IATMI22-146

Success Story Casing Design Optimization in Bentayan Structure

Ahmad Burhan Noviaris*[1], I Putu Agus Saputra[2], Sapto Edi Nugroho[3], Ruhut Batara Hutabarat[4], And Sayid Faisal Abdilla[5]
[1,2,3,4] PERTAMINA, [5]SKK MIGAS
* Email: ahmad.burhan@pertamina.com

Abstract.

One of the structures being developed and very challenging in South Sumatra is Bentayan structure with strong water drive characteristics. This structure has been developed for more than 35 years by producing heavy oil and non-erupted oil, so most of it requires an artificial lift to produce well. Typical architecture of Bentayan well were using three casing there are 13-3/8", 9-5/8" and 7" and drilled up to 1200 meter. So far, no optimization has been carried out on the casing design. The new optimization was carried out at the end of 2021 by trying to reduce one section casing (13-3/8") then become two casing section which size 9-5/8" and 7".

Section casing 9-5/8" was drilled by 12-1/4" bit at shallow depth and this phase is part of the endurance test rig which is including rig up phase. The challenge in this phase is drilling without diverter up to 250 meters. It must be ensured that there is no shallow gas zone. The purpose of drilling up to 250 meter is the next phase can be drilled using BOP, not diverter. Section casing 7" then was drilled by 8-1/2" bit from spud to total depth. At this time, drilling was done using BOP with FIT calculations, kick margins and the correct MAISP for well control. Subsurface hazard analysis such as shallow gas, reservoir gas, sloughing shale must be carried out to mitigate potential hole problems. Rig operational planning must be delivered properly to all personal at the rig site.

This Casing Design Optimization in the early stages was successfully applied in two wells. Dry Hole Basis were drilled faster on average 3 - 4 days, saving costs around US $ 300,000 / per well. There had been shale sloughing at a depth of 400 - 500 meter but it's solved by increasing mud weight. In general, drilling can be implemented without significant hole problems.

With successful implementation of this optimization, this optimization will be applied for future will be applied to the next Bentayan wells and other structure to be drilled. This can reduce drilling cost so that drilling in Bentayan structure is more economical.

Keyword(s): Casing, Optimization, Bentayan.

1 INTRODUCTION

1.1 DRILLING PROGNOSIS OF BENTAYAN STRUCTURE

One of the structures being developed and very challenging in South Sumatra is Bentayan structure with strong water drive characteristics. This structure has been developed for more than 35 years by producing heavy oil and non-erupted oil, so most of it requires an artificial lift to produce well. The location of Bentayan Structure, which is ± 103 km northwest of Palembang city, the capital city of South Sumatra province, including the working area of PT. Pertamina Hulu Rokan (PHR) Zone 4 Area 1, Ramba Field. The Bentayan Reservoir is located on Talang Akar Formation (TAF) which is a sandstone rock at a peak depth of 1.113 mbpl. The initial reservoir pressure is 1,500 psi,

the reservoir temperature is 200 oF. This formation is characterized by the development of syn-rift deposits at the bottom, which is a braided channel facies, in the middle part sandstone develops with facies channel with coal insertion and the top part of the sandstone deposited facies tidal bar gradually from transgressive upwards changed to post-rift deposits, characterized by alternating sandstone and shale fluvio-deltaic deposits to shallow sea. Total for about 120 wells have been drilled in Bentayan Structure. On average, Bentayan structure wells are drilled to ±1200 mTVDss to reach main target Talang Akar Formation. The purpose of drilling is to develop oil from Talang Akar Formation which layer from Sandstone. The formation that will be penetrated will pass through the following formations:

1. Palembang Formation. Predominantly soil on the top then dominant Claystone and Sandstone inserts.
2. Telisa Formation. Dominant Shale and Sandstone, Coal inserts.
3. Baturaja Formation. Undeveloped, Limestone rarely found (sometimes little Limestone is found)
4. Talang Akar Formation. Dominant Shale, Sandstone and Coal inserts.

