

Optimization of management measures for water-producing gas wells in SM gas field

Zhiqiang Fan¹, Guangjun Xu¹, Liying Xi¹, Dangni Zhao¹, Sihong Liu¹, Long Sun¹, Runhua Zhu^{2,*}

¹The Research Center of Sulige Gas-field, Changqing Oilfield Company, CNPC, Xi'an, China

²College of energy, Chengdu University of science and technology, Chengdu, Sichuan, China

Abstract. SM gas field is a typical tight sandstone gas reservoir, which adopts the production mode of downhole throttling and inter-well series connection. Gas wells will have different production characteristics at different stages of production, which will cause the management measures implemented by gas wells in different stages to have different effects on efficiency[1-2]. Based on the complex production law of water-producing gas wells in SM Gas Field, this paper is based on the quantitative evaluation of the impact of water production on gas well development indicators for the latter. Clarify the reasons for the production of water and water from gas wells, understand the production rules of water-producing gas wells, optimize the management measures of water-producing gas wells in SM Gas Field, and clarify the rational production allocation methods and work under various complex water-producing conditions during the development of water-producing gas wells system[3]. It can also lay a foundation for the subsequent development of low-yield and low-efficiency wells to tap potential measures, to propose technical countermeasures to enhance oil recovery in the SM gas field, and to carry out gas field-related stable production potential evaluation.

1. Preface

The SM gas field is located in the northeastern part of the Yishan slope in the Ordos Basin. It is adjacent to the Yulin gas field in the west, the Daniudi gas field in the north, and the Zizhou gas field in the south. It is a typical tight sandstone gas reservoir in my country. Due to the generally weak productivity of gas wells in the SM gas field, and the production model of downhole throttling and inter-well connection, the gas production and liquid production of gas wells cannot be directly and accurately discriminated during production, and the production rules of complex water-producing gas wells have not yet been clarified. Therefore, combined with the static and dynamic production data and related structural geological models of the SM gas field, comprehensively analyze and summarize the gas production and water production dynamics of the gas field, and reflect the development effect and the dynamic reserves through the relationship between the current gas production and dynamic reserves of the natural decline of gas wells. The rationality of allocation[4-5].

This paper mainly takes the blocks near the well groups such as Shuang 58-51 as the analysis object, and analyzes and studies the local storage of formation water in the work area. The water-producing gas wells are mainly controlled by sand bodies and structures. Tracking and dynamic analysis of water-producing gas wells can clarify the reasons for water-producing wells and water-producing wells, understand the production rules of water-producing gas wells, and classify water-producing

gas wells."atmospheric small water" type gas wells and "atmospheric large water" type gas wells, and according to the classification standards and the combination of gas well production characteristics and gas well process adaptability, various supporting processes at different stages are designed, and development technology countermeasures are formulated respectively[6]. It is of great significance to optimize the working system of gas wells in the later development of SM Gas Field, formulate potential tapping measures for low-yield and low-efficiency wells, put forward technical countermeasures for enhancing oil recovery of SM Gas Field, and carry out the evaluation of gas field stable production potential.

2. Gas well production system optimization

From the relationship between initial daily production and dynamic reserves (Figure 1), it can be seen that there is a certain relationship between the initial production capacity and dynamic reserves of gas wells. (Figure 2), we make a trend line based on the average value of the current daily gas production (m³/day) of 0-5000, 5000-10000, 10000-15000, 15000-20000 of dynamic reserves (10,000m³), which is higher than Wells in this trend line are wells with poor development effect, and wells below this trend line are wells with higher production allocation. According to this, there are 36 gas wells with higher production allocation at present.

