IATMI22-031

Integrated Reservoir Characteristics And Production Enhancement Strategy Of Tight Oil Reservoir In Upper Talang Akar Formation Case Study Limau Field – South Sumatera Basin

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Abstract. Low quality and tight oil reservoir is a crude oil contained in low permeability formation, including but not limited to shale. Oil reservoir with low quality and tight was initially unattractive to be developed, it is very low porosity (< 10%), very low permeability (<0.2 mD) and high water saturation (>95%) but eventually given unpredictable oil production performance Every low quality and tight oil reservoir is unique and field development should be determined based on individual petrophysical attributes, reservoir characteristic and production enhancement strategy. In this paper, reservoir and production characteristics of low quality and tight oil reservoir are summarized, the investigated reservoirs include calcareous sandstone reservoir in Upper Talang Akar Formation, AN Structure. Almost mud logging data unit is also captured very low gas reading (only up to C3) and no traces oil show during drilling activity. Pressure measurement using wireline formation test (XPT) and modular dynamic tester (MDT) is also confirmed loss seal and supercharged. The primary key evaluation that have led to identify hydrocarbon in tight oil reservoir on this paper are : a. Petrophysics interpretation attributes is optimized by Dipole Shear Sonic Imager (DSI) and surrounding well data analogy. b. Certain criteria were used to select the pilot well test such as gas chromatograph or formation cutting log, nearby well correlation, single open hole log and the distance from key well refference. c. Acid solubility data labtest as critical part of production enhancement strategy The result of petrophysic optimization is given more optimistic water saturation, but reservoir properties such as permeability and porosity is still needed to be enhanced. As primary recovery is quite low in tight oil reservoirs, the production enhancement strategy is necessary and it must be conducted based on a deep understanding of petrophysical and minerals contained in the rock matrix. Deep penetration of matrix stimulation HCl 15% seems the best fit in this case.As a result 8 idle wells were perforated and stimulated HCl 15% during 2019 - 2021. It has been an attractive oil production result with incremental reach to 822 Bopd, 45 - 60% water cut and 247 MSTB oil production cumulative. Well stimulation job has to be conducted periodically to maintain stiff production decline By understanding the characteristics of tight oil reservoir and proper production enhancement strategy, this paper can be expected engineers to unlock potential hydrocarbon and increasing the production,

Keyword(s): tight oil reservoir, petrophysic evaluation, production enhancement strategy, reservoir and production characteristics, dipole shear sonic imager

1 Brief Background

1.1 Field Overveiw

Limau Field is one of active field as oil producer that located in PT. Pertamina Hulu Rokan, Zone 4, South Sumatra, Indonesia (Fig.1). The field consist of 11 structure and was developed in 1930, total wells and peak production xx BOPD in 19XX. Currently, the field has 103 active oil wells and 58 injection wells (status per September 2022).

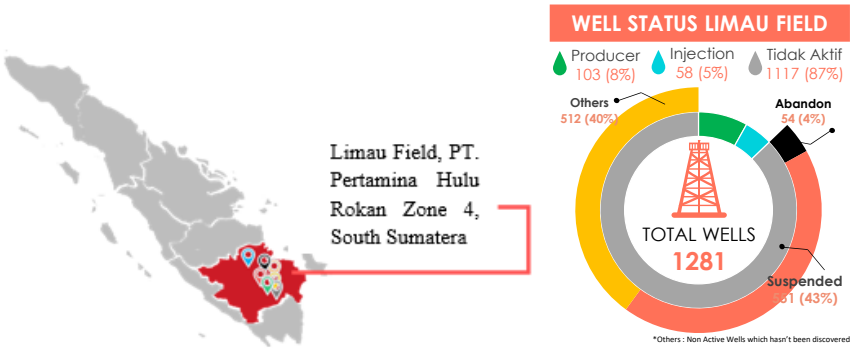

Figure 1. The Location of Limau Field

As Limau Field classified as a mature field (Fig.2), the next development program become more challenges. One of the challenges is the cumulative oil production almost reached the estimate ultimate recovery, depleted reservoir pressure and production problems such as scale, high water cut, high gas associated produced. One of the opportunities in this mature field is tight oil reservoir that need to be detailed analysis in term of zone identification & characterization, reserves calculation and how to produce.

