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Escalating Oil Recovery Production Rate by Installing A Tandem Choke Tube (TCT) in Papua Field

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***Abstract*— Hitting the jackpot by producing 10,961 barrels oil during 2023 from the *Simson* idle well reactivation through a choke manifold utilization, an emerging challenge was to modify the only existing bulky and high-cost choke manifold into a more transportable and economical one. Thus, it could be duplicated and used on other idle wells that are potential to be reactivated in Papua Field. This study addressed the issue by creating a Tandem Choke Tube (TCT) – a capillary tube pipe made of materials complying with API 6A and used for flowing well fluid from an annulus to a Tank On Site (TOS) and controlling the flow rate of well formation pressure drop enabling the well to produce in a longer period.**

The TCT installation in the *Simson* idle well revealed positive results i.e. (1) the cost avoidance is over IDR 5 billions; (2) value creation in production optimization reaches approximately IDR 14 billion; (3) the unit weighs only 5 kg that is considerably lighter than the previous choke manifold weighing more than 100 kg; (4) the well has been continuously producing oil and reaching the cumulative production rate 7,766 bbl oil by 2024; (5) the forecasted cumulative production rate until Production Sharing Contract (PSC) between Pertamina EP and SKK Migas due by 2035 is 81 MSTB or 51 MTSB higher than by utilizing an artificial lift SRP at 30 MTSB ; and (6) Gain Event Recover from April to September 2024 can be accelerated by 12.23 BOPD or 41%. To sum up, this TCT choke innovation design is proven to be low-cost, productive, and effective.

Keywords*— *idle well; reactivation; choke manifold; remote oilfield; brownfield

I. INTRODUCTION

Had been produced crude oil from 1976 to 2021, the *Simson* well in the *Purnomo* oilfield encountered a high water cut problem caused by several artificial lift methods (Gas lift dan Sucker Rod Pump/SRP). As a result, this well could not meet a production rate target and has sat idle since then. Idle wells screening in 2023 disclosed that the well had the potential to be reactivated and produced as a rig-less and natural flow well since it had high shut-in pressure.

The well reactivation was in several steps. The optimum was controlling the production by installing a choke manifold and applying an intermittent production

method where the oil flowed naturally in a cyclic process into a Tank on Site (TOS) through an annulus to restore pressure. Remarkably, the production rate rocketed significantly, reaching 10,961 barrels of oil cumulatively in 2023. An emerging challenge was the insufficient choke manifold while the potential idle wells to reactivate in the Purnomo oilfield were more than one with a possible production rate ≥ 100 BOPD.

To anticipate the production loss from the idle wells in the *Purnomo* oilfield, a tool that had the same function as the choke manifold yet should be low-cost and light was necessary to create.

II. METHOD

An Analytical Hierarchy Process (AHP) method was used to determine alternative solutions. There were three possible solutions i.e. the procurement of an automatic valve actuator and electrical network installation, the procurement and installation of the choke manifold, and the fabrication and installation of a Tandem Choke Tube (TCT). Among them, the first rank with a value of 0.648 was a Tandem Choke Tube (TCT) fabrication and installation. Hence, the fabrication and installation of a Tandem Choke Tube (TCT) was selected as the best solution.
Later, the steps to undergo the TCT installation were as follows.

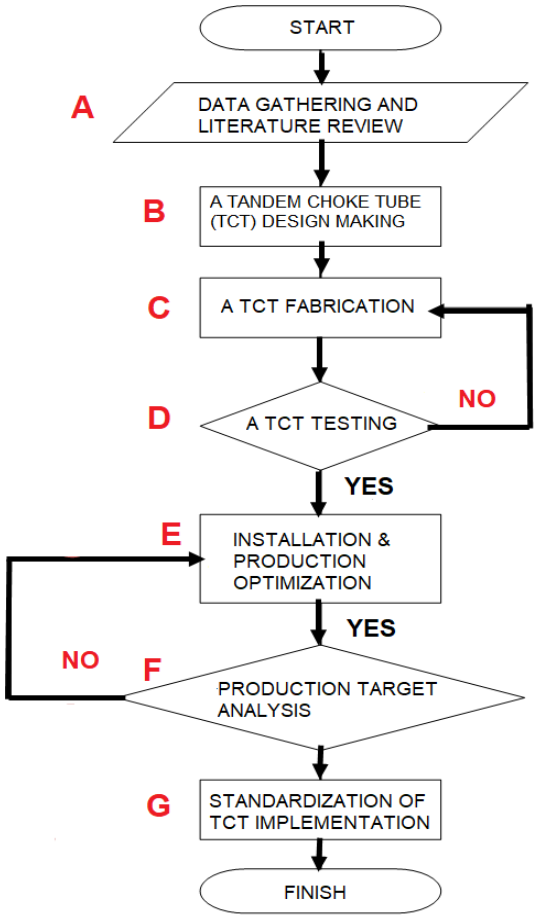

Fig. 1. *The TCT plan flowchart*

A. Data gathering and literature review

Besides well recovery data, previous studies such as Guo, Liu & Tan (2017), Chukwuma & Nmegbu (2022), Carter, Sims, Britton & McKee (2013) were reviewed to determine choke simulation sizes and well critical rates.