* Corresponding author: 201704010310@stu.cdut.edu.cn

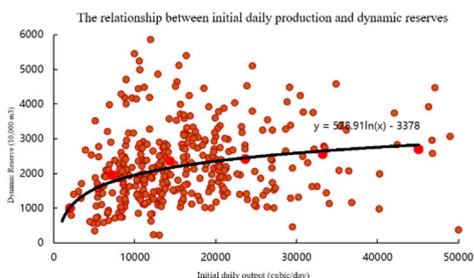


Figure 1. The relationship between initial daily production and dynamic reserves

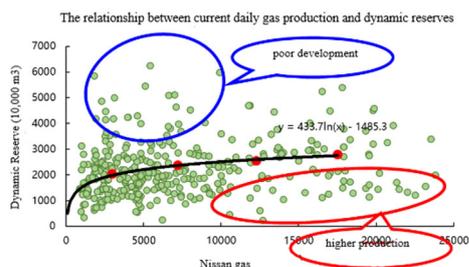


Figure 2. Relationship between current daily gas production and dynamic reserves

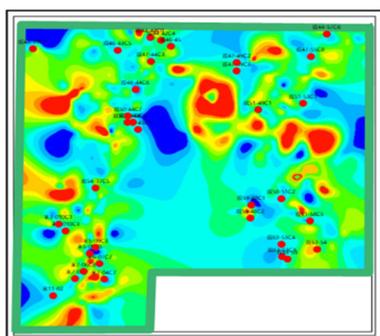


Figure 3. Adjust the plane distribution map of gas distribution wells (superimposed with ϕ)

3. Development Countermeasures for Water-Producing Gas Wells

3.1 Gas and water distribution characteristics

Generally, the main sources of water production in gas wells are divided into the following categories: ① residual fracturing fluid, but the amount of residual fracturing fluid is generally small and not the main source of water production in gas wells; ② condensate water, accounting for about 5% of the total water volume, the gas well is shown as small atmospheric water; 3. Locally sealed formation water, which is widely present in the formation, is the main source of water production for gas wells. According to the different water production, gas wells can be expressed as large atmospheric water and small gas and large water; (4) Formation pore water. Formation pore water is widely present in the formation and is the main source of water production in gas wells. Gas wells can appear as small gas and small water. According to the distribution map of water-producing gas wells in the study area (Figure 4), water production from gas wells occurs in the entire study area. From the

distribution plan of the water-gas ratio in the study area (Figure 4), it can be seen that due to the local storage of formation water in the study area, The water cut around Shuang 58-51 well group-Shuang 114-Shuang 60-54 well group, Shuang 55-36 well group-Shuang 54-36 well group-Shuang 105 is higher.

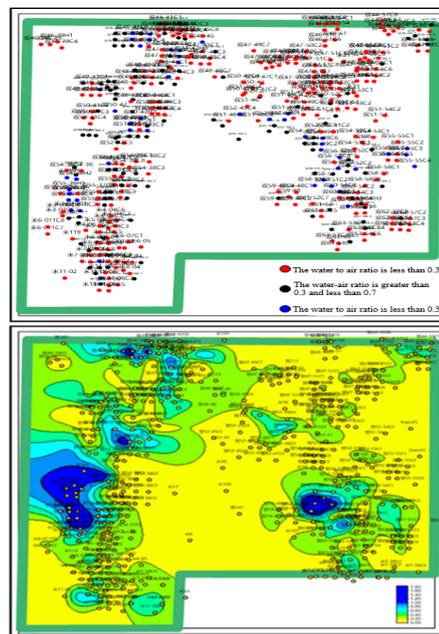


Figure 4. Plan of distribution of water-producing gas wells and distribution of water-gas ratio in the study area

It can be seen from the superimposed map of high water-to-gas ratio gas wells and cumulative effective sand body thickness (Figure 5) and the superimposed map of high water-to-gas ratio gas wells and structure (Figure 5) that the gas wells with higher water production are mainly affected by sand bodies and structures. control.

