production decline steadily. Currently, decline production in Kamojang field reaches 7% /year. The strategy to solve production decline is through drill makeup well but it has a problem due to limited land access, the success ratio of drilling makeup well within 10 years under the target and reservoir condition have been depleted. Another option to maintain steam supply by hole cleaning. Scaling has formed due to a dynamic production process in a wellbore, it resulted in decline production well and obstacle while logging tool survey. The aim of hole cleaning is to clean the wellbore from scaling with the result that increases steam supply and clears the obstruction in the wellbore.

II. METHODS

2.1. Analysis Well Condition

1. Collect and identify well test data, daily production data, running pts, drilling costs on wells in the wellpad X.
2. Preliminary screening:
   - Decline curve analysis using data normalization with equations as follow:

$$p^2 = \left(\frac{W}{C}\right)^{\frac{1}{n}} + p_f^2 \qquad (1)$$

   - Production decline rate calculation with exponential model
   - Analysis of production variants. The production deviation is closely related to the change in values of the two main production parameters, C_{wb} (kg/s-bar) and PI (m^3). The empirical approach used to identify changes in the value of C_{wb} and PI refers to the formula developed by Acuna (Acuna, 2008):

$$W = (C_{WB}A^2p_{si}^2 - Ap_f^2)^{0.5}A\frac{v_s}{PI}P_{si} \qquad (2)$$

Where :

$$A = \frac{1}{C_{WB} - \left(\frac{v_s}{PI}\right)^2} \quad (3)$$

3. Pre-Hole Cleaning:
- Calculate steam gain potential from production variants
- Based on steam gain potential, calculate the economical indicator which is Net Present Value
- Checking actual wellbore condition with well integrity logging
- Determine the appropriate hole cleaning method to be carried out
- Well ranking based on technical and economic evaluation result

4. Post-Hole Cleaning, using data comparison of well integrity logging to see maximum clear depth and modified isochronal test data to see productivity of wells before and after hole cleaning.

III. RESULTS AND DISCUSSION

3.1. Preliminary Screening

Indications of wells that are damaged are the wells which has a decline percentage production more than 10%/year. Analysis variants is a systematic process to identify variants or deviations of well production data projected between natural declines and actual production data. The more variants or deviation that occurs, the more potential for possible hole problems in the wellbore or formation. The production deviation is closely related to the change in values of the two main production parameters, C_{wb} (kg/s-bar) and *PI* (m^3). **Equation 2**. This model is optimized to identification fluid flow in wellbore and feed zone so it's possible to explain characteristics well deliverability curve in terms of Productivity index (m3) and wellbore storage (kg/s-bar).

Table 1. Decline values and Production Variants for Wellpad X wells

Well	Decline Rate	Prod. Variants
A	**18.3%**	✓
B	**11.0%**	✓
C	4.0%	
D	2.2%	
E	**14.6%**	✓
F	**10.4%**	
G	1.5%	
H	**18.3%**	✓
I	1.0%	
J	2.9%	
K	7.0%	
L	0.7%	
M	3.7%	
N	3.7%	

Although well F has a decline rate of 10.4%, after analysis this well does not have a production variant. From the results obtained, the C_{WB} value of well F did not change due to no change in the size of the wellbore. Therefore, the most likely is a change on the reservoir side, which indicates a problem in the well test feedzone.

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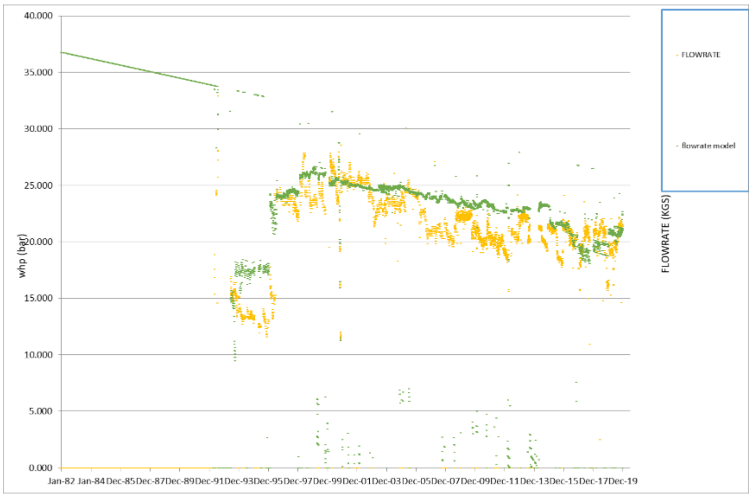