B. A Tandem Choke Tube (TCT) design making

The TCT design for high pressure at 2000 psi and 2-inch body size should meet the API 6A standard, the international standard for drilling and oil and gas equipment.

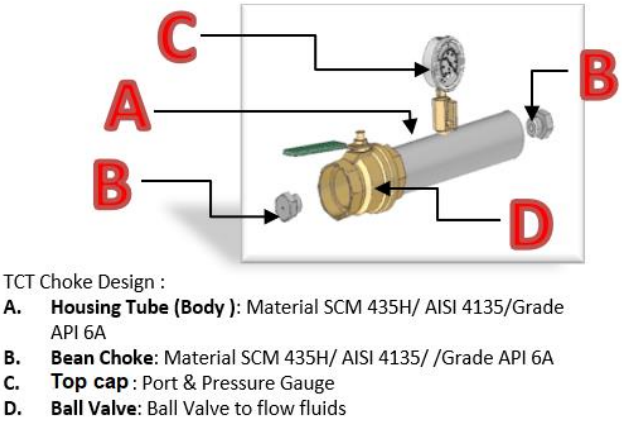

Fig. 2. *The TCT choke design*

The TCT design was originally from the positive choke manifold or common X-mas tree. The difference lay in a fluid pattern. The TCT had a parallel fluid pattern and had a cage for two beans installation i.e. upstream and downstream while the common X-mas tree had an upright flow pattern. The TCT installation was as follows: **(A)** a housing as a connector of capillary pipes with a cage for **(B**) two bean chokes as the choke to make a selection of the installation position easy. To maintain stable production in the *Simson* well, the optimum flow coefficient for the *Simson* well was Cd 0.838 by installing the first 5-mm choke and the second 8.7-mm choke. The first bean controlled the output flow rate, and the second bean held back the drastic pressure drop during production time. Between these two beans, there was **(C)** a top cap with a connection port and pressure gauge to detect the well pressure, ensuring that the flow into the Tank on Site (TOS) could prevent the hydrostatic pressure according to a nozzle level in the TOS. A ball valve **(D)** is an isolation to open and close the flow into the TOS.

C. A TCT fabrication

High-precision equipment was used in a TCT fabrication.

D. A TCT testing

The TCT testing validated the choke's fixed size by performing a Non-Distraction Test (NDT) and a hydro

test. The TCT was validated externally by PT Inti Sentosa and PT Sucofindo.

E. Installation and production optimization

This process involved validating simulation results of bean chokes and the well test operation time to reach the optimum production rate below a critical rate and above the minimum production target while maintaining a recoverable well's decline pressure.

F. Production target analysis

An operation standard was determined if a certain operation pattern could reach the minimum production target at 10 BOPD and below the critical rate while maintaining a recoverable well's decline pressure.

G. Standardization of TCT implementation

A concluded operation pattern that met the requirements in (F) became the standardization of TCT implementation in the well production operation.

III. RESULTS AND DISCUSSION

A Tandem Choke Tube (TCT) – a capillary tube pipe made of materials complying with API 6A and used for flowing well fluid from an annulus to a Tank on Site (TOS) and controlling the flow rate of well formation pressure drop; thus, the well could be produced in a longer period. It came as the best solution for an absence of X-mas tree wellhead in a low pressure well. Moreover, it could be installed in an idle well that was reactivated as a rig-less well in a remote area to save the production cost [1] and [2].

The TCT installation in the Simson well depicted the following results:

A. Quality

1) The oil recovery production of the Simson well could last continuously, contributing a cumulative production rate of 7766 barrels of oil in 2024. After the TCT installation on 21 April 2024, the average gain rose 41% from 30.20 BOPD to 42.44 BOPD.

