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The Effect of Regular and Long Cyclic Steam Stimulation Method on Oil Production Performance of Rua Field in Central Sumatra

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ABSTRACT - RUA field is classified into heavy oil reservoir type due to the high viscosity value and low API degree . This causes the RUA field can not be produced conventionally. the solution of this problem is to apply steam or thermal injection into reservoir which could reduce the viscosity of the heavy oil (Bera & Babadagli, 2015) in-situ combustion, hot water and steam flooding, and steam assisted gravity drainage have been widely applied over decades. Currently, non-aqueous heating methods, generally named electromagnetic, are in consideration as an alternative to the aqueous methods, which may not be applicable due to technical and environmental limitations. This technique still requires further research and field scale pilot applications to prove their technical and economic viability. In this paper, a critical discussion on the review of electromagnetic heating is presented. An attempt is undertaken to review most of the research works (computational and experimental as well as a limited number of field applications. One of the best EOR methods that has been proven to overcome this issue is using CSS method (Suranto, *et al*., 2020). During the production period, the CSS process can affect the viscosity of the oil by increasing the temperature of the oil in the reservoir. In one production well, cyclic work are applied periodically, its called repeated cyclic (Sheng, 2013). This is because time of reservoir temperature stays above the baseline temperature reservoir shortly. Even though the cyclic already done repeatedly, there is still a decrease of oil production, different peak reservoir temperatures, and found the possibility of pump damage after the cycle job which led to the need for analysis on these issues. The analysis was performed by looking at the historical production data, historical reservoir temperature data, and production pump work data in the RUA field. After a production history data that reprsentative analyzed, it was found that teh production after cyclic there is increasing, and there is also a decline from the previous cyclic production. Based on the results of the production analysis, it was found that 53.24% of the production wells in the RUA field were already in the ramp down stage and 46.75% were already in the ramp-up stage. Meanwhile, the average HET for regular cyclic jobs is 3-4 months and 5-6 months for long cyclic jobs. And from the pump work data, only 3 wells were damaged. This suggests that cyclic stimulation is completely safe to be performed in this field.

Keywords: Cyclic Steam Stimulation, Heat Endurance Time (HET), Regular cyclic, Long cyclic.

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INTRODUCTION

RUA field was found in 1941 with the large of area 34730 hectars in Central Sumatera. The oil was found at the depth 300 - 700 ft when the first well was drilled in 1941. The Oil reserves which are found in the RUA field Indonesia is around 5.7 billion BBL. The type of reserve in this field is classified into Heavy Oil reservoir. The density of the oil in this field is 22.4 API with 118 cp viscosity of oil. Due to the characteristic of the oil in this field there are only 7.5% of total oil reserve which could be produced at the primary recovery (Fuaadi, *et al.*, 1991). It is different from conventional petroleum insofar as it is much more difficult to recover from the subsurface reservoir. The recovery of this type usually requires thermal stimulation of the reservoir (Speight, 2009). It is required an advance method to increase the production oil in this field. One of the method that implemented to reducing the oil viscousity in this field is Cyclic Steam Stimulation (CSS) (Afdhol, *et al.*, 2020).

According to (Sheng, 2013), CSS is an effective method can be implemented to reduce the oil at this range of viscosity due to the heavy component. Cyclic steam stimulation (CSS) involve steam injection into a reservoir during some weeks (injection stage), allowing the reservoir to undergo short period of "soaking" where the well is closing during a few days (Trigos, *et al.*, 2016)presence of swelling clays, low lateral and vertical continuity of the producing sands, steam channeling, among others.According to the oilfield complexity some strategies are currently being implemented after previous studies of numerical simulation and lab test evaluation: diesel slug to improve injectivity, reduced steam quality in the first cycles to increase steam injectivity, using clay inhibitor during steam injection, reduced spacing in the better zones according to opportunity index map, nitrogen injection in wells with more than six stimulation cycles, high frequency cycles and changes in completion design and drilling scheme among others.The set of lab test, numerical simulation and pilot test have resulted in the following: 1. When the oil rate decline to a low level, the whole cycle - injection, soak and production - is repeated, and this may be continued as many times as is economical. The main purpose of CSS implementation in RUA field is to reduce oil viscosity, drive the oil easier to flow and produced. There are three type of CSS, short CSS, regular CSS and long CSS. The concern in this study is only on regular CSS and long CSS which is required long period in implementation and affect oil viscosity in RUA field.

METHODOLOGY

The reservoir data and production field data for heavy oil RUA field has been collected and used for analyze the influence and contribution of regular and long cyclic job in RUA field. These data has been collected from 2013 - 2016 time work of each wells in RUA field.

In this study, we will analyzed the influence of cyclic jobs on RUA field in temperature reservoir, oil production and production pump performance. The production pump are also analyzed because those are a part of all cyclic job.

The steps below must be followed to get the target of the research, Figure 1.