Planned open hole electric line logging will only be carried out at Talang Akar Formation and drill cuttings are taken every 2 m depth is reached. Completion will be Single Completion. The characteristic of crude oil produced are nonerupted with heavy oil and asphaltic, so it generally requires using an artificial lift, mostly using Electrical Submersible Pump (ESP). Perforation using High Shoot Density. In Bentayan will need to be doing stimulation prior to production for maximum result.

1.2 DATA FORMATION OF BENTAYAN STRUCTURE

The formations that will be penetrated in Bentayan structure drilling are Palembang, Telisa, Baturaja and Talang Akar formations. Pore pressure fract gradient plot data can be shown in Figure 1 below. In that, it can be seen that there is no pressure anomaly and tends to be mature.

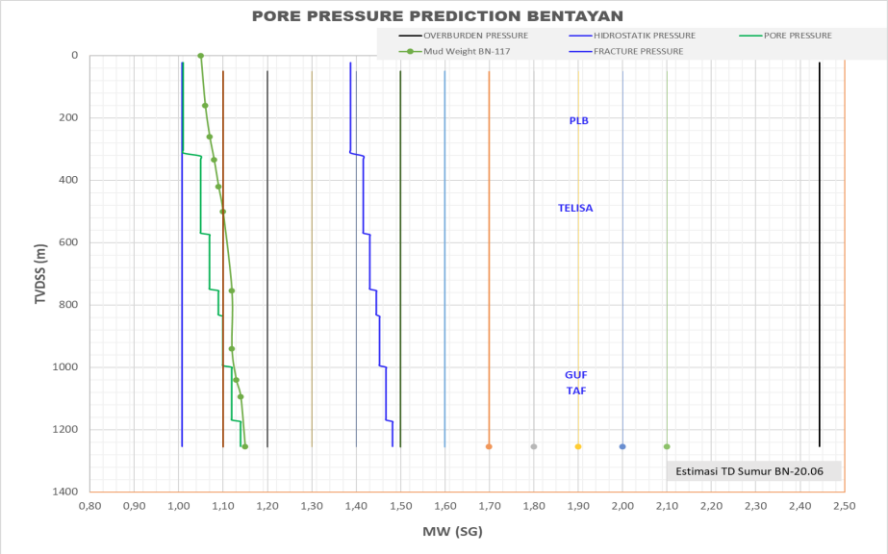

Figure 1 Pore Pressure Fract Gradient Prediction for BN-20.06

The references well that have been drilled show that there is very rare shallow gas. This data is analyzed as one of the considerations to get most optimum casing design. Shallow gas data obtained from nearby wells can be shown in Figure 2 below. Drilling hazard in Bentayan structure can mitigated including sloughing shale, sloughing coal and increase gas unit. But the

most drilling hazard to be considered is sloughing shale due to in references well data for previous well drilling, each is found.

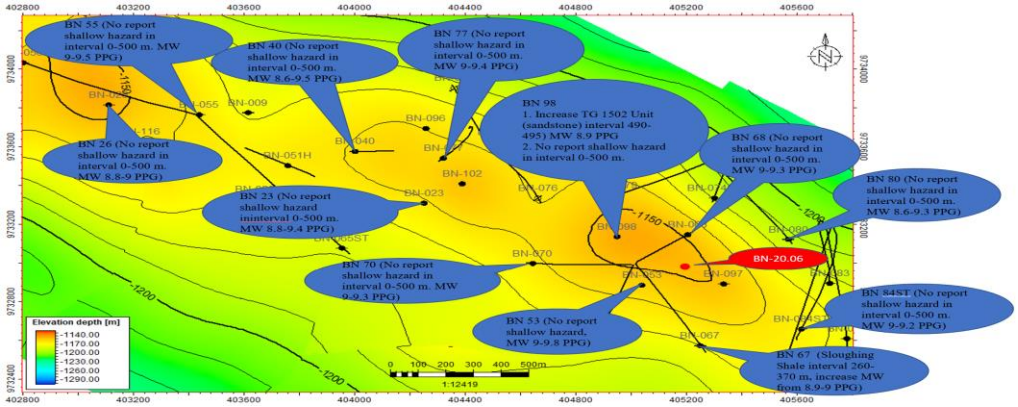

Figure 2 Data report shallow gas reference well

2 WELL DESIGN ARCHITECTURE

2.1 ORIGINAL DESIGN

Typical architecture of Bentayan well were using three casing there are 13-3/8", 9-5/8" and 7" and drilled up to 1200 meter. Casing 13-3/8" as a conductor is set at depth 50 m. While casing 9-5/8" as surface is set at depth 500 m. A 7" production casing is utilized and set at depth about 1200 m in Total Depth. Casing design, mud design and cement design shown in table 1 below. The trajectory for Bentayan well use directional with J type.

