Optimization Research on Centralized Monitoring Design of Ternary M1 Joint Station

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Abstract. In the centralized monitoring construction mode of oilfield stations, the original duty posts set by functional units are cancelled, and a centralized control room is set up to transmit the production data information to the central control room and then upload it to the higher-level production command system step by step, so as to realize remote monitoring, centralized duty, unified layout, unified monitoring and unified management in the station. The density of well pattern and stations in old oilfields is large. With the construction of productivity projects, it is necessary to make rational use of existing facilities to complete the optimization study of centralized monitoring design of new stations, so as to reduce the difficulty of production management, improve the quality of monitoring system and improve the level of production management. In this paper, the centralized monitoring design of ternary M1 joint station is optimized through comparison and selection of multiple schemes, and a reasonable monitoring system construction mode is selected according to each station's own situation, so as to simulate the employment situation of production operation management, fully analyze and consider the production management needs, and avoid affecting the production operation due to the omission of centralized monitoring design.

Keywords: Ternary M1 joint station; Centralized monitoring; Optimization research.

1. Present situation of ground construction
In 2019, the newly built ternary M1 joint station and M2 joint station in Sanan Oilfield will be built adjacent to each other. Ternary M1 joint station includes one ternary oil transfer and water discharge station, one ternary sewage station and one binary station, and the design capacity of each station includes the future ternary treatment capacity of Block H. In addition, the centralized monitoring scope includes four ternary injection stations. M2 joint station was built in 2011, including one advanced sewage treatment station, one water injection station, one central control room and one boiler room. The area covers 9 stations (10 posts). The location of stations is shown in the following figure.

A total of 30 people have been built in M2 joint station, including 12 in day shift and 8 in night shift. Its centralized monitoring room is designed to be 30.5 meters long and 12.5 meters wide with a building area of 382 square meters, of which the control room is 12.5 meters long and 7.8 meters wide with a building area of 97.5 square meters. There are 5 control cabinets, 2 communication cabinets and 4 staff operation stations in the control room. See the following figure for the functional division of each room.
2. Comparison and selection of construction schemes

Combined with the practical experience of field management, the overall layout is optimized and the reasonable station arrangement mode is selected [1]. After simulated operation analysis, three solutions are put forward.

2.1. Scheme 1: Use the central control room of the existing M2 sewage post as the regional centralized monitoring room

According to the plan, the newly-built centralized monitoring will realize centralized monitoring and management of at least 9 stations (10 posts). See the following figure for the regional location relationship between ternary M1 joint station and M2 joint station.

![Figure 1](image)

**Figure 1.** Schematic diagram of regional location of ternary M1 joint station and M2 joint station

Reconstruction quantities of scheme 1: the centralized monitoring facilities of the newly-built joint station will be expanded in M2 joint central control room, and the existing cadre duty room will be transformed into power distribution room, and the damaged plastic-steel windows will be updated. See the following figure for the functional division of each room in the centralized monitoring room of M2 joint station after renovation.

According to Scheme I, the centralized monitoring management after completion is simulated on site and the employment situation is calculated. There are many problems in production management after completion.

(1) Simulate the employment situation of production management operation

On-site operation simulation is carried out for centralized monitoring and management of ternary M1 joint station to be built in the future. It is estimated that at least 61 people need to be equipped, including 24 in day shift and 13 in night shift, as shown in the following table.
Table 1. Team and personnel configuration of centralized control operation mode of ternary M1 and M2 joint stations

| Job title | Staffing in traditional management mode | Centralized attendant configuration |
|-----------|----------------------------------------|-----------------------------------|
|           | Total number of people | Team | Overall number of people | Day shift | Night shift |
| M1 oil transfer and water release station | 10 | Big monitor | 2 | 2 |
| M1 sewage station | 10 | Run monitor | 8 | 2 |
| M1 binary deployment station | 15 | Patrol class | 8 | 2 |
| Public team | | Monitoring class | 16 | 4 |
| | | Laboratory class | 4 | 1 |
| | | Settlement clerk | 1 | 1 |
| | | Maintenance class | 8 | 8 |
| M2 sewage station | 10 | Patrol 2 shifts | 8 | 2 |
| M2 water injection station | 10 | | |
| M2 boiler post | 10 | | |
| TernaryA1 No.1 injection station | 13 | Patrol 3 shifts | 6 | 2 |
| TernaryA2 injection station | 13 | | |
| TernaryB1 injection station | 13 | | |
| TernaryB2 injection station | 13 | | |
| add up to | 117 | | 61 | 24 |

(2) There are problems in production management

According to the design idea of Scheme I, it is estimated that there will be the following problems after completion:

1) Insufficient locker room area

Set up a male locker room and a female locker room. There are about 15 male employees and 46 female employees in 61 people in the simulated operation. Although some positions have 4 shifts, it is necessary to equip each employee with a fixed locker room with a specification of $0.6 \times 0.4 \times 1.8$ m. According to the calculation of the currently designed locker room, each locker room can be placed with 16 wardrobes at most near the wall, and the locker room area is insufficient. It is estimated that 4 locker rooms (1 male and 3 female) are needed.