RESULTS AND DISCUSSION

The study was conducted on RUA field which has 122 production wells that have been carried out regular cyclic and long cyclic jobs. Regular cyclic were carried out on 116 production wells in RUA field and long cyclics carried out on 6 production wells.

Cylic jobs effect on reservoir temperature

From the temperature analysis performed on the RUA field, different temperature peaks were obtained for each cyclic job. Well Heat Temperature data are taken as reservoir temperature data. Because the WHT data is considered to represent reservoir temperature data on the well. Analysis carried out on one of the wells carried out by regular cyclic and long cyclic jobs on field RUA shows an increase in each cyclic job performed.

The following is an example of a well done regular cyclic job on the RUA field, namely YA22 wells, and long cyclic jobs, namely YA23 wells.

Figure 2 and Figure 3 explain that after cyclic job, there is an increase in reservoir temperature, where at each temperature increase has a different temperature peak. Different temperature peak causes the injection of steam which is carried out on different reservoirs and heat distributions. Judging from the high-temperature reservoir after cyclic, the distribution of injected steam is very good, above 200^{o}F.

Heat is well distributed when the reservoir temperature is at 200^{o}F, which is when the injection and soaking processes are carried out. Then over time, it decreases to reach the baseline temperature, indicating that the well is in the production stage.

The influence of the distribution also not only had an impact on the peak temperature obtained but also on the time needed for the temperature reservoir to return to the temperature baseline reservoir after cyclic, called the Heat Endurance Time (HET).

Figures 4 and 5 show the percentage of HET obtained after regular cyclic and long cyclic jobs on the RUA field. Of the 50 regular cyclic workshops, the highest percentage was 26% at 3-4 months which required the reservoir temperature to return to normal after cyclic job. Meanwhile, 34% of the 9 long cyclic work on the RUA field took 5-6 months for the reservoir temperature to return to normal after the cyclic job was done.

The time the temperature reservoir needed to return to the temperature reservoir baseline varies greatly depending on the distribution or distribution of heat given to the reservoir. If the heat given is

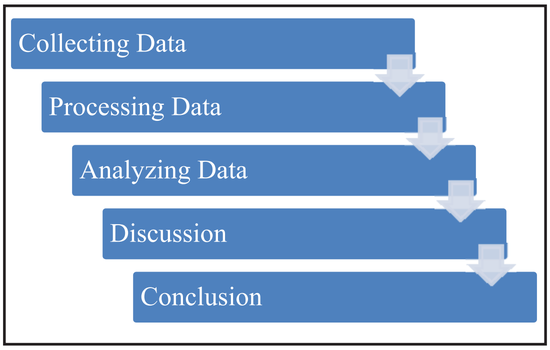

Figure 1
Process chart.

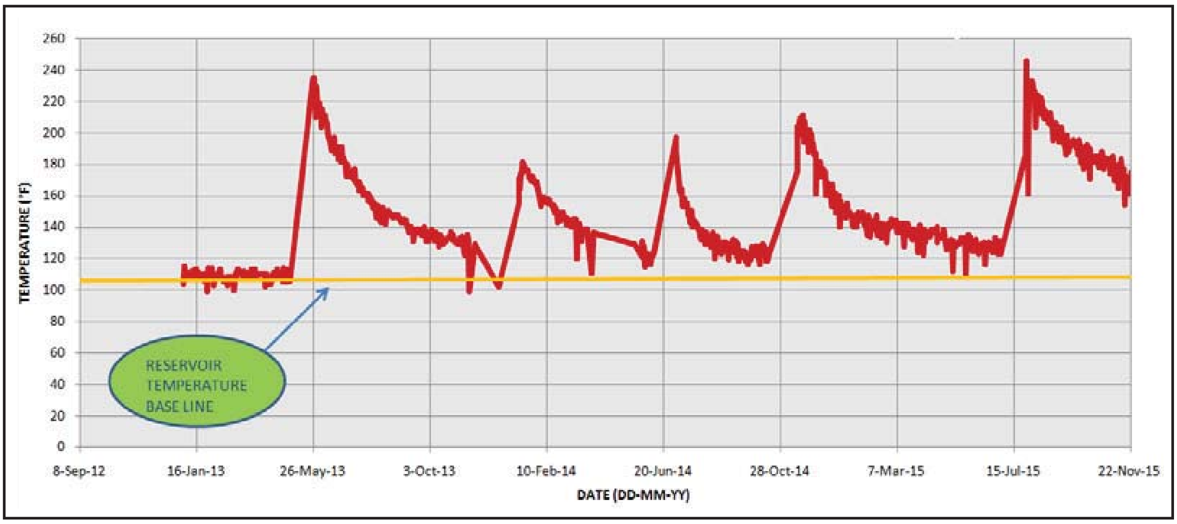

Figure 2
Graph YA22 well reservoir temperature data at regular cyclic job (January 16th, 2013 – November 22th, 2016).