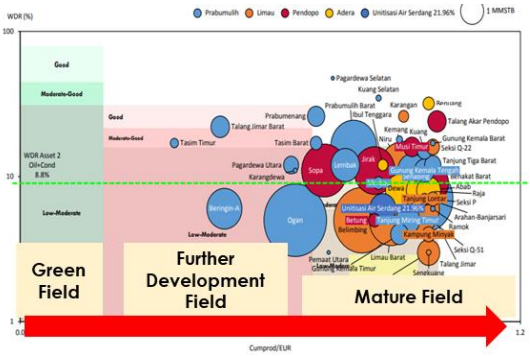

Figure 2. WDR vs Cumulative Production / Estimate Ultimate Recovery

1.2 Problem Identification

AN structure as one of mature oil structure in Limau Field which has been reach the biggest oil production on 1967 with an oil production between 6000 – 7000 BOPD in average. During production phase from 1967 until 2018, the oil production declined to 580 Bopd in average and in majority the wells have high water cut (>90%) decline rate 33% average per year. The main hydrocarbon reservoir in AN Structure is in the upper part of Talang Akar formation that called as Transitional Member (TRM). This unit is deposited in fluvial deltaic to marine environment that consist of interbedded thin claystones, sandy-claystones, and fine-sandstones with

calcareous sandstone nodules, and thin calcarenite limestone intercalation. It shows fining upward sequence with a medium – good reservoir permeability (Fig.3).

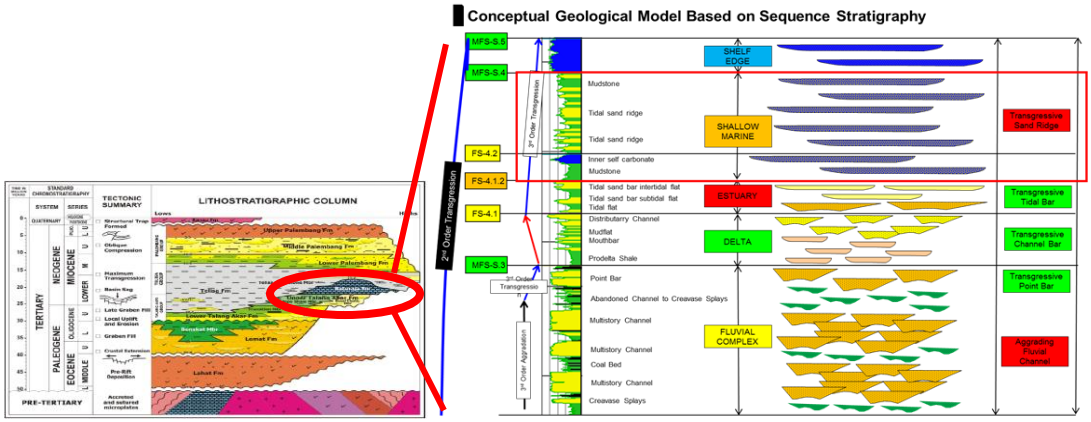

Figure 3. Upper Part of Talang Akar Formation

In another hands, AN structure is also consist of potential tight and low quality reservoir in the upper part of Talang Akar formation that has not been proven yet as hydrocarbon (Table.1). Tight & Low Quality Reservoir (LQR) is a term for oil tight reservoirs which in general has characteristics as follows:

- Defined as having less than 0.1 mD (gas) or 20 mD (oil) matrix permeability and less than 10 percent matrix porosity.
- Production rates from tight reservoirs are marginal, but probably has opportunity as big reservoir for a large percentage of the long-term supply of oil and gas.
- The oil contained within the reservoir typically will not flow to the wellbore with conventional lifting method at economic rate.
- Tight oil reservoir need advance technology from drilling, completion and production aspects

Table 1. Various GC, Cutting Description, XPT – MDT Analysis During Drilling Activity

No	Well Name	Summary of GC	XPT (Psia)	MDT (Psia)	Description
1	AN-39	Up to C3; TG 1000	Loss Seal	1624	SST : pr, dkgy, (brn) dkgy, cons, hd, fmg, (ang) srt, carb, Qz, calc cmt
2	AN-33A	Up to C3; TG 16	No Data	No Data	SST : por, V glauc, calc cmt
3	AN – 40	Up to nC4; TG 655	No Seal – Tight	No Seal – Tight	LST : wh-off wh, md hd-hd, wks tpkst
4	AN – 41	Up to nC4; TG 49.5	No Seal – Tight	No Seal – Tight	LST : mds t-wskt, offw, cream, com milky wh, firm-mhd, britt, blky, vangular shape, mic xln, chly
5	AN – 31	Up to C3; TG 22	No Data	No Data	LST : por, frm mhd, Md st. Wkst
6	AN - 37	Static Loss	No Data	No Data	LST : Mdst – Wkst, mhd – sft, chlky

2 Methodology

The methodology to identify and characterize tight & low quality reservoir has been developed with following steps:

a. Petrophysics interpretation attributes is optimized by Dipole Shear Sonic Imager (DSI) and surrounding well data analogy as described on Fig.4 and Fig. 5