2) Insufficient squatting position in toilet

There are 2 toilets, with one squatting position for the male and one squatting position for the female toilets. According to the on-site simulation, there are 24 day shift workers and 13 night shift workers, and there are generally more female employees in the station management, especially about 40 people in the upper and lower shift periods of day shift and night shift, which is not conducive to going to the toilet in the concentrated period.

3) Lack of bathroom

Ternary M1 joint station centrally monitors and manages at least 9 stations, and it is inevitable that stains will splash on people and sweat will soak clothes during inspection, maintenance or test, so it is necessary to equip one male and one female bathing room respectively.

4) The temporary rest room of maintenance class and inspection class has insufficient area
In order to realize centralized monitoring and class management, the principle of nearby management is adopted to effectively guide the employment. It is necessary to provide one temporary rest room for M2 couplet and injection station inspection class and one temporary rest room for maintenance class.

5) The inspection area has a large span, which takes a lot of time and lacks emergency safeguard measures.

The oil post, sewage post and water injection post of M2 joint station and ternary М1 joint station shall be inspected once every 2 hours. In addition, regular inspection shall be conducted for 4 injection stations. The centralized monitoring inspection area has a large span (about 3.1km away from ternary B1 injection station), which takes a lot of time. Failure to arrive at the site in time when dealing with emergencies will result in large-scale oil, gas and water leakage incidents, and there are great potential safety hazards. In order to improve the efficiency of patrol inspection and emergency handling, it is suggested to allocate more motor vehicles and electric vehicles, and at the same time, consider providing motor vehicle storage and heating warehouse and electric vehicle storage and charging room.

6) The two joint stations have a large span and there are risks such as night theft

The straight-line distance between the walls of M2 Union Station and ternary М1 Union Station is about 130 meters, and they are independent courtyard walls, so there are risks such as theft and robbery at night. In order to facilitate night duty management, both stations need to be equipped with duty rooms.

7) M2 central control room has no expansion position and no old functional room

The east and west sides of M2 central control room are pump houses, the north side is the entrance road, the south side is the tank farm, and there is no expansion position around. 186 samples/month need to be tested in M2 water injection post, and 266 samples/month need to be tested in M2 sewage post. The laboratory is frequently used and cannot be cancelled. The maternity ward cannot be cancelled.

8) Missing reference room and tool room

According to the standard preparation, lack of reference room and tool room.

9) The production management requirements of polymer flooding and ternary flooding sewage stations are different, so it is difficult to manage the post staff.

The production management requirements of polymer flooding and ternary flooding sewage stations are different in terms of test standards, back washing intensity, oil collection frequency, etc., and there are fewer employees with one specialty and multiple functions, which brings difficulties to the production management of employees.

Advantages of scheme I: less reconstruction works. Disadvantages: There are many problems mentioned above, which can not meet the safety production and operation, and is not suitable for the needs of this capacity building.

2.2. Scheme 2: a new standardized central control room will be built in ternary M1 Joint Station, and the functions of each room in the central control room of M2 Joint Station will be reconstructed and adjusted together

The functional rooms of the central control rooms of the two joint stations are equipped as follows:

(1) New standardized central control room in ternary M1 Union Station

A new central control room is set up in ternary M1 joint station, and relevant control units of M2 are connected to the control room of the newly built central control room. The original cabinet of M2 joint central control room is not adjusted, so that centralized control of M2 joint station and ternary M1 joint station can be realized by using one central control room of ternary M1 joint station. It is also necessary to build two car storage and heating warehouses adjacent to the central control room. Operation, monitoring and patrol inspection of ternary M1 joint station (12 persons in day shift) are fixed in the newly-built central control room, as shown in the following figure.

(2) Rebuilding and adjusting the central control room of M2 joint station

The transformation and function adjustment are as follows: First, add partitions to the control room cabinet of M2 central control room, and isolate the area as the storage and charging room for electric vehicles; Second, keep the duty room, maintenance room, cathodic protection room, bathroom, women's locker room and laboratory, and adjust the warehouse into a tool room and the men's locker room into
a women's locker room; Third, the office will be changed into the patrol lounge of M2 joint station and injection station (4 persons in the day shift), and the cadre duty room will be changed into the maintenance lounge (8 persons in the day shift). The patrol personnel of M2 joint station and injection station and the maintenance personnel will work in M2 joint station, as shown in the following figure.

Advantage of scheme 2: centralized monitoring and management of multi-station area is realized, and the total number of people is equivalent to scheme 1. Disadvantages: The management scope is large, and the patrol inspection distance is long, which is not conducive to the timely discovery and disposal of emergencies.

