Water Quality Control Technology of Sewage Treatment in Nanpu Oilfield

Guangbo Ma[1,*], Guohua Luan[2], Haoyang Li[3] and Mingjie Shi[2]

1 China National Petroleum Corporation Jidong Oilfield Branch, Tangshan City, Hebei Province, Caofeidian District 116.
2 CNPC Research Institute Of Safety&Environment Technology, Beijing City, Block A12, West Petroleum Technology Park, Xishantaxi, Shahe Town, Changping District.
3 China University of Petroleum，Beijing City，Changping District House Xue Road on the 18th.
E-mail: shpeng@cc.ctu.edu.tw

Abstract. An oilfield sewage treatment process during use often cannot continue to have good adaptability. (An oilfield sewage treatment process couldn't possess a good adaptability when putting into use.)The new equipment and new process should not be introduced fragmentarily to solve the existed problems since the sewage treatment equipment has been put into operation. Starting from the whole, many aspects should be treated such as the management standard, the operation mode, technological transformation and optimization of reagent, etc. in order to realize overall upgrade of sewage treatment system.

1. Introduction

Nanpu Oilfield which belongs to the marine oil using land drilling oilfield is located in the Bohai Sea[1]. (Nanpu Oilfield is located in the Bohai Sea, which belongs to the marine oil using land drilling.) There are 5 water treatment stations located in NP1-1D, NP2-3LP, NP3-2LP, NP403X1LP and NP4-2D, including 1 sewage treatment station and 4 water treatment stations. The summary of each water treatment station is shown in Table 1.

Table 1. Statistics of water treatment stations in Nanpu's operating area.

Serial number	name	Process	Water quality	Processing capacity	Remarks
1	NP1-1D Sewage Treatment Station	Flotation degreasing + 3-level filtration	B1	9600 square / day	flotation degreasing + 2-level filtration before 2014
2	NP2-3LP water treatment station	Single-stage dual filter filtration	B1	1700 square / day	
3	NP3-2LP water treatment station	Single-stage dual filter filtration	B1	400 square / day	
4	NP403X1 water treatment station	Fine membrane filtration	A1	800 square / day	
5	NP4-2D water treatment station	Fine membrane filtration	A1	800 square / day	

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The sewage treatment station in Nanpu Oilfield undertakes the water treatment and supply of the No. 1 construction. Its daily processing capacity is much higher than the other four water treatment stations[2]. Compared with the water treatment station, NP1-1D sewage treatment station has the following three characteristics: First, The qualification rate of water quality in sewage treatment system is much lower than the qualification rate in water treatment system; the second is the suspended solid particles and qualified rate of median diameter in the output water are lower than the qualification rate of oil content; Third, the water quality in sewage treatment system has obvious volatility[3].

NP1-1D sewage treatment system is mainly responsible for water supply task of the No. 1 construction. The current formation pressure maintains less than 0.8. Compared with the water treatment, sewage treatment is trapped in the low qualified rate of the suspended solid particles and median diameter, the large fluctuations of the water quality in sewage treatment system and the situation that water quality is difficult to be guaranteed during water injection. Therefore, it has important practical significance to study and find new ways to improve the effect of sewage treatment[4].

2. The Main Process of NP1-1D Sewage Treatment

NP1-1D sewage treatment system adopts flotation degreasing and two-level filtration in the early production, which includes the main process and auxiliary process. The main process achieves the coagulating sedimentation of sewage, flotation degreasing and filtration. The auxiliary process achieves drug injection, system backwash and pollutant recovery. After the oil-gas-water mixture is separated by the three-phase separator, the oil-contaminated water enters the receiving tank and reaches the buffer tank by flotation degreasing and coagulation settling. Finally the water reaches the treated water tank for external output after being filtered through two stages. The flow chart of sewage treatment system is shown in Figure 1.

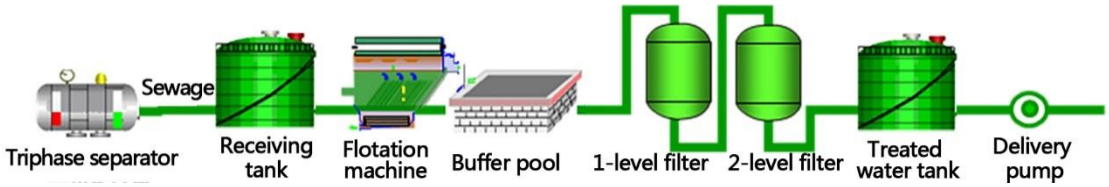


Figure 1. NP1-1D The flow chart of sewage treatment system.

With the continuous development of Nanpu Oilfield, the source of sewage in the system has been increased and the water quality has changed obviously. [5] After four years of operation, the circulating volume of internal sludge continues to increase and the operating efficiency of each equipment decreases. The original process structure, operating parameters and pharmaceutical selection have been unable to meet the requirements of the current water quality.

