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Thru-Tubing Ceramic Screen Application to Unlock Mature Sandy Well Efficiently: Successful Implementation in Sisi Nubi Field

Zenitzya Virgia[*1], Runi Kusumaning Rusdi[2], Khalid Umar[3], Andria Surya Kusumah[4], and Rahmad Wahyudi[5]
[1,2,3,4,5]PT PERTAMINA HULU MAHAKAM
* Email: mk.zenitzya.virgia@pertamina.com

Abstract. Controlling sand production from shallow gas reservoir(s) is a challenge. Sand control is needed to avoid wellbore productivity damage and excessive sand production on the surface. Sisi Nubi is a gas field located in 25 km offshore from Mahakam delta. Most Sisi Nubi wells are completed with sand control in primary well completion to minimize sand production. Thru-Tubing Ceramic Screen (TTCS) is a new sand control method used in Mahakam. Ceramic screen was selected as it has higher durability and resistance against erosion than metal screen. Previous application in the swamp area shows good indication, thus encouraging further application offshore. Therefore, the objective of this paper is to perform the first trial of three joints TTCS implementation in offshore Mahakam field and unlock well potential to produce more than 3 MMscfd by applying thru-tubing ceramic screen (TTCS).

In this project, TTCS was utilized in a new perforated shallow reservoir in Sisi Nubi, NX-Y. The installation involved isolating water producing zone, perforating reservoir target, setting three joints of thru-tubing ceramic screen in front of perforation interval, and cleaning up the well with sand filter. However, this was the first trial of three joints TTCS, as previously only one or two joints installed. As per previous experience, one joint can only accommodate 3 – 4 MMscfd to maintain operating in safe working envelope area. Since targeted reservoir indicates higher potential (i.e. > 4 MMscfd), three joints of thru-tubing ceramic screen was implemented for the first time. In order to ensure TTCS execute properly, well ramp-up was performed step by step to form natural packing between the screen and the wellbore supported by fixed acoustic sand detection to monitor sand production.

As a result, NX-Y well succeed to produce up to 10 MMscfd which is more than 300% from initial target with sand free indication. Furthermore, this successful trial potentially leads to other implementations in Mahakam offshore further.

Keyword(s): acoustic sand detection, efficient, offshore, safe production, sand control, sand production, shallow reservoir, thru-tubing ceramic screen, unlocking potential

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1 Introduction

Sisi Nubi (SNB) is a retrograde gas field located in 25 kilometres offshore the modern Mahakam delta and 30 kilometres to the southeast of the Tunu field with the water depth of 60 – 80 m, as shown in Figure 1. The field lies at the boundary between two permits: Mahakam PSC and Tengah JOA. A unitization of this field (Sisi Nubi Production Unit) was approved in 1997 by BPPKA/PERTAMINA. Pertamina Hulu Mahakam is currently the Operator of the field.

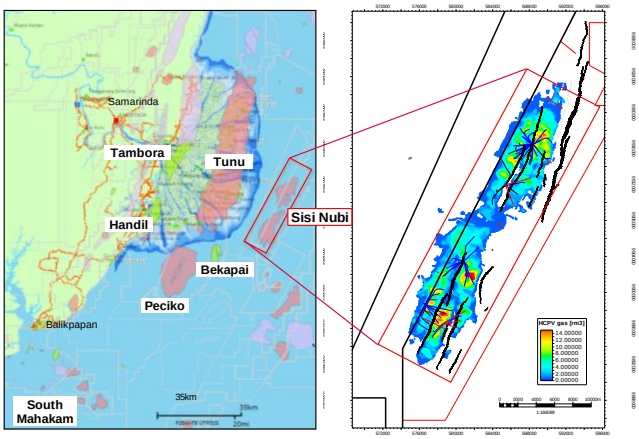

Figure 1. Sisi Nubi Field Location

Hydrocarbon zones of Sisi Nubi are in general located from 500 to 3,800 mTVDSS and vertically classified as shown in Figure 2 below:

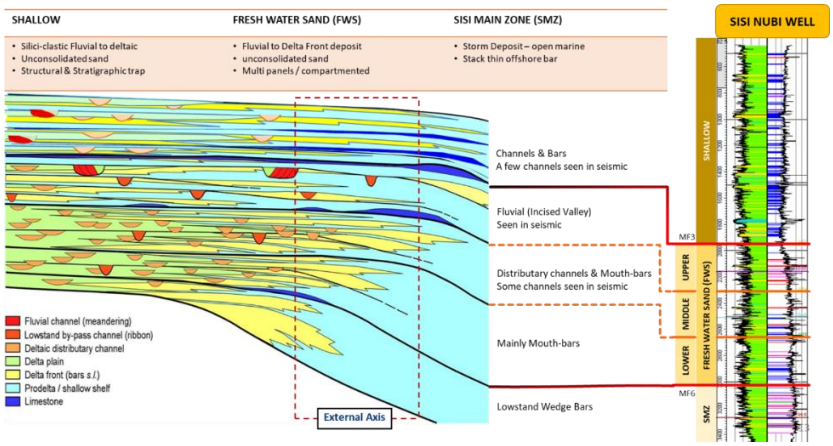

Figure 2. Sisi Nubi Main Hydrocarbon Zone

1.1 Shallow Zone (SZ) Characteristic

The Main reservoir characteristics in Sisi Nubi shallow reservoirs are as follow:

- Unconsolidated sand reservoirs with porosity range 20 – 30%, channel type reservoirs, with most of the reservoirs found are characterized by seismic.
- Dry gas fluid reservoir composition: Methane, C1 > 90%.

- There is reservoir pressure maintenance by strong aquifer support, where pore pressure is generally identified as hydrostatic.

Sisi Nubi Shallow Zones (SZ) was developed since 2012. Up to today, Sisi Nubi SZ's contribution has increased steadily and currently accounts for 40% of Sisi Nubi's yearly production. To produce hydrocarbon from SZ, sand control is mandatory to avoid wellbore productivity damage and excessive sand production on the surface.

1.2 Thru-Tubing Ceramic Screen (TTCS)

Sand production has always been one of the main challenges in gas wells. This issue occurs mainly in unconsolidated formation that is shallow reservoir characteristic. The risk and damage of sand production can lead to the inner lining of tubulars or pipelines being eroded due to the higher velocities of gas flow, causing sand to be transported at higher velocities [2]. Therefore, sand control is needed on several wells to act as barrier against formation sand. Sand control in Mahakam is classified into Cased Hole Single Trip Multi-Zone Gravel Pack (CH-STMZ-GP), Open Hole Stand Alone Screen (OH-SAS), Chemical Sand Consolidation (SCON), and thru-tubing metal screen.

The result of installation hanging metallic screen in Tunu shallow zone (swamp area) gives 33% to 55% failure during clean-up the well due to plugging issue. And also, it was observed that 35% to 42% had to be shut in due to sand production on the surface. The quality of the result is highly affected by factors: screen placement method, slot opening selection, and material. Installation position hanging metallic screen above perforation involved a poorly developed natural sand pack (NSP). Thus, screen placement in front of perforation was implemented to achieve effective natural sand pack [7]. Ceramic sand screens (Figure 3) utilized the strength of sintered silicon carbide ceramics to ensure the robustness of design suitable for a field-ready deployable solution [1]. Characteristic of silicon carbide is suitable to withstand high pressure, temperature, erosion, and corrosion [4]. Thru-tubing ceramic screen was successfully implemented in 9 wells of offshore area and the highest production achieved was 3 MMscfd. This is because when ramping up to exceed 3 MM executed, sand detector indicated high sand production to the surface.

