

# Evaluation and Potential Analysis of Fracture Network Fracturing in Oil Production X Plant

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**Abstract.** The oilfields developed by our factory are mainly ultra-low permeability reservoirs, and the problems of non-injection and non-production are prominent. When conventional oil well fracturing is used, there are problems such as insufficient water injection energy, low oil increase rate after fracturing, and short validity period, and it is difficult to achieve benefit management. To this end, since 2013, while controlling the under-injected wells, the application of fracture network fracturing has been gradually increased, and a total of 116 wells have been fractured. The contribution reached 4.13%, and the annual mitigation comprehensive decrease contribution was 3.62%.

**Key words:** Fracture network fracturing, natural decline, fracturing effect.

## 1. Introduction

The main development target layers of ultra-low permeability reservoirs in our factory are Putaohua, Gaotaizi and Fuyu oil layers. Judging from the test results, the southern Putaohua oil layer, Gaotaizi oil layer and Fuyu oil layer have better adaptability, while the northern Putaohua oil layer has a low liquid increase rate and poor oil increasing effect, and the adaptability needs to be further evaluated. In the initial stage of fracture network fracturing, the daily oil increase is more than 3.0t, the validity period is more than 30 months, and the cumulative oil increase during the validity period is more than 1400t, which is 2.0 times, 3.3 times, and 6.9 times that of conventional fracturing, respectively.

Since the development of Southern Portugal, there have been 194 casing losses, including 50 oil Wells and 144 water Wells, which are mainly divided into fault blocks no. 3, 4 and 8 in southern Portugal, accounting for 53.1% of the total casing losses. In this paper, 82 casing losses Wells in southern Portugal from 2010 to 2018 were compared and analyzed. It is found that the main causes of casing damage in southern Pu area in recent years are fault occlusion, high water injection intensity, influence of drilling control, poor cementing quality and so on. The longitudinal comparison and analysis mainly focus on the mudstone layer of The 1st, 2nd and 3rd member of The Nen and the mudstone interlayer of the main oil layer of the Pui group. It can be seen from the plane distribution that the block with complex fault structure is prone to forming high pressure abnormal area and sheath damage, such as The Third and fifth fault blocks in Punan.

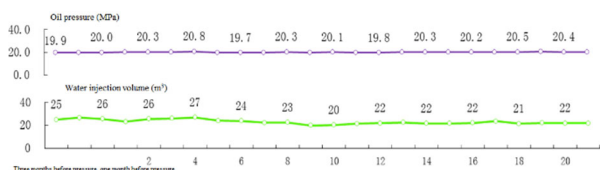
In the initial stage after fracturing, the production ratio of sandstone thickness in the whole well increased from 65.4%

to 96.3%, and the production degree of reservoirs with different thicknesses increased. The production ratio of sandstone thickness in reservoirs with effective thickness less than 0.5m increased from 47.4% to 95.1%, the daily fluid production accounted for 26.3% of the whole well, and the effect of increasing fluid was obvious.

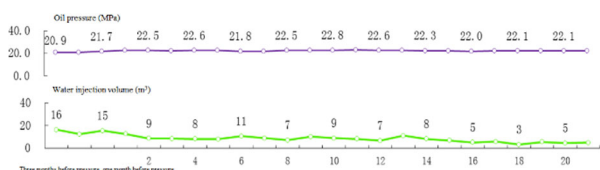
After the fracture network fracturing, the water injection conditions of the surrounding water wells were significantly improved. The water injection pressure of the eight normal water injection wells around the fracture network fracturing well in the southern Putaohua oil layer block 3 decreased from 1.35 MPa/year to 0.68 MPa/year, and the water injection pressure increased. The water volume was stable; 14 under-injection wells were closed in winter and opened in summer, the water injection pressure showed a downward trend, the water injection volume was stable, and the water injection condition was improved.