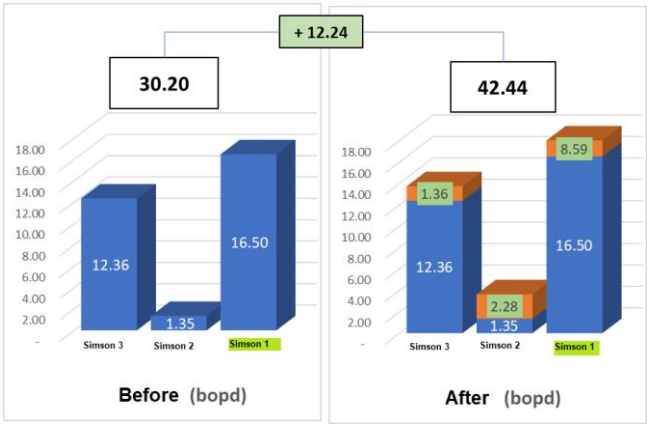

Fig. 3. *The oil recovery after the TCT installation*

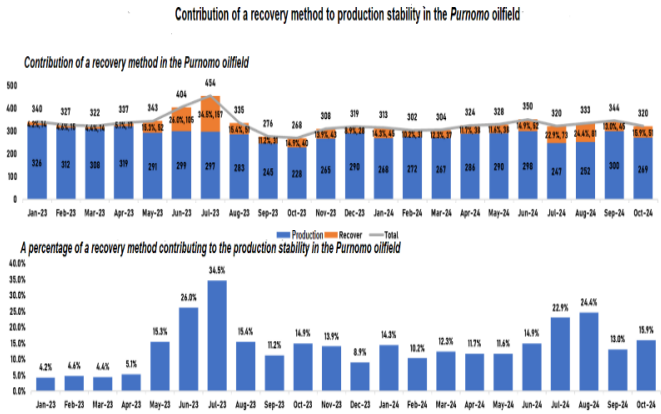

Fig. 4. *Contribution of recovery method to production stability in the Purnomo oilfield*

A positive impact of a recovery method by the TCT installation in the *Simson* well was its contribution to the production stability trend in the *Purnomo* oilfield.

2) Decline Curve Analysis (DCA) was used to forecast the *Simson* well production rate by the TCT installation compared to the production test data by the ALS SRP method. By the end of the Production Sharing Contract (PSC) in 2035, the production forecast value using the choke manifold can reach 81 MSTB – 51 MSTB higher than the SRP method before the well was shut-in.

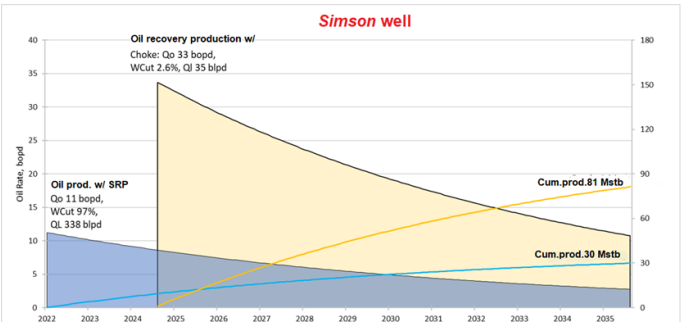

Fig. 5. *The forecast production value by the TCT installation*

The water cut control and the cumulative production rate of the *Simson* well was acceptable as a short term program in PT Pertamina EP Zona 14 Papua Field. To optimize the production, a surface structure analysis was necessary to perform in the *Simson* well. It was based on the pressure drop data in the Simson well and the RF value of 63% from OOIP. Since there was only well in the Simson structure, a long term study to apply a maintenance pressure technology as a secondery recovery [3] should be considered by PT Pertamina EP Zona 14 Papua Field in proposing the Plan of Development (POD) to SKK Migas.

3) The average Basic Sediment Water (BSW) level from January to October 2024 was at 0.42%. The average water cut was at 1.64% or at a maximum of 2%. Production facilities in the *Purnomo* oilfield had a capacity limit affecting the idle wells reactivation potential. A gross-up method could not be applied due to safety reason. A current safe method was a cyclic

crude oil recovery. Idle wells in the *Purnomo* oilfield including the *Simson* well faced high water cut problem and were shut-in several times. The *Simson* well was selected as a pilot reactivation project based on shut-in evaluation data and complete history data. It tended to have high water cut (97%) and possible water coning. Thus, decreasing the flow rate below the critical rate i.e. 172 BFPD was necessary to avoid a drastic rise in water cut. It was produced from Kais Formation that was deposited from the Early Miosen to the Late Miosen. It consisted of limestone that thinned out in a depocenter [4]. Carbonate stones tend to be oil wet leading to lower oil relative permeability and lower oil recovery in the life of a waterflood, which is about 3 pore volume (PV) injection [5]. Carbonate reservoirs usually have a strong heterogeneity [6]; thus, an appropriate fluid flow control was necessary since a production well usually encountered different life phases, starting from a post-drilling and completion early increase through a stable period to a decline phase [1]

B. Cost

The cost spent to create the TCT was only IDR 55 million, saving 90% more than the choke manifold installation. Hence, it resulted in the avoidance cost of over IDR 5 billion and the value creation in production optimization reached approximately IDR 14 billion. As a marginal oilfield, a cost-saving project was a breakthrough. A low operational cost and high production rate are keys to a positive NPV [7]. A comprehensive economic analysis gives an insight of a financial eligibility of the Simson well reactivation project and production optimization by applying the TCT.