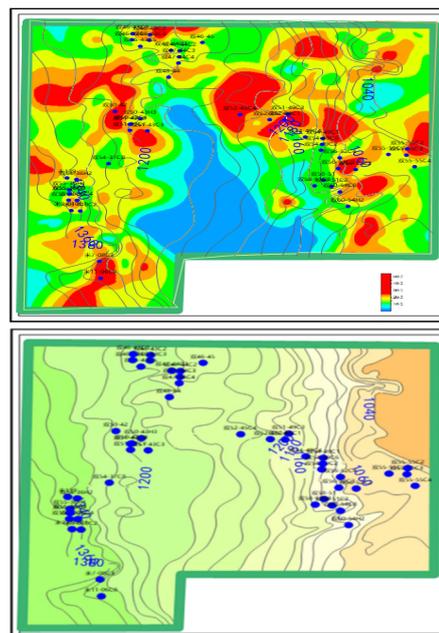


Figure 5. Superimposition map of gas wells with high water-gas ratio and cumulative effective sand body thickness and structural superimposition map

3.2 Production dynamic characteristics of water-producing gas wells

Water-producing gas wells can be divided into four categories: ① "small gas and small water" type gas wells, ② "small gas and large water" type gas wells, ③ "atmospheric small water" type gas wells, and ④ "atmospheric and large water" type gas wells.

"Small gas and small water" type gas well: Take Well Shuang 44-57 as an example, the average daily gas production in the first year is 7,700 m³/day, the daily water production is 0.14 m³/day, and the water-gas ratio is 0.26.

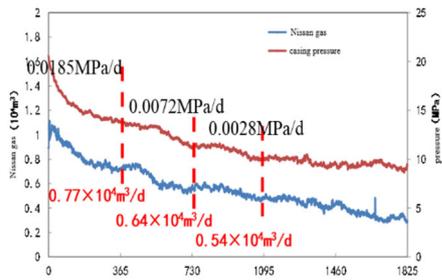


Figure 6. Production characteristics of small gas and small water type

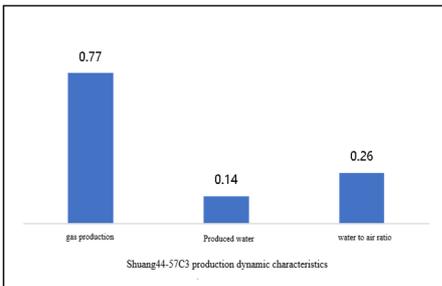


Figure 7. Shuang 44-57C3 production dynamic characteristics

There are 127 small gas and small water type gas wells, with an average daily gas production of 8,812 cubic meters per day in the initial stage, and an average daily gas production of 6,217 cubic meters per day at present, with an average water-gas ratio of 0.12, as shown in the figure below (Figure 8).

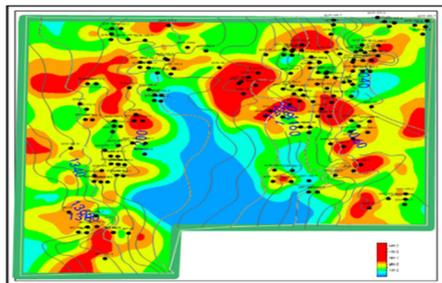


Figure 8. Distribution of small gas and small water wells (superimposed with effective thickness)

"Small gas and large water" type gas well: Take Well Shuang 60-54 as an example, the average daily gas production in the first year is 8,400 cubic meters per day, the daily water production is 0.74 cubic meters per day, and the water-gas ratio is 0.94; take Well Shuang 60-54 as an example.

There are 64 small gas and large water type gas wells, with an average daily gas production of 9938 cubic meters per day in the initial stage, and an average daily gas production of 8446 cubic meters per day at present, with an average water-gas ratio of 0.58.