Figure 1. Well F production variants

3.2. Pre-Hole Cleaning

1. **Steam Gain Potential**

Analysis variants is a systematic process to identify variants or deviations of well production data projected between natural declines and actual production data. The more variants or deviation that occurs, the more potential for possible hole problems in the wellbore or formation. Following are the results of the analysis:

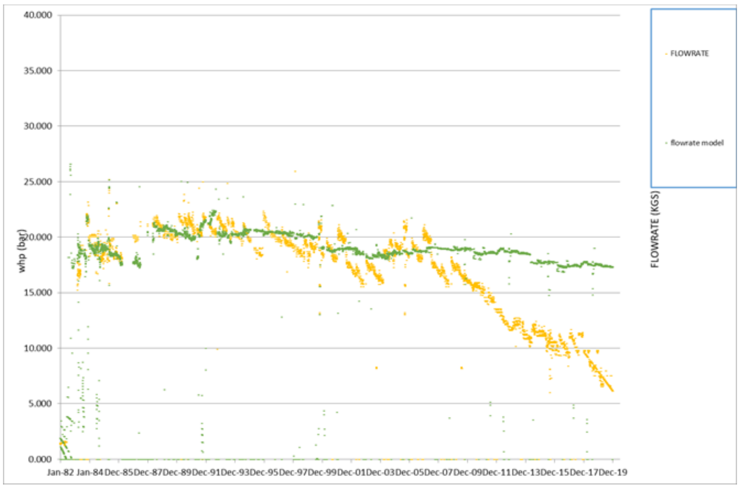

Figure 2. Well A Production Variants

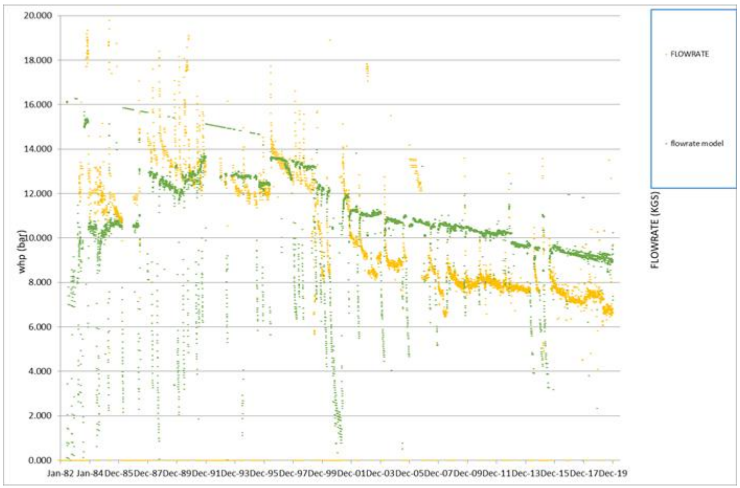

Figure 3. Well B Production Variants

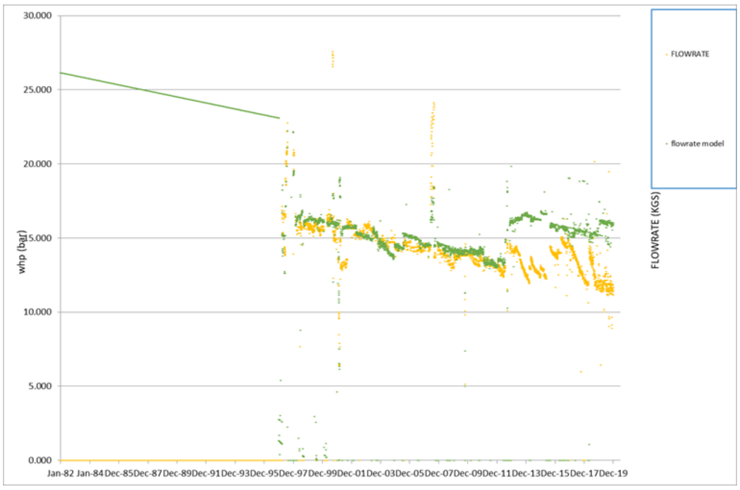

Figure 4. Well E Production Variants

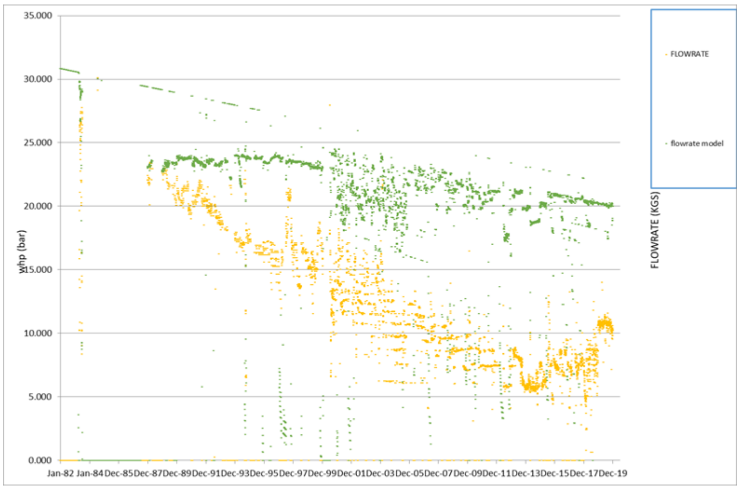

Figure 5. Well H Production Variants

Calculating steam gain potential aims to provide an idea of how much steam the well can produce. In this calculation several probabilities are used, namely 10%, 50% to 90%.

Table 2. Steam Gain Potential

Well	Steam Gain Potential (*kg/s*)		
	10 %	**50 %**	**90%**
A	1.33	6.65	11,97
B	0.36	1.81	3.25
E	0.73	3.66	6.59
H	0.88	4.40	7.92

2. **Net Present Value**

Based on technical evaluation obtained well a candidate for Hole Cleaning which has potential to increase steam gain, further evaluation is done by Net Present Value (NPV), with NPV can be known a feasible or not.

Table 3. NPV Result

NPV (*Steam gain* 50%)			
	CTU	**HWU**	**Rig**
Well A	$1.23MM	$0.44MM	-$0.06MM