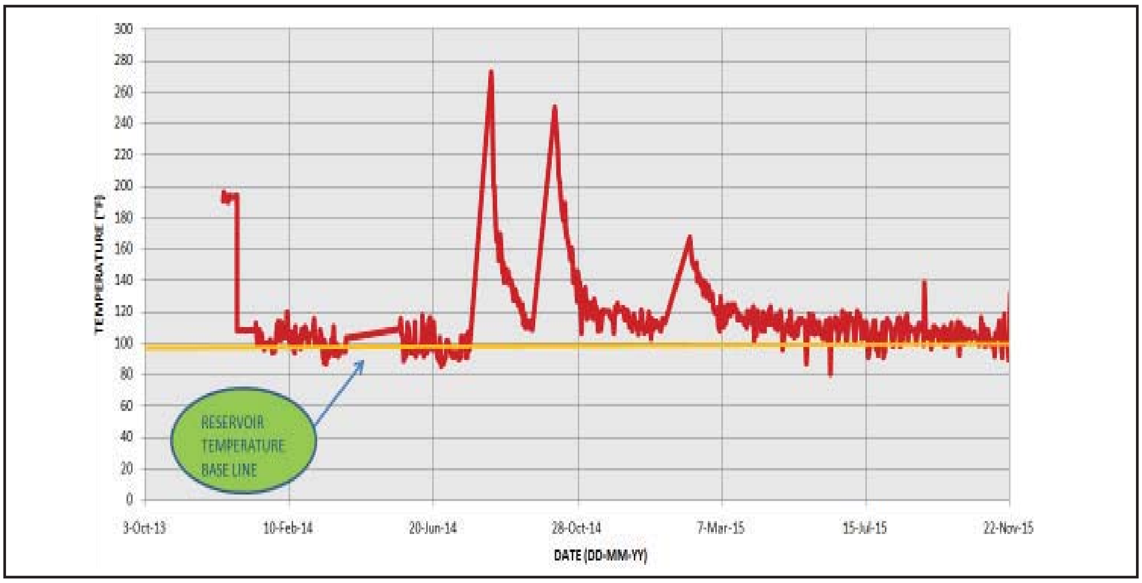

Figure 3
Graph YA23 well reservoir temperature data at long cyclic job (Desember 14th, 2013 – November 22th, 2015).

well distributed, the reservoir temperature will last longer. Thus, the viscosity of oil in the reservoir will last longer.

Then in one cyclic job, it can also have a different HET from other 'repeated' cyclic job in the same well. This is due to the different heat distribution from one cycle to another.

Analyze oil production after regular cyclic and cyclic long

The following is the trend of heavy oil flow for the field with steam injection (Figure 6).

Figure 6 shows the 3 stages of oil flow in the field by steam injection. The first stage is ramp-up, the first time the oil is produced, at this stage the rate of production can continue to increase after cyclic jobs are carried out. Then the plateau stage, which is the peak stage of oil production in the well that has been done by the cyclic job. And the last is the ramp-down stage, that is if a cyclic job is carried out, the increase in production after cyclic jobs tends to continue to decline.

Typically, the total oil produced declines from cycle to cycle, whereas the volume of water

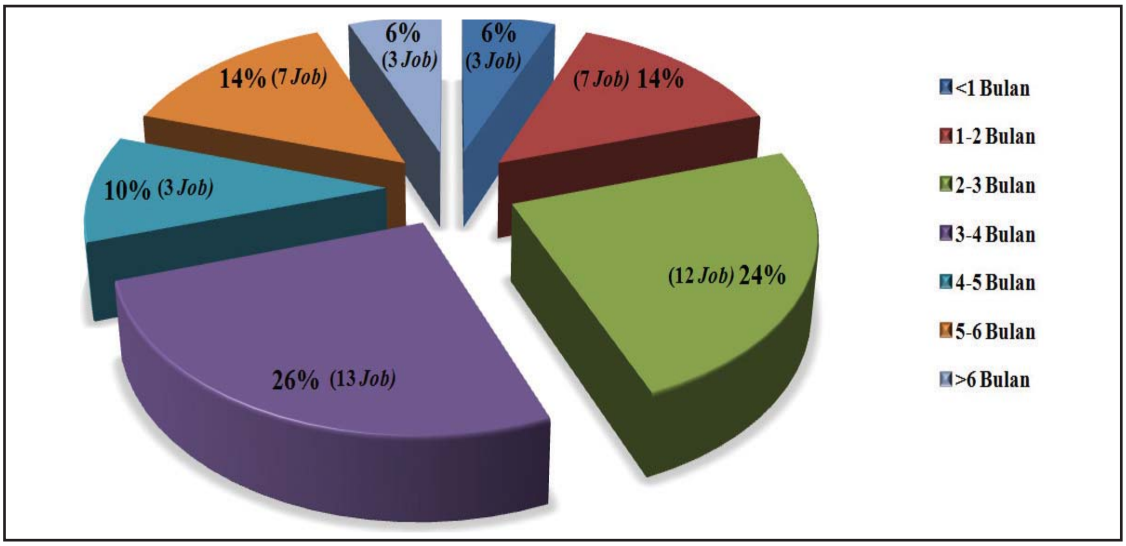

Figure 4
Regular Cyclic Heat Endurance Time (HET) (Januari 2013 - Oktober 2016).