## 2. Water injection conditions of normal water injection wells around the fracturing wells in the Putaohua reservoir

The water injection pressure of 13 normal water injection wells around fracture network fracturing wells in block 2 of Fuyu oil layer continued to rise before fracture network fracturing. After the fracture network fracturing of 9 under-injection wells, the water injection pressure was stable, and the water injection volume decreased, but no obvious effect was seen. Among them, the water absorption capacity of one of the 2 wells became stronger. Fill normally.



**Fig. 1.** Water injection status of normal water injection wells around fracture network fracturing wells in Fuyu oil layer



**Fig. 2.** Water injection status of under-injected wells around fracture network fracturing wells in Fuyu oil layer

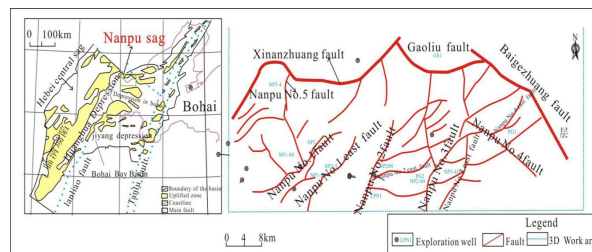
In southern Putaohua oil layer and Fuyu oil layer, 102 wells were fractured with a common fracture network. After fracturing, 15 wells were obviously effective, and both liquid and oil production increased in different magnitudes; 11 wells broke through after fracturing, and the rest were effective. It is not obvious, but compared with the fracture network fracturing wells without water injection supplementation, the monthly decline rates of Putaohua and Fuyu oil layers are 8.8% and 1.9% lower, respectively.

In the southern grape flower layer, 18 wells and 34 wells were implemented in block 4 and block 3 respectively. Among them, 15 fractured network fracturing wells were implemented earlier in block 4, all of which were supplemented by water injection. After the decline before and after fracturing, In the later stage, the decline slowed down, and the monthly decline rate was 6.2% lower than that in the previous stage, of which 5 wells were obviously effective.

## 3. Geological survey

X Plant is located between Tangshan city and Qinhuangdao City in Hebei Province. It is connected with Bohai Sea in the south and east, jianhe River at the boundary of Tianjin-Hebei province in the west, and bohai Petroleum Company is bounded by 5m water depth line in the sea. Nanpu sag is located in the south margin of Yanshantai fold belt and the northeast end of Huanghua Depression of Bohai Bay Basin. It is a meso-Cenozoic superimposed fault basin in the north of Huanghua Depression, with a total area of 1932km<sup>2</sup> and a land area of 660km<sup>2</sup>. Nanzhuang fault is connected with laowangzhuang and Xinanzhuang uplift in the west of the sag, Baigezhuang fault is adjacent to Baigezhuang and Matouying uplift and Shimoltuo sag in the east, Shabei fault is adjacent to Shaletian uplift in the south, and Jiandong fault is separated from Beitang sag in the west (see Figure 3).

Nanpu Sag has a typical oblique extension deformation pattern [19], and its overall structure is a semi-graben basin controlled by the xinanzhuang fault and The Baigezhuang fault and other listric boundary faults. Its fault pattern is affected by changes in local tectonic stress field controlled by oblique extension. The tectonic transition period of Nanpu sag was in the sedimentary period of the second member of Shahejie Formation. The evolution process of the sag rifting has experienced the shahejie stage and Dongying Stage rifting extension stage in early Tertiary and depression stage in late Tertiary. Tectonic stress field is the fundamental driving force controlling the formation, development and evolution of basins. Nanpu Sag has experienced two major structural evolution stages, which were mainly extensional fault depression in Paleogene and twist strike-slip in Neogene. It has developed significantly since the deposition of Minghuazhen Formation and is a small petroliferous sag with extremely rich oil and gas resources. Fracture is a complex “zonal” structure composed of fault core and fracture zone. The anticlockwise torsion field of the main faults in Bohai Bay Basin since Oligocene is the main mechanism leading to the extension and turning of X Plant.