3. Improvement Measures and Application of Sewage Treatment System

Focused on the problems of NP1-1D sewage treatment system, we have made treatments through the aspects of the management standards, management models and process optimization in order to improve the efficiency of the equipment and achieve the system's overall upgrade. [6]

3.1. Standardization Management

According to the company's water-quality management principle of "taking control of the source, controlling by stages, strengthening the monitoring and ensuring compliance", the segmented assessment system of water quality has been established. The water treatment system is divided into seven sections and the water quality standards for each section are formulated. In the meantime, nine improvement measures are analyzed and formulated to achieve the goal of controlling water quality, take measures on the management of water quality, and strive to form a long-term mechanism. [7]

3.2. Implement the Model of Note Management

Based on functional division, the model of node management is implemented[1]. According to the independence and synergy of sewage treatment facilities, the system is divided into crude oil dehydration zone, sewage sedimentation zone, sewage filtration zone and output zone. The four-node water quality standard in Table 2-1 is formulated. By improving each module's qualified rate, this model of node management maximizes the efficiency of the sewage treatment system. System node is divided as shown in Figure 2.

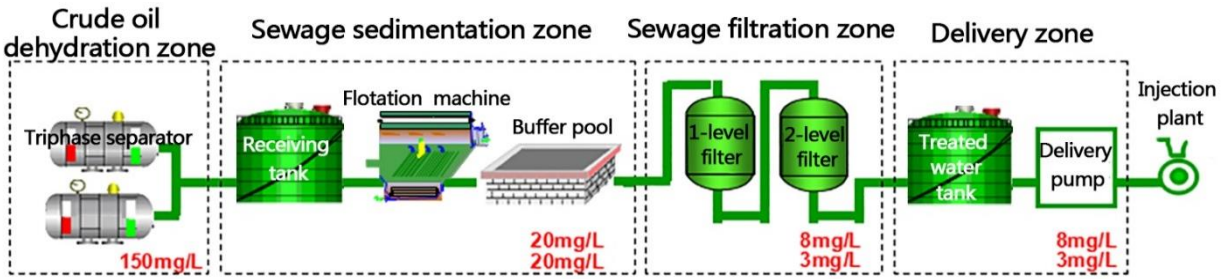


Figure 2. Node Partition map of sewage treatment system

Table 2. Node water quality standards of sewage treatment system.

	crude oil dehydration zone	sewage sedimentation zone	sewage filtration zone	outp ut zone
Oil content（mg/L）	150	20	8	8
Suspended particle content （mg/L）	/	20	3	3
Diameter of suspended particle（μm）	/	/	2	2

3.3. Carry Out Optimization and Transformation of Process

Following the principle of node control, the main process facilities and auxiliary process facilities of the node module are transformed to improve the qualified rate of node water quality.

3.3.1. Crude oil dehydration zone. The function of crude oil dehydration zone is liquid separation dehydration, including three-phase separator dehydration process and de-emulsifier injection process, in which fluid quality and oil-water separation effect are the core elements. In order to improve fluid quality and oil-water separation effect, this node takes four measures: the first is to implement the policy of liquid approval system and control flushing wells, rainwater and industrial sewage into the collection and transportation system; the second is to control the three-phase separator's operating parameters, adjust the oil-water interface and water level to improve the separation Quality; the third is to install stirring device of de-emulsifier to achieve uniform concentration of drug; the fourth is to optimize the amount of de-emulsifier by controlling the oil content of effluent and adjusting the injection concentration.

Through the optimization, the dosage of de-emulsifier is gradually adjusted from 500kg / d to 250kg / d. The oil content of effluent is controlled within 50mg / L which is far below the index of 150mg / L.

3.3.2. Sewage sedimentation zone. The function of the sewage sedimentation zone is to complete sewage receiving, flotation degreasing and coagulation settlement, including receiving tank, flotation machines, buffer tanks and medicament injection systems. The degreasing effect, sedimentation effect and mud-removing effect are the core elements. To enhance the degreasing effect, sedimentation effect and mud-removing effect, the node carries out the measures of process infrastructure maintenance and pharmaceutical compatibility test: The first is to replace flushing wheel in buffer tank, optimize automation control parameters of flotation machine, implement artificial silt-removing and mud valve replacement of receiving tank; the second is orthogonal test designed by using water

purification agent, flocculant and coagulant. The best treatment effect is the use of 50mg / L water purification agent, 60mg / L flocculant and 50mg / L coagulant resulted from sampling three-phase water and analyzing turbidity indicators.
Through facilities maintenance and pharmaceutical research, it greatly reduces the amount of circulating sludge in the system and lowered the turbidity of the effluent from the sedimentation zone. The oil content and suspended solids in the effluent are strictly controlled within 20mg / L.