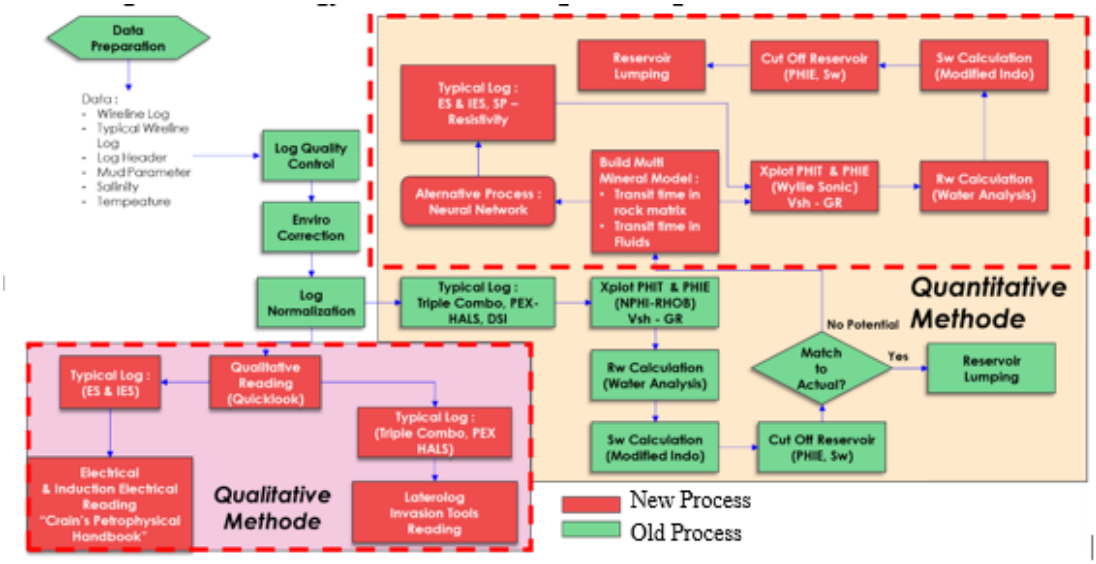

Figure 4. Petrophysics Interpretation Workflow Optimized by Dipole Shear Sonic Imager

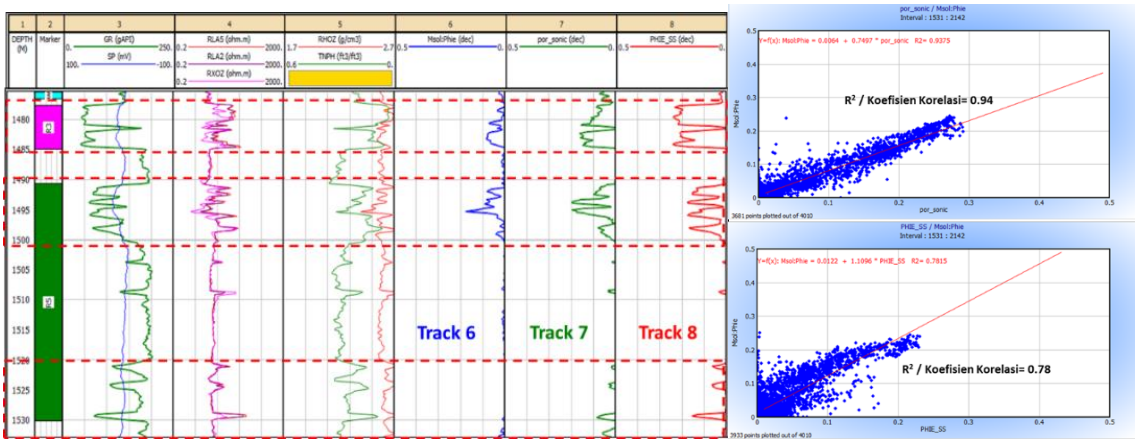

Figure 5. The Difference of Typical Porosity Calculation.
Track 6 (Blue line): Density – Neutron Equation **(Phie <0.03)**
Track 7 (Green Line): Wyllie Sonic Equation **(Phie 1-1.5)**
Track 8 (Red Line): Synthetic Porosity.

b. Certain criteria were used to select the pilot well test such as gas chromatograph or formation cutting log, nearby well correlation, single open hole log and the distance from key well reference

c. The result of acid solubility are shown in the following table (Table 2) Table 2