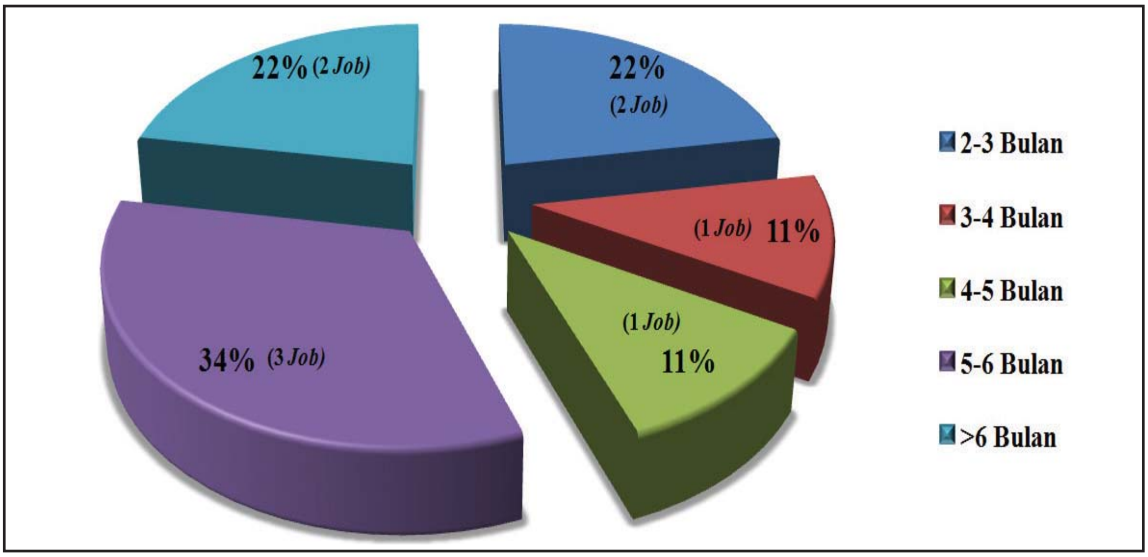

Figure 5
Long Cyclic Heat Endurance Time (HET) (Januari 2013 - Oktober 2016).

increases, as if the volume affected is only the original hot zone (Ali, 1994).

In RUA field there are 2 different trends in oil production after cyclic jobs. In figure 7, it can be seen that the trend shown by the increase in production after the cyclic job has continued to decline. So, based on an analysis of the trend of heavy oil flow rates for the steam injection field, the YA01 well in Figure 7. has entered the ramp-down stage. At this stage, the highest production peak has been reached, so that when the well is carried out repeatedly cyclic jobs, increased production will tend to continue to produce a declining trend. While the analysis for YA03 wells in Figure 8. is still at the ramp-up stage. When a well is still in the ramp-up stage, the well will have a production trend several times increased when the cyclic repeats which later will produce the highest peak production (peak production).

The majority of production wells found in RUA field have entered the ramp-down stage. This is seen from 122 wells in RUA field, only 77 wells that provide representative data. Where can be seen in figure 9. there are 53.24% have entered the ramp-down stage and 46.75% of the 77 wells analyzed are still at the ramp-up stage.

In addition, steam quality can influence oil recovery factor. As steam quality increases, the heat carried