**Fig.3** Regional location map of X Plant (modified according to Liu Kexing)

### 4. Economic analysis of fracture network fracturing potential

According to the relationship between oil price and oil increase, the potential wells of each formation under different oil prices are clarified. When the oil price is 60\$/bbl, there are 132 potential wells in each layer, including 74 in Gaotaizi oil layer, 20 in Fuyu oil layer and 38 in Putaohua oil layer.

Micro-faults cause casing damage of oil and water Wells. Based on the analysis of seismic data interpretation results, it is believed that micro-faults have a certain influence on casing damage of oil and water Wells. There are 7 Wells with the same fault and casing damage horizon of micro-faults (Table 1), accounting for 17.5% of the casing damage Wells in puI formation.

Research Nanpu no. 2 buried hill chose trace277 profile, this profile is located in the study area in the south of the east-west section, Nanpu fault 2 and Nanpu 2 east fault control, regional survey shows that in the Cambrian - ordovician, weak tectonic movements in the study area, the sedimentary environment of shallow sea, mainly for a set of carbonate formation, the overall weak tectonic movements, sedimentary environment for the shallow sea, Mainly for a set of carbonate formation, the overall tectonic deformation is very weak, during the silurian - devonian strata overall uplift, denudation, cause the ordovician carbonate rocks to suffer whole in carboniferous - Permian, sediments deposited a set of sea and land to pay each other, in the Triassic period, as the north China plate on the edge of the north and south ocean closed, the study area has been subjected to intense ns compressional, High profile on the uplift, denudation degree is big, the upper ordovician erosion, and low relative to the west side of lift, but also suffered a certain denudation, the ordovician relatively preserved, palaeozoic group according to again, but the overall denudation extent is small, early in the late Mesozoic - Cenozoic, the hole does not have store group in the study area, It is speculated that the study area in this period is mainly tectonic highland, which caused the lower Paleozoic and Mesozoic to suffer denudation again.

**Table1.** The lower limit and potential table of economical effective Thickness under different oil prices for each layer

Layer system	Block/Field	Oil price (USD/barrel)	40	45	50	55	60	65	70	
		Oil price (Yuan/t)	2070	2299	2528	2749	2969	3227	3486	
GaoTaizi	Block 1	Economical and effective thickness lower limit (m)	8.3	7.5	6.8	6.3	5.8	5.3	4.9	
		Potential well (well)	25	32	42	56	74	87	98	
FuYu	Block 2	Economical and effective thickness lower limit (m)	Big sea m net	5.3	4.4	3.7	3.3	2.9	2.6	2.3
			Sm all sea m net	2.9	2.4	2.0	1.8	1.6	1.4	1.3
		Potential well (mouth)	Big sea m net	4	8	11	11	17	21	25
			Sm all sea m net	3	3	3	3	3	4	4
Putaohua	Block 3	Economical and effective thickness lower limit (m)	3.2	3.0	2.8	2.4	2.2	2.0	1.8	
		Potential well (well)	18	21	25	18	31	36	41	
	Block 4	Economical and effective thickness lower limit (m)	13.9	8.4	6.0	4.7	3.9	3.2	2.7	
		Potential well (well)	0	0	5	6	7	9	10	
Total		Potential well (well)	50	64	86	94	132	157	178	

### 5. Conclusion

Through the comparative analysis, it can be seen that compared with ordinary fracturing, the fracture network fracturing has the characteristics of good fracturing effect and can improve the water injection condition of each layer, and has achieved good results in our factory. At the same time, there are differences in the output contribution of two types of layers in different layers, differences in the first-time flowback rate and oil breakthrough time in

different layers, and differences in oil-breakback rate and flow-back rate when water is stable in different layers. The next step will continue. Experiments are arranged, and the adaptability is to be further evaluated.

## Acknowledgements

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