Figure 3. Ceramic sand screen assembly breakdown (Setiadi, R. et al., 2022)

2 Methodology

NX-Y well was very challenging due to shallow reservoir and presence of sand at the surface. SCON has been deployed with limited at 4 m/s in-situ gas velocity and 30 bar drawdown. However, the well was watered out and kept shut in until wellhead shut in pressure build up. TTCS is the preferred sand control method concerning its reliability. Based on Memo No. 18/WCIPTO/2021-S0, TTCS should be operated within its operating envelope [3]. The envelope boundaries are limited by in-situ gas velocity around 11 m/s, drawdown 48.5 bar, and the maximum gas rate at 4 MMscfd. As the well's potential is high, three joints TTCS was used to unlock potential the well in safe and efficient gas production. This trial is the first implementation of three joints TTCS in offshore area.

2.1 Well Intervention Program

Reservoir SN1-20X is a shallow reservoir in NX-Y well at depth ~1500 mSS with 14.5 m netpay and porosity 29.5%. This reservoir's estimated stakes is 8.23 BSCF based on seismic anomaly and completed with tubingless completion. Electric line was performed to perforate reservoir SN1-20X (Figure 4) using deep penetration gun with 18 spf. Bridge plug was then set below the perforation zone with electric line to isolate water source from reservoir SN1-20Y. Then, three joints of TTCS 250 microns were deployed and installed with coiled tubing in front of reservoir SN1-20X right above the bridge plug. The purpose of this configuration is to resemble the typical gravel pack (GP) completion which have an accumulation of sand or gravel in front of the screen to achieve natural sand packing mechanism. As depicted in Figure 4, the bridge plug was set just below the screen (±1 m) to minimize the column where the sand will be accumulated, thus accelerate natural sand packing mechanism. With this configuration, higher gas rate and sand production did not directly flow through the screen, thus minimize the likelihood of screen erosion.

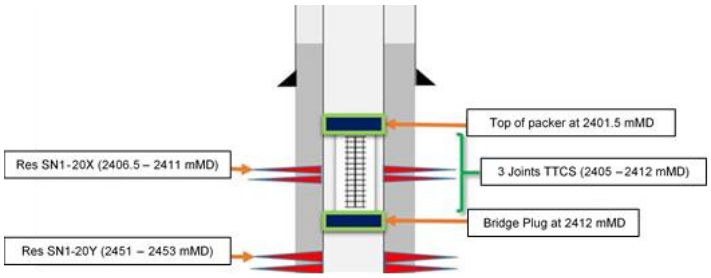

Figure 4. Completion Diagram NX-Y well

2.2 Clean-up Program

NX-Y well was cleaned-up using sand filter on the upper deck platform. The objective is to clean-up the well from liquid (if any) or to ensure no massive sand production to the surface by ramping up step by step. Figure 5 illustrates the well clean-up history. This data was used as a reference for putting on production (POP). Gas rate stable at 4 MMscfd with sand rate 0 g/s.

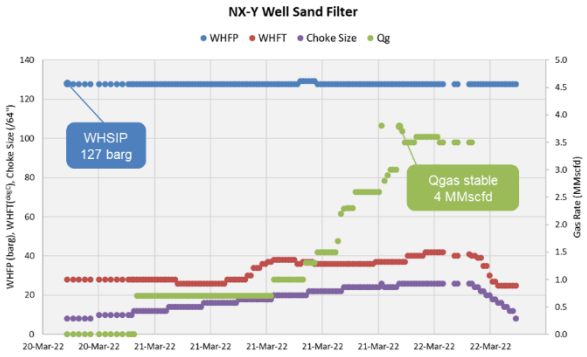

Figure 5. Graph of Clean-up program NX-Y well

3 Result and Discussion

Based on Figure 5, the well was ramped-up until 4 MMscfd at wellhead flowing pressure (WHFP) 127 barg and wellhead flowing temperature (WHFT) 37℃. No sand is present in sand filter, which indicates sand free. After clean-up program, the well was put on production and ramped-up step by step until 10 MMscfd.