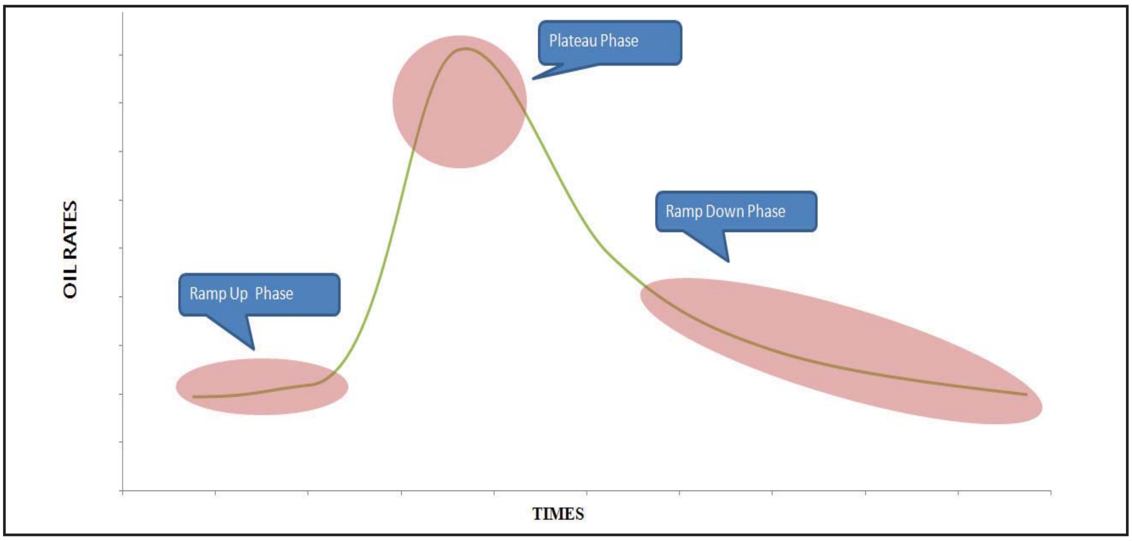

Figure 6
The trend of heavy oil flow rate for the field with steam injection.

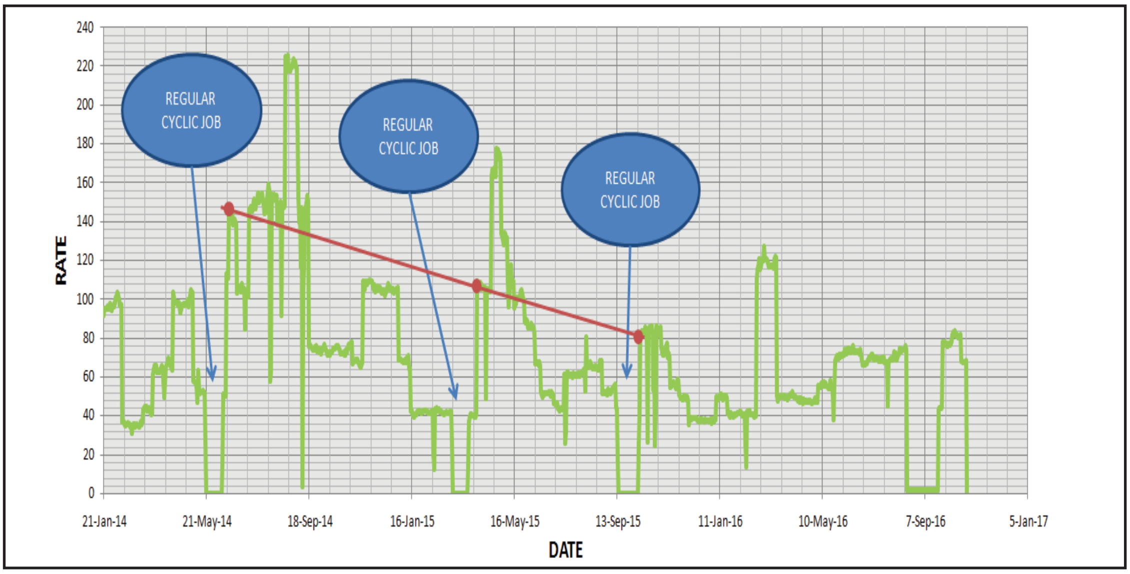

Figure 7
Graph of YA01 well oil production data on RUA field.

by the vapor increses, therefore, lead to an increased heated volume and the cumulative oil production also increases considerably. And ofcourse the economical factor must also be considered.

From the differences in the trend of the oil production curve after cyclic jobs, it was analyzed that the trend of oil gain that is always obtained is not always decreasing. The oil gain trend that is generated from regular and repeated long cyclic jobs can also increase. this depends on the stage of production where the well is located. So it is necessary to pay attention to the 3 stages of heavy oil production in the field with steam injection in order to know and predict the increase in oil production in the well.

Volume the cyclic steam injection. Cumulative oil recovery can be improved through increasing cyclic steam injection volume (Wang, *et al.*, 2018).

Analysis of pump damage after regular cyclic and long cyclic job

RUA field is a field that has a very high level of sand, therefore the artificial lift used in this field is