No	Well	Summary of % Solubility	XPT	MDT	Description
1	AN-39	Avg. 77%	Loss Seal	1624	SST : pr, dkgy, (brn) dkgy, cons, hd, fmg, (ang) srt, carb, Qz, calc cmt
2	AN-33A	Avg. 30%	No Data	No Data	SST : por, V glauc, calc cmt
3	AN – 40	Avg. 55%	No Seal – Tight	No Seal – Tight	LST : wh-off wh, md hd-hd, wks tpkst
4	AN – 41	Avg. 61%	No Seal – Tight	No Seal – Tight	LST : mds t-wskt, offw, cream, com milky wh, firm-mhd, britt, blky, vangular shape, mic xln, chlky
5	AN – 31	Avg. 27%	N/A	N/A	LST : por, frm mhd, Md st. Wkst
6	AN - 37	Avg. 73%	N/A	N/A	LST : Mdst – Wkst, mhd – sft, chlky

3 Result & Discussion

The UNIQUE methodology that has been discussed, then implemented to 5 wells in AN Structure which giving significant result with peak production to 520 BOPD (Fig 6)

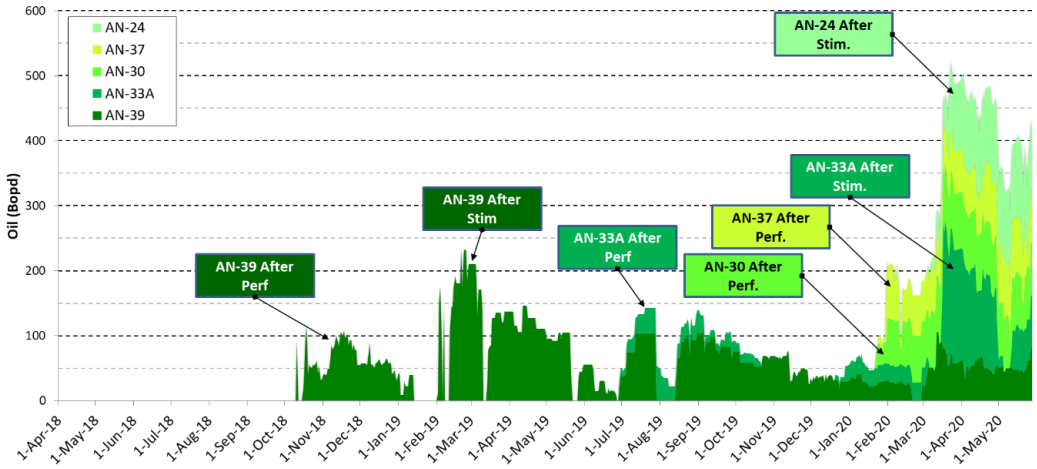

Figure 6. Production Performance Result of Unique Method Implementation to 5 Suspended Wells

The resume of oil production wells are shown on the table below (Table 3)

Table 3. Various Production Performance

No	Well Name	Initial Well Status	Production After Perforation			Production After Stimulation Acidizing			Js/Jo (Times)
			Gross (BFPD)	WC (%)	Oil (BOPD)	Gross (BFPD)	WC (%)	Oil (BOPD)	
1	AN-39	Suspended	125	66	43	728	68	233	5.8
2	AN-33A	Suspended	100	75	25	636	69	197	6.4
3	AN-24	Suspended	No rate during swab			226	46	122	
4	AN - 30	Suspended	511	83	87	Stimulation is not necessary			
5	AN - 37	Suspended	492	80	98	Stimulation is not necessary			

4 Summary & Conclusion

1. AN structure, one of the structure in Limau Field, as mature field, known as the biggest oil produced structure since 1967, peak production around 700 BOPD and declined to 580 BOPD, becoming a challenges for the next development. The UNIQUE Methodology in tight and low quality reservoir in AS Structure has been proved to increase the oil production to level 1100 BOPD.
2. In general, Unconventional Tight & Low Quality Reservoir is a term for oil tight reservoirs defined as reservoir with permeability less than 0.1 mD (gas). In AN Structure, the most applicable analysis is refer to wireline formation test (XPT) and modular dynamic tester (MDT) Analysis.
3. The primary key evaluation that have led to identify hydrocarbon in tight oil reservoir on this paper are: a. Petrophysics interpretation attributes is optimized by Dipole Shear Sonic Imager (DSI) and surrounding well data analogy. b. Certain criteria were used to select the pilot well test such as gas chromatograph or formation cutting log, nearby well correlation, single open hole log and the distance from key well reference. c. Acid solubility data laboratory test as critical part of production enhancement
4. Unique Projects with reactivating 5 suspended oil wells give 520 BOPD oil production incremental or as much as 260% (equivalent 100 BOPD/well) from target 40 BOPD/well. Unique Projects are able to increase oil reserves 414 MSTB in AN Structure using DCA Method.s
5. Furthermore, The UNIQUE Method wil be implemented in another structure at the Middle and East Limau Field to develop tight oil reservoir.

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