3.3.3. Sewage filtration zone. Sewage filtration zone includes 1-level dual filter, 2-level fiber bundle filtration. Due to filtration system is the end of sewage treatment equipment, water quality must meet the B1 standard. However, there are a series of problems during the operation, which are the poor filter effect, the serious filter leakage, the incomplete backwash, the filter board knot and short regeneration period of the filter. In order to improve water quality, system maintenance and optimization have been implemented.
Through the equipment maintenance and filter replacement of 1-level dual filter, 2-level fiber bundle filtration, the suspended solids content and the median diameter in the output water have been significantly reduced. The qualified rate of water quality has increased from 80.9% to 92% with 6 months of validity.
Through the research, it is found that 1-level filter is poor because of small cloth area and fast water flow caused by irrational fabric structure, leading to poor filtration and backwashing. The 2-level filter is poor because the traditional fiber bundle filter has been unable to meet the demand, which needs to be replaced by a new filter. For the existing problems, the following aspects have been restructured: the water distribution mechanism of the filtration system, the type selection of the filter material and the overall layout. The first method is to replace the screen tube with a radial-shaped wire tube to increase the cross-sectional area of water distribution and improve the effects of filtering and backwashing; the second method is to use modified fiber ball filter instead of fiber bundle filter to improve the filtration effect; the third method is to change the four 1-level filtration into a 3-level filtration to improve filtration accuracy and system stability. Comparison chart of dual filter before and after the transformation is shown in Figure 3.

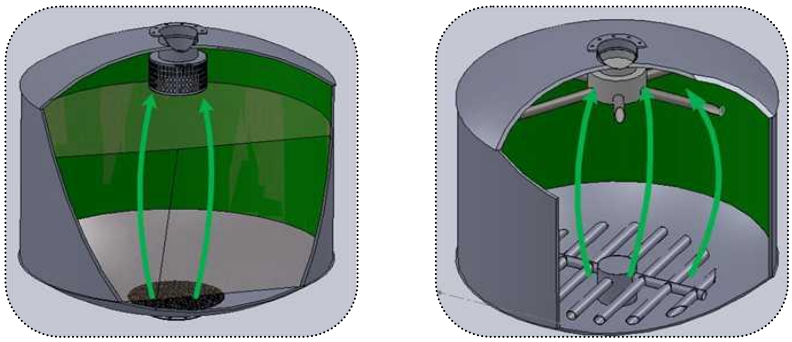


Figure 3. The comparison chart of dual filter before and after the transformation.

Through the optimization and transformation of filtration system, the problems of the filter board knot, short regeneration period of the filter, poor effluent effect and unstable water quality are effectively solved. The suspended solids content and the median diameter of the output water have been obviously decreased.

3.4. Treatment Effect
By standardizing management standards, implementing node management mode and carrying out technological transformation measures, the qualified rate of water quality of output water B1 in the sewage treatment system has been raised from 80.9% to 100%. There are 11 consecutive months which have achieved the standard stably and 7 of which reached standard A2. The comparison chart of water quality in NP1-1D sewage treatment system before and after treatment is shown in Figure 4:

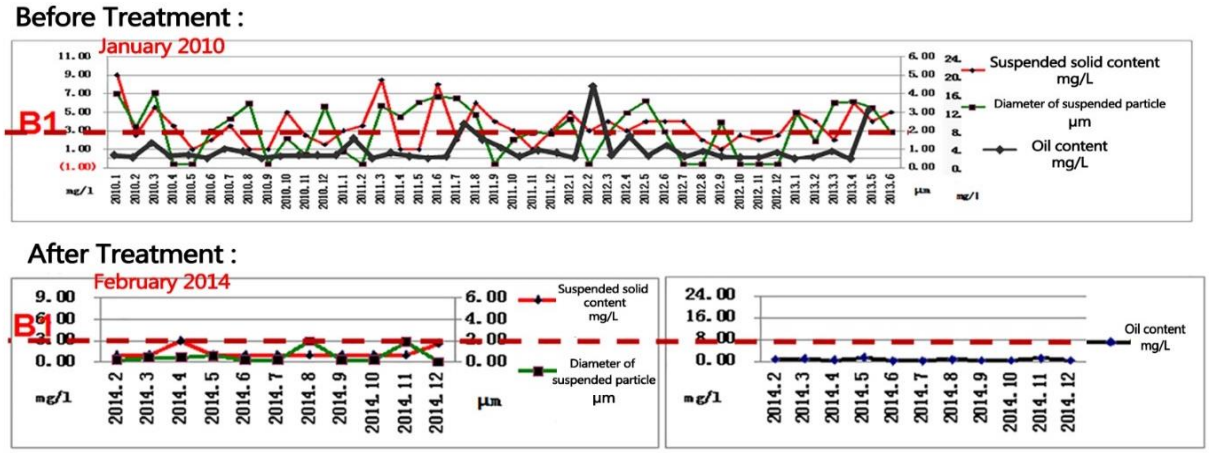


Figure 4. The comparison chart of water quality in NP1-1D sewage treatment system before and after treatment

4. Conclusion

Firstly, the management system, operating mode and process optimization should be proceeded at the same time to upgrade system in the face of the problem of poor output water quality in sewage treatment system.

Secondly, the node management mode should be innovated based on functional division and the maximum efficiency of the sewage treatment system could be achieved by improving the qualified rate of each module.

Thirdly, the transformation of the system must rely on the current facilities. At the beginning, the process improvement within the system should be set out in order to achieve the desired treatment effect without adding new equipment.

Finally, the management of sewage treatment system must pay attention to every step. The filter replacement, tank dredging, equipment maintenance and pharmaceutical optimization should be carried out periodically.

5. References

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