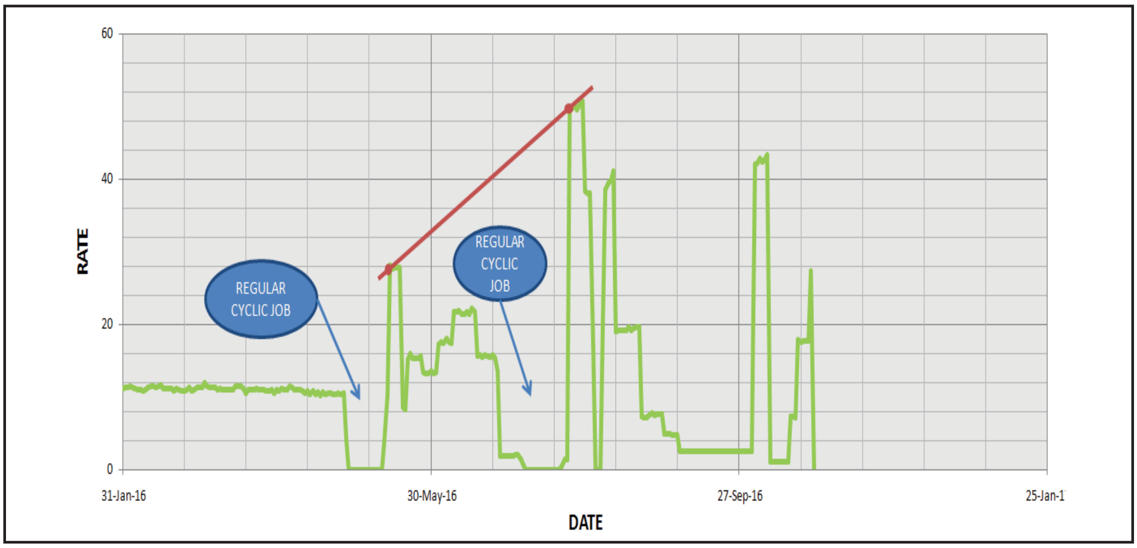

Figure 8
Graph of YA03 well oil production data on RUA field.

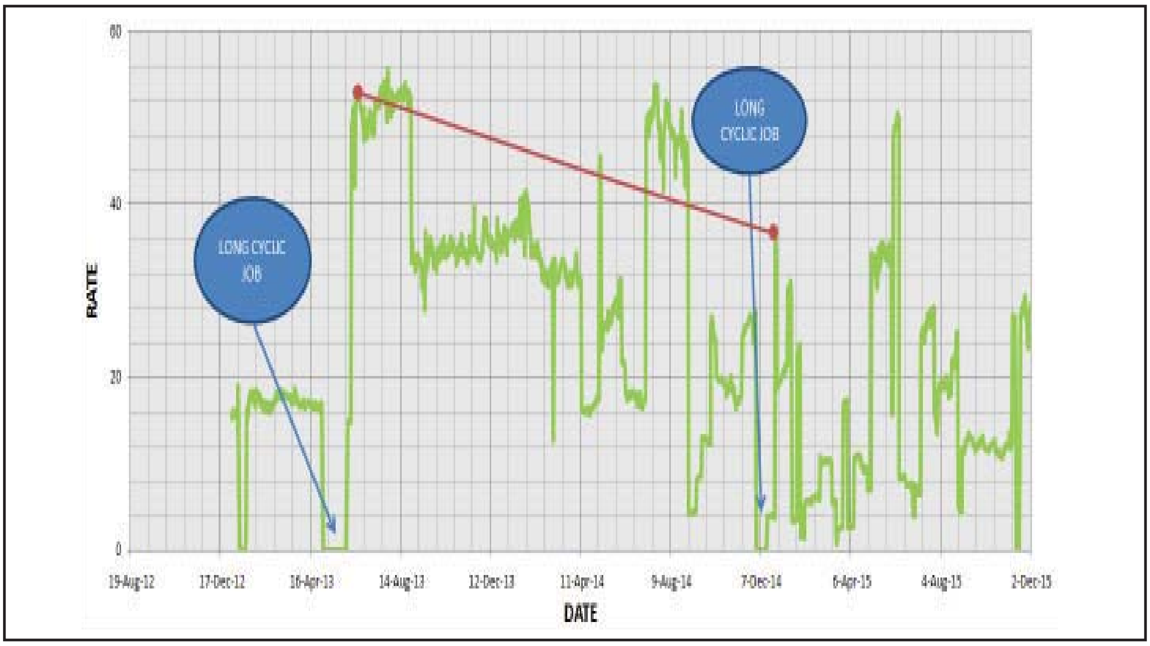

Figure 9
Graph of YA02 well oil production data on RUA field.