C. Safety

The TCT design was transportable since it was considerably lighter than the previous choke manifold weighing more than 100 kg. Weighing 5 kg, the TCT was easy to install, transport, and store. According to the SOP of Manual Handling of PT Pertamina EP Cepu, the TCT design has already met the category of As Low As Reasonably Practicable (ALARP).

Fig. 6. *The existing choke manifold*

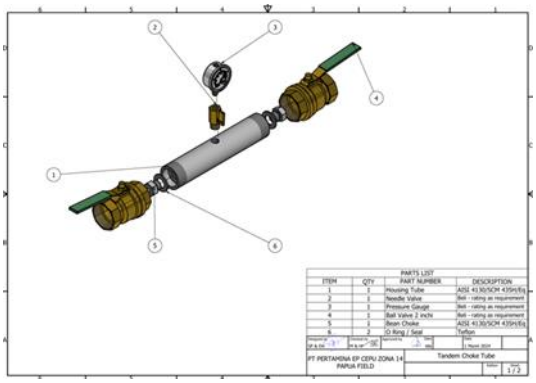

Fig. 7. *Tandem Choke Tube (TCT)*

Fig. 8. *TCT Instalation*

IV. CONCLUSION

Despite its remote location and low quality of produced oil, the *Simson* well in the *Purnomo* oilfield could be reactivated as a rig-less and natural flow well by installing the choke manifold and applying an intermittent production method. Hence, the oil production recovery hit the jackpot at 10.961 barrels of oil with the average BSW at 2% in 2023.

An issue was raised when the existing choke manifold was inadequate whereas the potential idle wells to be reactivated in the Purnomo oilfield were more than one with the potential production rate ≥ 100 BOPD. It triggered the emergence of a Tandem Choke Tube (TCT) – a capillary tube pipe made of materials complying with API 6A and used for flowing well fluid from an annulus to a Tank On Site (TOS) and controlling the flow rate of well formation pressure drop enabling the well to produce in a longer period.

The TCT outweighs the choke manifold for its economic efficiency and weight. Weighing 5 kg, the TCT was easier to install, transport, and store than the previous choke manifold. Moreover, its fabrication cost was IDR 55 million, saving 90% more than the choke manifold installation. More importantly, the average gain rose 41% from 30.20 BOPD to 42.44 BOPD after the TCT installation on 21 April 2024 forecasting a production value at 81 MSTB by 2035.

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REFERENCES

[1] E. Nnanna, E. and J. Ezekwugo, "Uptime improvement for selected intermittent oil producers", August 2020, In the SPE Nigeria Annual International Conference and Exhibition (SPE-203696-MS).

[2] Y.A. Rilwan and G. Nmegbu, "Analyzing wellhead choke sizes for liquid flowrate performance optimization" in Global Scientfic Journal vol.10, pp. 1304-1323, November 2022, https://www.researchgate.net/publication/366083918

[3] S.L. Kokal, and A.U. Al-Kaabi, "Enhanced oil recovery: challenges and opportunities", in Expec Advanced Research Center, Saudi Aramco 2010, https://api.semanticscholar.org/CorpusID:16917044

[4] Y.B. Susilo, M.A. Jambak, Y. Sutadiriwiria, and C. Prima, "Source rock geochemical characteristics of Sirga and Faumai formation, Salawati Basin, West Papua", *Karakteristik Geokimia Batuan Induk Formasi Faumai Dan Formasi Sirga, Cekungan Salawati, Papua Barat*, in https://www.researchgate.net/publication/379257461, July 2021.

[5] K. Mohan, R. Gupta, and K.K. Mohanty, "Wettability Altering Secondary Oil Recovery in Carbonate Rocks", in Energy & Fuels vol. 25(9), August 2011.

[6] Y. Chen, L. Zhao, L., J. Pan., C. Li., M. Xu, K. Li, F. Zhang and J. Geng, "Deep carbonate reservoir characterisation using multi-seismic attributes via machine learning with physical constraints", in Journal of Geophysics and Engineering,18(5), 761–775, 2021, https://doi.org/10.1093/jge/gxab049

[7] P. Nandasari, and I. Priadythama, "An economic analysis of oil and gas company's project: A case study of ABC Oil", *Analisis Keekonomian Proyek Perusahaan Minyak Dan Gas Bumi: Studi Kasus ABC Oil*, in https://idec.ft.uns.ac.id/wp-content/uploads/2017/11/Prosiding2016_ID015.pdf, 2016.