Well B	$0.20MM	-$1.54MM	-$1.68MM
Well E	$2.81MM	$2.53MM	$2.03MM
Well H	$3.77MM	$3.49MM	$2.99MM

3. **Well Integrity Logging**

The next evaluation is wellbore checking with well integrity logging with Go Devil, Impression Block and Scale Catcher. Go devil is a tool used to observe the diameter condition of the casing. Go devil size used in accordance with the size of production casing and well-perforated liner, this is intended to determine a depth of obstruction caused by scaling.

Figure 6. Impression Block

Impression block is a tool used to check the profile of obstruction in the wellbore. The size of the impression block used is adjusted to the size of the casing to be measured. Scale catcher is a tool used to take out scale in a wellbore. Scale identification depth based on Go devil and impression block.

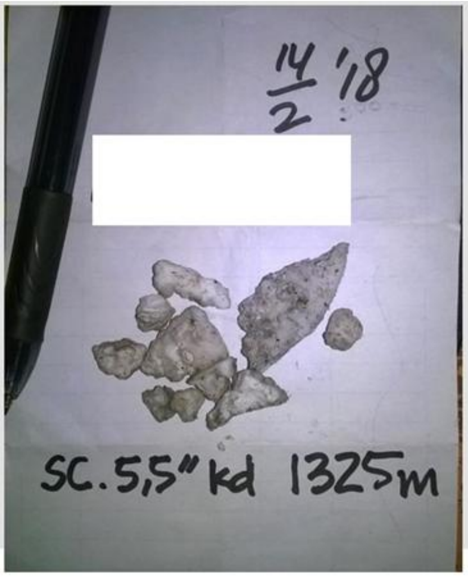

Figure 7. Silica Scale Well A

The scale is then analyzed in the lab to determine the type and level of hardness. Several examples of scale were obtained in almost all wells which indicated narrowing in the wellbore.

4. **Well Ranking**

Well ranking in the selection of well candidates for hole cleaning is an evaluation and ranking process to determine the priority order of wells that require special attention in operations. The classification categories of the parameters evaluated justify the ranking of priority wells for hole cleaning.