Table 1 Casing Design, Mud Design and Cement Design

Depth (mMD)	Hole (in)	Size Casing (in)	Grade, Weight (ppf), Conn	Description	Mud (sg)	Cement
50	17-1/2	13-3/8	K-55; 54,5; BTC	Conductor	Spud Mud 1.03 – 1.05	Lead SG 1.9
500	12-1/4	9-5/8	K-55; 36; BTC	Surface	KCL Polymer 1.06 – 1.11	Lead SG 1.65 Tail SG 1.90
1260	8-1/2	7	K-55; 23; BTC	Production	KCL Polymer 1.11 – 1.18	Lead SG 1.65 Tail SG 1.90

Drilling plan as scope of project includes drilling for three casing, open hole logging on 8-1/2" hole size, 7" cased hole logging and completion with total of 36 rig days. Drilling Time for original design can be seen in figure 3 below.

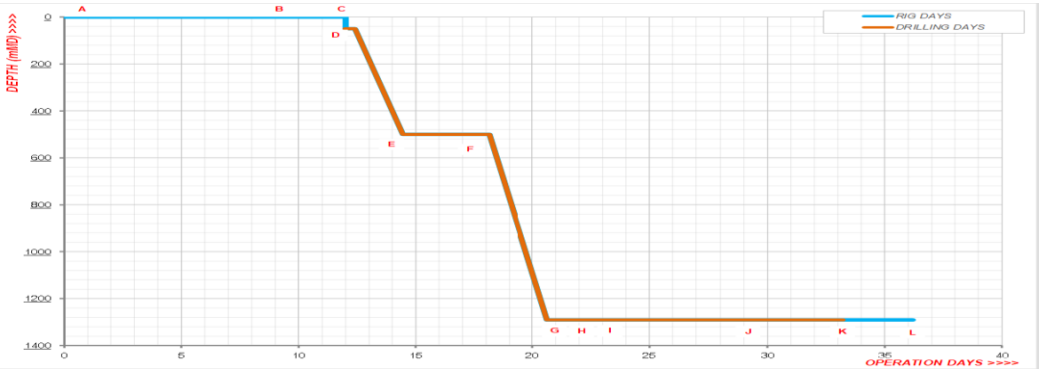

Figure 3 Drilling Time

2.2 *CASING DESIGN OPTIMIZATION*

So far, no optimization has been carried out on the casing design. The new optimization was carried out at the end of 2021 by trying to reduce one casing section (13-3/8") then become two casing section which size 9-5/8" and 7". Based on subsurface aspect of Bentayan structure, there is a reservoir potential at shallows depths in Palembang formation (400-700 m). The main reservoir produced from Talang Akar formation then Telisa formation as an additional target. Then also evaluated subsurface and drilling hazard from surrounding wells, generally at depth 0-300 m there are no anomalies or shallow gas, either kick or loss. However, in several wells there was an increase in peak gas but did not cause kick. Below is resume subsurface review to be considered shown on table 2.

Table 2 Resume Subsurface Review

1	Maximum Mud Weight Reff used 1,19 SG. Planning Mud Weight will be use : Open Hole 12-1/4" 1.08 SG, Open Hole 8-1/2" 1.08 - 1.19 SG,
2	Minor shallow gas at depth 410 m (did not appear in drilling of previous well). There are 37 unit @561 m of Total Gas, 361 unit @1134 m, 229 unit @1210 m, 348 unit @ 1234 m that do not continue come out. There is no abnormal shale pressure.
3	The result of measurement of crude oil API properties are 22.8 SG 0.917 and require an artificial lift to produce well generally with Electrical Submersible Pump.

Then to create a new design, plotting the latest pore pressure fract gradient profile with target of reducing casing and the result can be seen in figure 4 below.