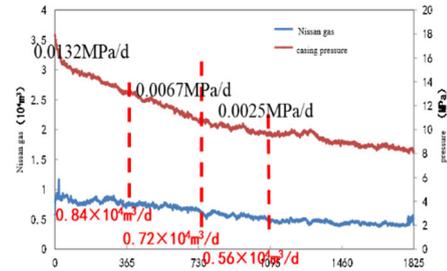


Figure 9. Production characteristics of small air and large water type

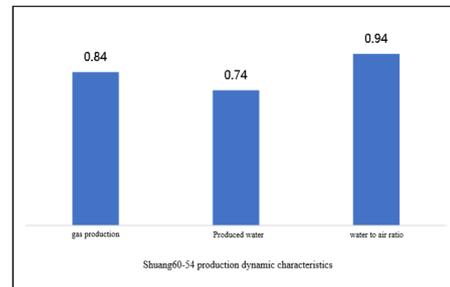


Figure 10. Shuang 60-54 production dynamic characteristics

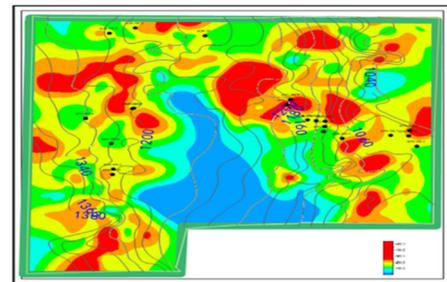


Figure 11. Distribution of small gas and large water gas wells (superimposed with effective thickness)

"Atmospheric small water" type gas well: Take the Shuang 55-55C3 well as an example, the average daily gas production in the first year is 14,000 m³/day, the daily water production is 0.53 m³/day, and the water-gas ratio is 0.42.

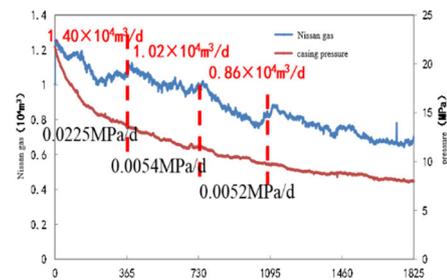


Figure 12. Characteristics of Atmospheric Small Water Type Production

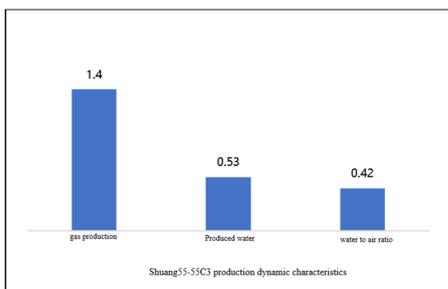


Figure 13. Shuang 55-55C3 production dynamic characteristics

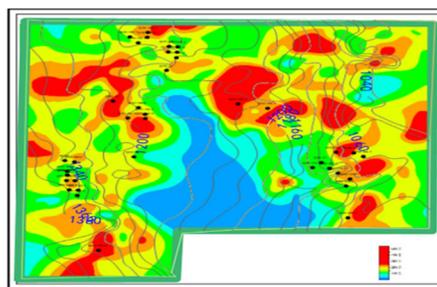


Figure 17. Distribution of atmospheric and water-type gas wells (superimposed with effective thickness)

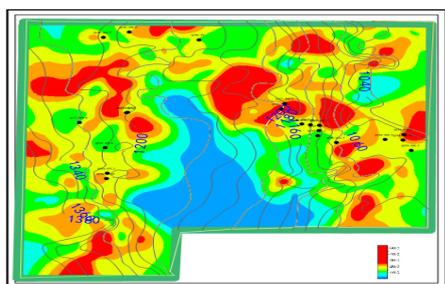


Figure 14. Distribution of atmospheric small water gas wells (superimposed with effective thickness)

There are a total of 140 atmospheric small water gas wells, with an average daily gas production of 24,062 cubic meters per day in the initial stage, and an average daily gas production of 10,986 cubic meters per day at present, with an average water-gas ratio of 0.176. "Atmospheric water" type gas well: Take Shuang 58-51C3 well as an example, the average daily gas production in the first year is 23,700 m³/day, the daily water production is 3.57 m³/day, and the water-gas ratio is 1.51.