2.3. Scheme 3: M2 joint station maintains the status quo, and ternary M1 joint station is provided with a central control room

The two joint stations independently carry out centralized monitoring and management of their respective jurisdictional posts. Optimize the organizational structure, and implement the management mode of central control duty+large class inspection in the station, that is, cancel the duty personnel of other posts, keep only the duty personnel in the central control room, adopt shift duty, and set up a large class inspection in the station, which is responsible for pump inspection and cleaning [2]. This not only saves manpower and material resources, but also facilitates production management. M2 joint station has 3 posts, with 30 employees, 12 day shift and 8 night shift. The operation management is as follows:

**Table 2.** Status quo of centralized control team and staffing in M2 joint station

| Job title                | Staffing in traditional management mode | Staffing                  |
|--------------------------|----------------------------------------|---------------------------|
|                          | Team                                   | Overall number of people  |
|                          | Overall number of people | Day shift | Night shift |
| M2 sewage station        | Water injection post                   | 8 | 2 | 2 |
| M2 water injection station| Sewage post                           | 8 | 2 | 2 |
| M2 boiler post           | Boiler post                            | 8 | 2 | 2 |
| Public team              | Gang Chang                             | 3 | 3 | 2 |
|                          | Data processor                         | 1 | 1 |   |
|                          | Settlement clerk                       | 1 | 1 |   |
|                          | Maintenance man                        | 1 | 1 |   |
| Add up to               |                                        | 30 | 12 | 8 |

A new central control room will be built on the south side of ternary M1 joint station to implement centralized control of ternary M1 joint station. After the block capacity construction is completed, the centralized monitoring will reach 7 posts. Operation management is as follows:

**Table 3.** Team and personnel configuration of centralized control operation mode in M1 joint station

| Job title                                | Staffing in traditional management mode | Centralized attendant configuration |
|------------------------------------------|----------------------------------------|-----------------------------------|
|                                        | Team                                   | Overall number of people  |
|                                        |                                        | Day shift | Night shift |
| M1 oil transfer and water release station| Big monitor                           | 1 | 1 |
| M1 sewage station                       | Run monitor                            | 4 | 1 | 1 |
| M1 binary deployment station            | Patrol class 1                         | 8 | 2 | 2 |
| Public team                             | Monitoring class                       | 8 | 2 | 2 |
Advantages of scheme 3: first, the management site is relatively centralized, the management scope is moderate, and the distance of patrol inspection is shortened; Second, under the condition of existing process equipment level and automation degree, it can improve management efficiency, reduce work intensity, facilitate the discovery and disposal of emergencies, and facilitate timely treatment. Disadvantages: It is still necessary to solve the problem of adding vehicles and building new garages for inspection personnel at the injection station. The total number of the two joint stations is relatively large.

2.4. Scheme comparison

According to the above analysis, scheme one, that is, the scheme of reusing the existing M2 sewage post central control room as a regional centralized monitoring room, has many problems, which is not suitable for the demand of this capacity building. Therefore, scheme 2 and scheme 3 are optimized. The construction investment of scheme 2 is higher than that of scheme 3, but the employment is 9 people less than that of scheme 3. Advantages of scheme 3: First, the management site is relatively concentrated, the management scope is moderate, and the patrol inspection distance is shortened; Second, under the condition of existing process equipment level and automation degree, it can improve management efficiency, reduce work intensity, facilitate the discovery and disposal of emergencies, and facilitate timely treatment. Comprehensive consideration is given to Option 3, that is, M2 Joint Station maintains the status quo, and ternary M1 Joint Station is provided with a central control room.

3. Summary

(1) The construction of centralized monitoring system for old oilfield stations follows the principle of "remote monitoring and centralized duty", completely changing the original production management mode, and realizing the monitoring and operation control of production process of each post in the central control room. When the capacity of new stations is combined with the capacity of old stations, the corresponding centralized monitoring construction mode should be selected according to the station's own situation. Although reducing staff and increasing efficiency can solve the problem of shortage of oilfield employment at present, the station situation should be considered in a unified way, so as to really achieve the purpose of facilitating management and improving work efficiency.

(2) When comparing the design schemes of centralized monitoring in the joint station, the construction investment and labor cost should be considered, meanwhile, the employment situation of production management operation should be simulated, and the problems existing in production management such as locker room area, provision of functional rooms such as bath room and reference room, temporary rest of team members, span and time consumption of inspection area, emergency safeguard measures and so on should be fully considered. The optimized scheme can provide reliable guarantee for the safe and stable operation of later production.
References

[1] Wang Shuping. Optimization and simplification of surface system in Xinmin Oilfield [J]. Oil and Gas Field Surface Engineering, 2014, 1 (41).

[2] Li Chunyan. Construction Mode of Centralized Monitoring System for Peripheral Oilfield Stations [J]. Oil and Gas Field Surface Engineering, 2017, 5 (57).

[3] Wei Jide. Distribution Characteristics and Controlled Factors of Residual Oils in Daqing Oilfield [J]. Oil & Gas Geology, 2001, 22(1): 57-59.

[4] Dou Zhilin. A Study on Flow Unit Model and Distribution of Remaining Oil in Fluvial Sandstone Reservoirs of the Guantao Formation in Gudong Oil Field [J]. Petroleum Exploration and Development, 2000, 27(6): 520-526.