Table 4. Scoring Well Candidate

Parameter	Indicator	Score
Decline Rate	<12%	1
	12-15%	2
	>15%	3
Production Rate	<7 kg/s	1
	7-9 kg/s	2
	>9 kg/s	3
Production Variants	<3%	1
	3-5%	2
	>5%	3

Based on the technical and economic evaluation result, we get the candidate hole cleaning well as follows:

Table 5. Well Ranking

Sumur	*Decline Rate*	*Prod. Rate*	*Prod. Variants*	Jenis *Scale*	Metode HC	*Score*
A	18.3%	19.4 kg/s	13.3 kg/s	Silica Amorph	CTU	9
H	18.5%	7.15 kg/s	5.50 kg/s	Kuarsa	HWU	8
E	14.6%	8.92 kg/s	4.58 kg/s	Kuarsa	HWU	6
B	11.0%	6.63 kg/s	3.61 kg/s	Silica Amorph	CTU	4

3.3. Pots-Hole Cleaning

Hole cleaning job has been successfully done in 4 candidate wells, to evaluate post hole cleaning job performed Well integrity and production test.

1. **Well A**

Table 6. Comparison of Maximum Clear Depth Well A

Pre-Hole Cleaning		*Post-Hole Cleaning*	
Size	**Depth**	**Size**	**Depth**
8 "	875 m	8 "	875 m
5 ½ “	1325 m (Scale)	5 ½ “	1429 m
3 ½ “	1406 m (Scale)		
2.125 "	1406 m	-	-

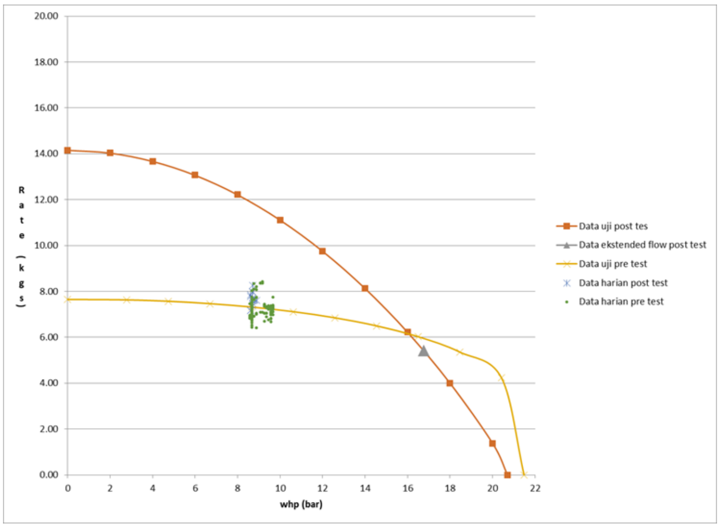

Figure 8. Comparison of MIT Pre and Post Hole Cleaning Well A

2. **Well B**

Table 7. Comparison of Maximum Clear Depth Well B

Pre-Hole Cleaning		*Post-Hole Cleaning*	
Size	**Depth**	**Size**	**Depth**
8 "	664 m (Scale)	8 "	690 m
5 ½ “	989 m (Scale)	5 ½ “	1020 m
2.125 "	989 m	-	-

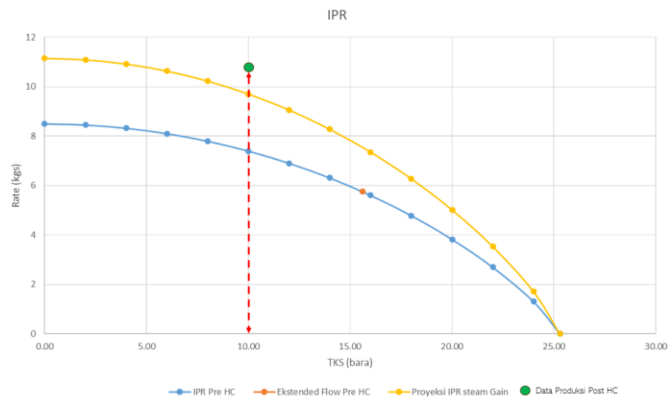

Figure 9. Comparison of MIT Pre and Post Hole Cleaning Well B

3. **Well E**

Table 8. Comparison of Maximum Clear Depth Well E

Pre-Hole Cleaning		*Post-Hole Cleaning*	
Size	**Depth**	**Size**	**Depth**
8 "	730 m	5 ½ "	1192 m
5 ½ "	741 m (Scale)	-	-
2.125 "	741 m	-	-