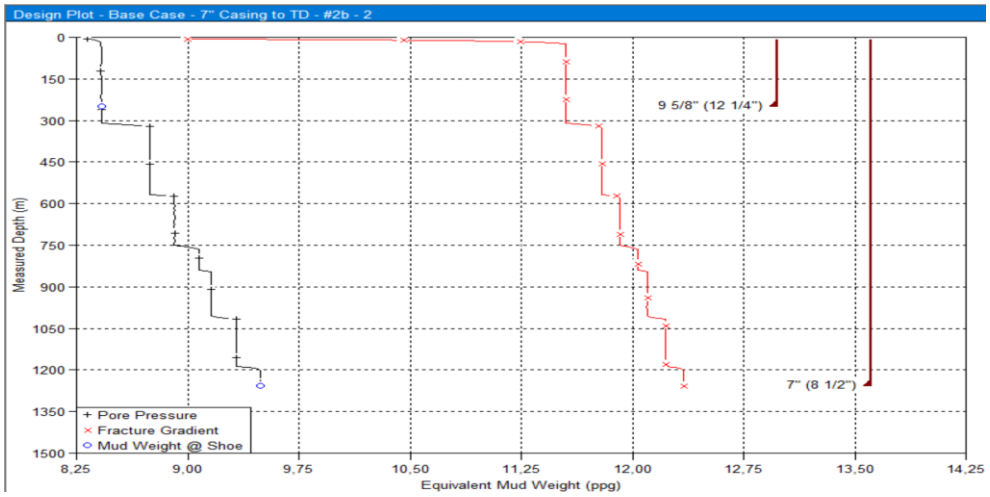

Figure 4 Casing Seat New Design Optimization

Casing 9-5/8" as a conductor is set at depth 250 m. While Production casing use size 7" set at depth about 1200 m in Total Depth. Casing design, mud design and cement design are shown in table 3 below.

Table 3 Casing Design, Mud Design and Cement Design Optimization

Depth (mMD)	Hole (in)	Size Casing (in)	Grade, Weight (ppf), Conn	Description	Mud (sg)	Cement
250	12-1/4	9-5/8	K-55; 36; BTC	Conductor	KCL Polymer 1.08 – 1.11	Lead SG 1.65 Tail SG 1.90
1260	8-1/2	7	K-55; 23; BTC	Production	KCL Polymer 1.11 – 1.19	Lead SG 1.65 Tail SG 1.90

The trajectory for Bentayan well use directional with J type. Drilling plan as scope of project includes drilling for three casing, open hole logging on 8-1/2" hole size, 7" cased hole logging and completion with total of 31 rig days. Drilling Time for optimization design can be seen in figure 5 below.

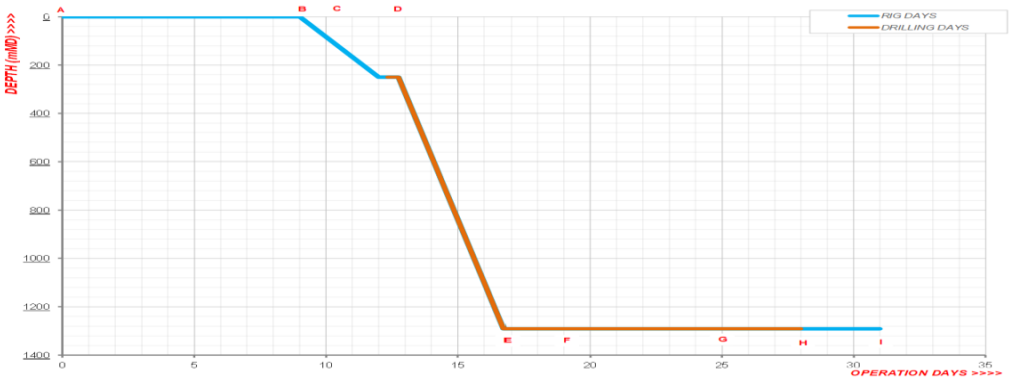

Figure 5 Drilling Time Optimation

3 IMPLEMENTATION

After obtaining the latest subsurface data and redesigning casing setting depth for Bentayan structure well, the next step was to conduct internal discussion with Pertamina team then followed by peer review with Regional dan Sub Holding Upstream for internal approval. The next stage was technical review meeting with SKK Migas for technical implementation and approval related to design changes. After obtaining SKK Migas Approval, the next step was to prepare for implementation of casing optimization design. In preparation, there were stages including location survey, Technical Meeting, HSE Meeting, Pre spud Meeting. After everything was ready, then Drilling operation and evaluation. In the drilling operation, there were several things to be considered such as:

- Squeeze cementing will be carried out if Formation Integrity Test (FIT) is below 1.45 SG. Kick Tolerance 25 bbl. MASICP = 92 psi.
- Key rig personal must understand their respective responsibilities during well control.

Here the comparation of original well design with actual optimization design is shown by Figure 6 below.

Well Design Original	Activity	Well Actual	Activity
13-3/8" @ 50 m	• Endurance Test. DOF 17,5" to csg point @ 50 mMD • Trips • Run & cement 13-3/8" casing. • Wellhead-A & Diverter Job	9-5/8" @ 248 mMD	• Endurance Test. DOF 12,25" to csg point @ 249 mMD • Trips • RIH & cement 9-5/8" casing. • Wellhead-A & BOP Job
9-5/8" @ 500 m	• Spud In. DOF 12-1/4" to csg point @ 500 mMD • Trips • OH logging 12-1/4" • Run & cement casing 9-5/8" • Wellhead-C & BOP Job		• Spud In. DOF 8-1/2" to TD @ 1291 mMD • Trips • OH logging 8-1/2" • Trips
TD @ 1291 mMD	• DOF 8-1/2" to TD @ 1372 mMD • OH logging 8-1/2" & Trips • Trips	TD @ 1291 mMD	
	Komplesi : • Run liner 7" • Run 7" scrapper • Cased hole logging 7" • Perforasi & RIH production string • Wellhead-B & X-Tree Job, Stimulasi • Production Test		**Komplesi :** • Run liner 7" • RIH 6" bit & 7" scrapper • Cased hole logging 7" • Perforasi & RIH production string • Wellhead-B & X-Tree Job, Stimulasi • Production Test

Figure 6 comparation design

Drilling operation could be completed three days faster on Dry Hole Basis in comparation to original design. Below is comparation of Drilling Time for original design and optimization design is shown by figure 7. And well profile is shown by figure 8.

Figure 7 Comparation of Drilling Time

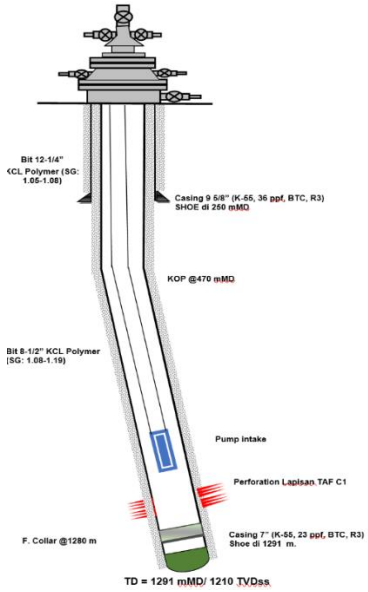

Figure 8 Well Profile

4 EVALUATION

Implementation of casing design optimization of Bentayan structure resulted in proven casing design that can improve drilling performance. Mud Weight as per program could hold the formation properly. During drilling operation, no shallow gas was encountered. Formation Integrity Test (FIT) could be reached with Equivalent Mud Weight 1.45 sg. Drilling operation could be completed safely, properly without any Non-Production Time Hole Problem, three days faster than original plan and more efficient than original budget of $ $ USD 300,000. The optimization design could be completed properly and can be replicated on other structure.

References

[1] Drilling Engineer, Drilling Program BN, Prabumulih, in 2021.
[2] Final Well Report wells BN, Prabumulih, in 2021.
[3] Technical Data Drilling Planning SKK Migas, Jakarta, in 2021.
[4] AFE drilling well BN, Jakarta, in 2021.
[5] Minutes of Meeting Pertamina – SKK Migas, “Perubahan casing desain struktur Bentayan”, Jakarta, in 2021.