3.1 Production History

NX-Y well was put on production on 23rd March 2022, and its production history is shown in Figure 6. At initial phase, the well produces steadily at rate 4 MMscfd, WHFP/T 125 barg/48°C, and 17% choke opening. Within three days, it was observed that the flow rate increased while pressure decreased at the same choke size opening. Thus, the well had to be shut in for choke check to investigate this anomaly. The result was choke in good condition. Therefore, this confirms the rapid WHFP decrease was not due to sand production that eroded the choke. The well was re-put on production and produced at flow rate around 4 MMscfd. After one month of stable production, the well was ramped-up until flowrate 7 MMscfd. At this rate, drawdown and in-situ gas velocity are still inside the boundary of TTCS operating envelope. The next ramp-up was executed one month afterwards up to flowrate 10 MMscfd. Calculated drawdown and in-situ gas velocity were 23 barg and 2 m/s per perforation hole respectively. During every step of production and ramp-up, sand production was monitored closely by sand detector. In this first trial of applying three joints TTCS, NX-Y well was ramped-up step by step to achieve natural sand pack (NSP) and keep the well parameters within sand-free operating envelope to prevent screen plug that can lead to TTCS failure.

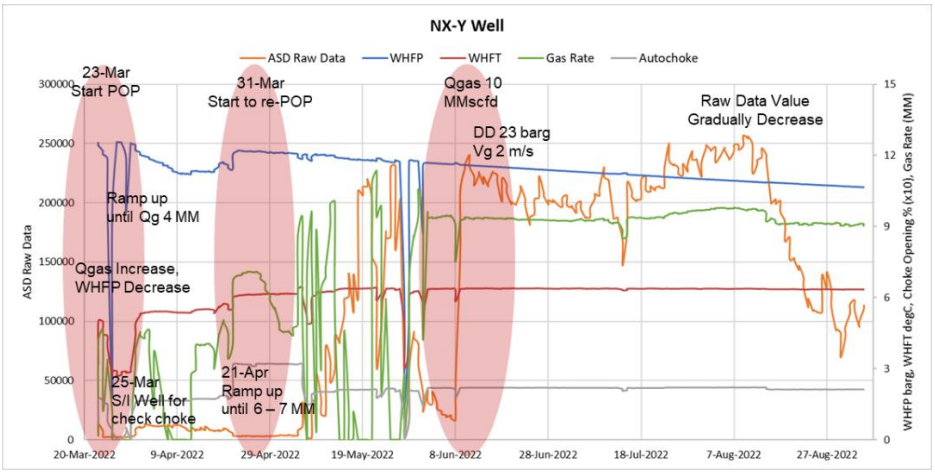

Figure 6. NX-Y Well Production Parameter Trend

3.2 Sand Monitoring

Sand detector is an instrument that can be used to detect sand concentration and determine safe operating limits within a flow stream across a given area [5]. The direct observation was based on "raw data" that can be monitored from control room/office. The raw data was then calculated into sand production rate. Any anomaly that occurs in raw data will be reported immediately for analysis and action.

NX-Y well is equipped with sand detector to get more representative data on sand production and determine safe operating limits for the well before ramp-up the well further. Sand detector will trigger sand alarm if the well produces sand above 0.02 g/s (after raw data conversion). During production of NX-Y sand alarm was only active once due to transient conditions after revival step and was interpreted as false alarm. Overall, no significant or extreme sand indication observed on the sand production graph (raw data). Calculated sand rate was still below maximum allowable sand rate of 0.02 g/s [6]. In general, raw data amplitude was relatively high due to high delta pressure across the choke (dP) and high velocity of fluid

those create high noise captured by acoustic sand detection. However, the raw data was stable and no sand indication.

4 Conclusion

Three joints Thru-tubing ceramic screen (TTCS) has successfully been applied in NX-Y well, Sisi Nubi Field, Offshore Mahakam. The screen was installed in front of reservoir to form natural sand pack (NSP) of sand control. The installation proved no plugging and no sand production at the surface by ramping up the well step by step. TTCS installation in NX-Y well indicates significant improvement in unlocking sand risk gas well. This well can be unlocked up to 10 MM, which means more than 300% initial target gas rate with sand-free indication. Further development and implementation of TTCS would open up bigger opportunities to unlock potential of wells with sand production problem throughout offshore Mahakam operation.

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