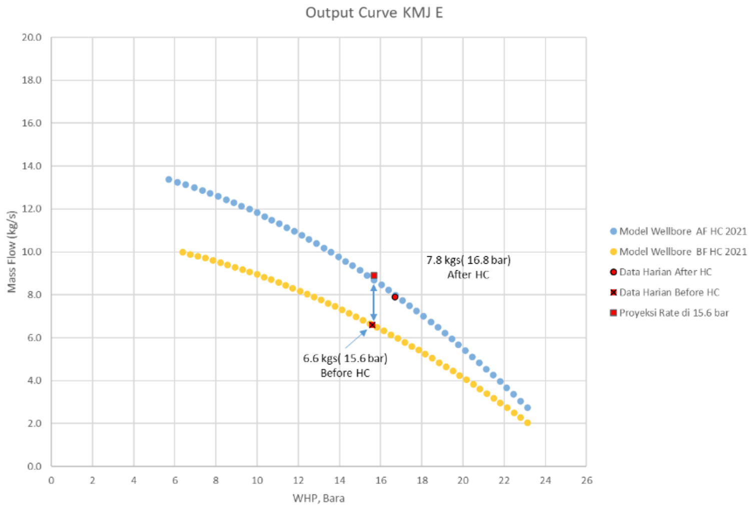

Figure 10. Comparison of MIT Pre and Post Hole Cleaning Well E

4. **Well H**

Table 9. Comparison of Maximum Clear Depth Well H

Pre-Hole Cleaning		*Post-Hole Cleaning*	
Siza	**Depth**	**Size**	**Depth**
8 "	848 m	5 ½ "	1291 m
5 ½ "	995 m (Scale)	-	-
3 ½ "	995 m	-	-

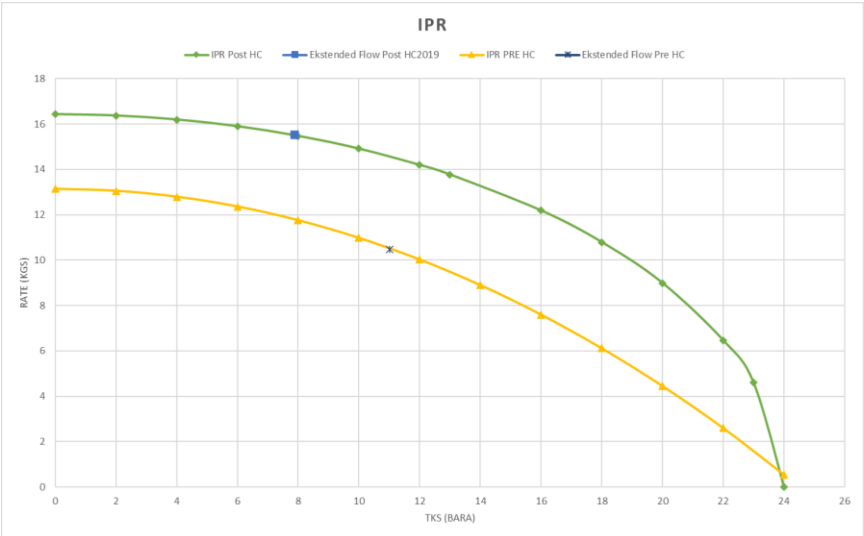

Figure 11. Comparison of MIT Pre & Post Hole Cleaning Well H

Checking well integrity is done by run logging go devil. Post Hole Cleaning logging results indicate that the scaling formed along the borehole has been successfully removed.

Post-HC production test at well A is done by Modified Isochronal Test (MIT) in same WHP setting. Post-HC production test shows a significant increase in productivity of wells of 16.1 kg/-s at an operational WHP of 11 bar. Overall, based on pre-HC and post-HC well test results, Hole Cleaning effectively improves hole conditions and well productivity, the following are Total Cumulative Steam Gain Production Post-HC for wells that have been done Hole Cleaning.

IV. CONCLUSION

1. From well screening based on the decline rate and the single-phase analytical method on Wellpad X, there were 5 wells that indicated well damage.
2. The recommended wells for hole cleaning are 4 wells:
   - Well A with amorphous scale silica type, has a steam gain value of 13.3 kg/s, and an NPV value of $6.70 MM using the Coiled Tubing Unit method,
   - Well B with amorphous scale silica type, has a steam gain value of 3.61 kg/s, and an NPV value of $0.20 MM using the Coiled Tubing Unit method,
   - Well E with a quartz scale type, has a steam gain value of 4.58 kg/s, and an NPV value of $2.53 MM using the Hydraulic Workover Unit method,
   - Well H with a quartz scale type, has a steam gain value of 5.50 kg/s, and an NPV value of $3.49 MM using the Hydraulic Workover Unit method.
3. Based on the evaluation results, hole cleaning is effectively able to clean scaling that forms along the wellbore and is able to increase well productivity, which in total can provide additional steam availability of 7.9 MWe.

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