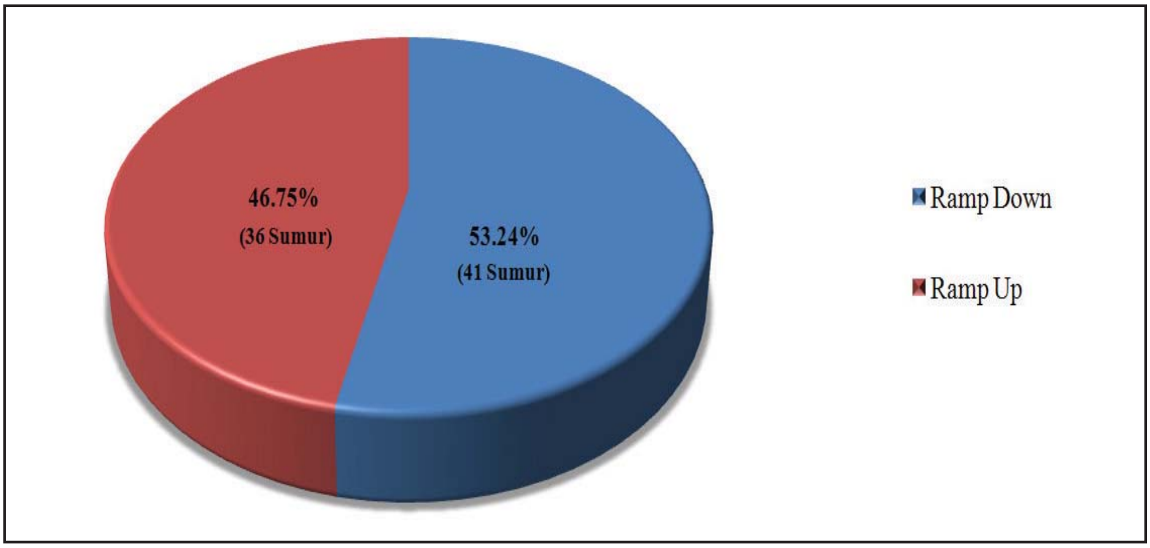

Figure 10
Percentage of well production stage on RUA field.

Table 1
Data Pump Work at Well YA06

Well Name	Time		JOB
YA06	3-Aug-2013	8-Aug-2013	Drill Hole
	19-Mar-2014	19-Mar-2014	Rod Pump-Bump Down Job
	30-Apr-2014	18-May-2014	Cyclic Steam, Improve Heat & Drainage
	10-Oct-2014	27-Oct-2014	Cyclic Steam, Improve Heat & Drainage
	27-Sep-2015	15-Oct-2015	Cyclic Steam, Improve Heat & Drainage
	16-Oct-2015	16-Oct-2015	Repair/Change Polish. Rod
	29-Oct-2015	30-Oct-2015	Cyclic Steam, Near Wellbore Stimulation
	15-Sep-2016	28-Sep-2016	Cyclic Steam, Connect to Steam Chest

Table 2
Data Pump Work at Well YA08

Well Name	Time		JOB
YA08	30-Apr-2013	18-May-2014	Cyclic Steam, Improve Heat & Drainage
	12-Feb-2015	10-Mar-2015	Cyclic Steam, Improve Heat & Drainage
	17-Mar-2015	18-Mar-2015	Rod Pump Stuck Normal
	28-Jul-2015	28-Jul-2015	Rod Pump-Bump Down Job
	23-Dec-2015	18-Jan-2016	Cyclic Steam, Improve Heat & Drainage

an Sucker Rod Pump (SRP). An analysis is done on the pump after the cyclic job is done by looking at the pump work data.

Of the 122 wells that have been repeated by cyclic, only 3 wells with pumpages have been damaged in less than 10 days after cyclic. Indications of damage are found in the replacement or repair of stuck rods and rod pumps that are stuck as shown in Figures 10, 11, and 12. In Figures 13, well YA06 undergoes the replacement /repair of polish rods that are carried out after 1 day of cyclic work. YA08 wells have a rod pump stuck after 6 days of cyclic work. As for YA12 wells, after 9 days of cyclic work, there will be replacement work/repair of polish rods.

Table 3
Data Pump Work at Well YA12

Well Name	Time		JOB
YA12	22-Jan-2013	26-Jan-2013	Cyclic Steam, Improve Heat & Drainage
	12-Nov-2013	30-Nov-2013	Cyclic Steam, Improve Heat & Drainage
	14-Aug-2014	21-Aug-2014	Cyclic Steam, Improve Heat & Drainage
	30-Aug-2014	30-Aug-2014	Repair/Change Polish. Rod
	31-Aug-2014	31-Aug-2014	Rod Pump-Bump Down Job
	27-Nov-2014	28-Nov-2014	Rod Pump Stuck Normal
	18-Feb-2015	7-Mar-2015	Cyclic Steam, Improve Heat & Drainage
	26-Aug-2015	16-Sep-2015	Cyclic Steam, Improve Heat & Drainage

Table 4
Data Production Pump Work at Field X

No.	Well Name	Time (After Cyclic)	JOB
1	YA06	After 1 Day	*Repair/Change Polish Rod*
2	YA08	After 6 Days	*Rod Pump Stuck Normal*
3	YA12	After 9 Days	*Repair/Change Polish Rod*