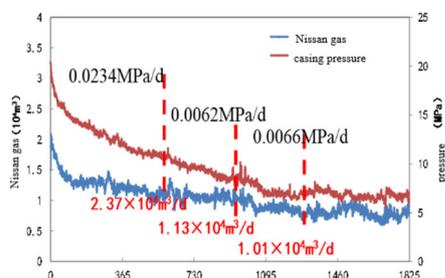


Figure 15. Atmospheric water type production characteristics

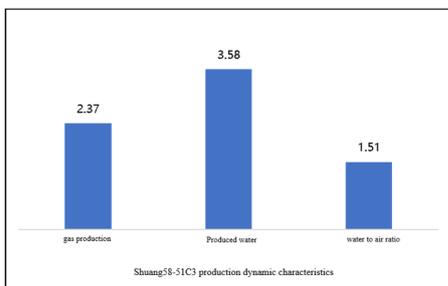


Figure 16. Shuang 58-51C3 production dynamic characteristics

There are 111 large-water gas wells in total, with an average daily gas production of 26,419 cubic meters per day in the initial stage, and an average daily gas production of 13,445 cubic meters per day at present, with an average water-gas ratio of 0.63.

4. Conclusion

(1) The development strategy of water-producing gas wells is mainly reflected in the rational production allocation in the early stage, the adjustment of the production system in the middle and late stage, and the intervention of production stimulation measures.

(2) For small atmospheric water wells, it is recommended to focus on rational production allocation, taking into account the management measures of drainage and gas production. In the early stage of production, it is recommended to rationally allocate production and increase gas production in the natural continuous production stage. In the middle and late production stages, it is recommended to strengthen dynamic tracking and take foaming at appropriate times. Drainage and gas recovery measures.

(3) For small gas and small water wells, it is recommended to adopt management measures that optimize the production system and take into account drainage and gas production. In the early stage of production, the production allocation should be slightly higher than the critical liquid-carrying flow rate. In the middle and late stages of production, it is recommended to carry out velocity string and plunger gas lift in a timely manner. Drainage and gas recovery measures.

(4) For large atmospheric water wells, it is recommended to adopt key management measures for drainage and gas production. Drainage and gas production measures such as velocity string and plunger gas lift should be carried out in a timely manner, and gas lift recovery should be carried out for wells with severe liquid accumulation, and plunger gas lift should be adopted after production recovery. synchronous rotary compressors, and composite drainage and gas recovery measures such as blockage removal and resumption of production.

(5) For small gas and large water wells, it is recommended to adopt key drainage and gas production management measures. Velocity string and plunger gas lift should be carried out. In the middle and late stages, the intermittent production system of short shut-off and short shut-off should be implemented to increase the instantaneous gas production and water production when the well is opened.

Drainage and block removal measures to resume production to realize wellbore drainage and resume production.

Reference

1. Liu Chang. Analysis of production characteristics and technical countermeasures of gas wells in Shenmu gas field [D]. Xi'an Shiyou University, 2018.
2. Wang Jingjian, Wang Yifei, Zhang Han, Wang Delong, Zuo Hailong, Zhang Haibo. Law of production decline of gas wells in Shuang 3 block of Shenmu gas field [J]. *Petrochemical Application*, 2015, 34(10): 16-20+ 40.
3. Zhou Tuo. Production characteristics and dynamic analysis of tight gas in Shenmu gas field [D]. China University of Petroleum (East China), 2013.
4. Wang Yajuan, Zhang Yanming, He Mingfang, Zhang Huaguang, Xiao Yuanxiang, Shi Hua. Research on stimulation technology of multi-layer tight sandstone gas layers in Shenmu Gas Field [J]. *Oil and Gas Well Testing*, 2017, 26(03): 66-68+78.
5. Zhang Xiaodong, Xie Yaxi, Han Cuku, Li Yinghong, Song Ping. Optimization of management measures for peak shaving gas wells in Sulige Gas Field [J]. *Petrochemical Applications*, 2017, 36(04): 44-47.
6. Cheng Jingjing. Research on production dynamics and rational development system of water and gas wells in Suxi [D]. Xi'an Petroleum University, 2018.