Selain itu, the css method also capable to minimized heat losses from the surface and resulted lo greenhouse gas emissions since there is no steam generator required (Putra, *et al.*, 2011) 22-26° API oil gravity and relatively shallow reservoir depth, Melibur has an appropriate character to perform steam injection. The project started with well selection with the main consideration is amount of remaining oil in reservoir. It is also considering completion diagram and operational aspect for each well. The injection process was performed in 10-12 days with certain injection parameter to meet the heat requirement for reservoir and follow with 5 days soaking.This paper focuses on the result and effect of cyclic steam stimulation to well and offset wells production rate and fluid properties. Many experiences acquired from the project of cyclic steam stimulation perform in Sihapas formation, one of them is the effect to offset well that indicates there is a connection and high heat conductivity between wells. Incremental of initial production rate about 40% occurred in first well. In second well, this operation gives an effect to offset well with the incremental of production rate reach 100% in nearest well. Oil properties changes with different in viscosity, oil gravity and pour point value after cyclic steam stimulation (Putra, *et al.*, 2011).

CONCLUSIONS

From the results of the analysis of well data, regular work data and long cyclic and pump work data on this RUA field, the following conclusions are obtained:

Temperature resistance above the baseline or heat endurance time in this field is the majority of 3 to 4 months for regular cyclic and 5 to 6 months for cyclic longs.

Wells - wells on the RUA field, still provide increased production every time cyclic is carried out. Whether it's a well that has a historical trend of declining production (rump-down phase) or that has a historical trend of increased production (rump-up phase). The wells in the RUA field are already on the ramp-down phase, which is as much as 53.24% and while at the ramp-up stage it is 46.75%.

Regular work and repeated long cyclic carried out on production wells did not significantly influence the production pump. Of the 122 wells analyzed, only 3 wells were damaged after less than 10 cyclic days. So that this work is very safe to do repeatedly to increase production.

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GLOSSARY OF TERMS

Symbol	Definition	Unit
CSS	Cyclic Steam Stimulation	
WHT	Well Heat Temperature	
HET	Heat Endurance Time	
RATE		
SRP	Sucker Rod Pump	

REFERENCES

Afdhol, M. K., Erfando, T., Hidayat, F., Hasibuan, M. Y., & Regina, S. (2020). The Prospect of Electrical Enhanced Oil Recovery for Heavy Oil: A Review. *Journal of Earth Energy Engineering*, *8*(2), 73–94. https://doi.org/10.25299/jeee.2019.4874

Ali, S. M. F. (1994). CSS - Canada's Super Strategy For Oil Sands. *Journal of Canadian Petroleum Technology*, *33*(09). https://doi.org/10.2118/94-09-01

Bera, A., & Babadagli, T. (2015). Status of electromagnetic heating for enhanced heavy oil/bitumen recovery and future prospects: A review. *Applied Energy*, *151*, 206–226. https://doi.org/https://doi.org/10.1016/j.apenergy.2015.04.031

Fuaadi, I. M., Pearce, J. C., & Gael, B. T. (1991). *Evaluation of Steam-Injection Designs for the Duri Steamflood Project*. https://doi.org/10.2118/22995-MS

Putra, E. A., Rachman, Y. A., Firmanto, T., Arsyadanie, R., & Hafizh, G. (2011). *Case Study: Cyclic Steam Stimulation in Sihapas Formation*. https://doi.org/10.2118/147811-MS

Sheng, J. J. (2013). Chapter 16 - Cyclic Steam Stimulation. In J. J. B. T.-E. O. R. F. C. S. Sheng (Ed.), *Enhanced Oil Recovery Field Case Studies* (pp. 389–412). Gulf Professional Publishing. https://doi.org/https://doi.org/10.1016/B978-0-12-386545-8.00016-6

Speight, J. G. (2009). CHAPTER 7 - THERMAL METHODS OF RECOVERY. In *Enhanced Recovery Methods for Heavy Oil and Tar Sands* (pp. 221–260). Gulf Publishing Company. https://doi.org/https://doi.org/10.1016/B978-1-933762-25-8.50012-2

Suranto, A. M., Swadesi, B., & Widyaningsih, I. (2020). Combination of Cyclic Steam Stimulation and Steam Flooding to Improve Oil Recovery in Unconsolidated Sand Heavy Oil Reservoir. *Journal of Earth Energy Engineering*, *9*(2), 80–87. https://doi.org/10.25299/jeee.2020.4659

Trigos, E. M., Avila, R. D., Lozano, M. E., Jimenez, A. M., & Osorio, C. A. (2016). *Strategies to Increase Production in a Colombian Heavy Oil Field with Cyclic Steam Stimulation* (p. afd). https://doi.org/10.2118/181198-MS

Wang, Y., Ren, S., Zhang, L., Peng, X., Pei, S., Cui, G., & Liu, Y. (2018). Numerical study of air assisted cyclic steam stimulation process for heavy oil reservoirs: Recovery performance and energy efficiency analysis. *Fuel*, *211*(August 2017), 471–483. https://doi.org/10.1016/j.fuel.2017.09.079