



## ARTICLE

# An Inquiry into the Application and Preparation of Surfactant in Oil Field

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### ABSTRACT

As a commonly used chemical agent, surfactant is used to improve the efficiency of oil-and-gas exploitation. Since the conventional surfactant technology fails to meet the requirements of oil-and-gas resources exploitation currently, this paper deeply researches on the studies of cutting-edge technology of oil-and-gas exploitation, and learns the advanced experience from foreign countries. It aims to point out that the needs of China's demand for oil-and-gas exploitation can be met with through technology innovation, preparation methods improvement and key technology mastery of surfactant in oil field.

## 1. Preface

With the increasingly rising of China's economy, the manufacturing and industry develop rapidly. The development of all industries cannot do without plenty of energy, especially the oil-and-gas resources. China's oil-and-gas resources mainly rely on imports. Up to now, the development of oil-and-gas resources in China mostly features in complex fault block storage, which is difficult to exploit. Due to many complex reservoirs fail to meet the production demand with conventional technology, the oil-and-gas resources are not fully utilized in China. Although the use of surfactant can improve the efficiency of oil use, the original surfactant technology may not meet the requirements. As a result, it is essential to develop and then further improve a new surfactant system.

## 2. Analysis of the Application of Surfactant in Oil Field

The application of surfactant used in oil field needs to be analyzed in combination with the present situation, and a new preparation scheme should be made before the preparation of new type surfactant:

### 2.1 Researches on New Type Surfactant

This new type surfactant is mainly to study the structure, synthesis, compound preparation and industrialization of surfactants. The scheme of the active surfactant is mainly to design the overall structure of the surfactant by means of theoretical analysis, molecular simulation and model compound technology. Moreover, the main task is to design efficient molecular

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structure of salt-resistant surfactant, through which the compound system of surfactant with salt resistance can be established. In this case, it can evaluate the performance of surfactants, optimize the structure of products through product quality inspection. After a successful experiment, the industrial production equipment can be picked out to industrialize the surfactant [1].

## 2.2 Preparations of New Type Surfactant

There are many ways to prepare this new type surfactant. Firstly, the preparation process of new type is more complex, which requires a detailed overall planning to study some contents of surfactant, especially molecular design and synthesis. Secondly, the active surface involves the interdisciplinary knowledge of many fields and disciplines, especially the integration of theoretical chemistry, physical chemistry, organic synthetic chemical engineering and so on. Not only that, in order to improve the oil recovery efficiency and reduce the waste of oil-and-gas resources, the most outstanding characteristics should be innovative, especially in technology [2].

## 2.3 Performance Advantages of New Type Surfactant

The performance of the new type surfactant is much better than that of the conventional type. Firstly, the new type adopts the present synthesis technology, designs the highly effective surfactant molecular structure, optimizes the process parameters, and conforms to the green scientific design. Secondly, the solubility and interfacial tension of the new type were optimized based on the original fundamental conditions. Moreover, the new type is also calcium-and-magnesium resistance, which can improve the oil displacement performance. In addition, the new type has little payable losses, which can improve the oil recovery efficiency of surfactant [3].

## 3. Preparation Project of New Type Surfactant

To develop a preparation project of the new type surfactant, we must have a full understanding of the oil field. It is essential to strengthen technological innovation to improve the efficiency of production.

### 3.1 Structure Design of New Type Surfactant

The structure design of new type must meet higher standards. Due to the imperfect interaction theory be-

tween surfactant and crude oil, it is difficult to design the molecular structure of surfactant. The molecular structure should be designed by means of molecular simulation, theoretical analysis and model compounds, and the "structure-activity relationship" should be completely designed. In the designing process, alkyl benzene sulfonate and alcohol ether sulfonate are used as the main structural objectives, which can optimize the length-and-branching structure of lipophilic end carbon chain, and the length and arrays of ethoxy and propoxy. In the process of design, the molecular structure of the surfactant with high efficiency and salt-resistance is the design goal, and a modern synthesis technology is used to optimize the process parameters to ensure the surfactant performance in the interfacial tension and energy [4].

### 3.2 Compounding System of New Type Surfactant

For both the compounding system and the molecular structure of this new type surfactant are more complex, we should give full play to the advantages of different surfactant, and ensure the requirements of compounding mechanism and law in the process of compounding. In particular, it is necessary to study the interaction mechanism and law with cheap sulfonate surfactant, which can reduce the cost. In order to give full play to the advantages of different oily surfactant, it is necessary to study the parameter equilibrium relationship among the interfacial tension, thermal stability and adsorption performance of surfactant, so as to form surfactant with high temperature and salt-resistance. A new type of active agent can be developed with help of the green raw material with low cost and the green synthesis circuit [5].

### 3.3 Performance Evaluation of New Type Surfactant

The requirements for the performance of new type surfactant are higher and more diversified. Firstly, we need to design a project to test the solubility, interfacial tension, calcium and magnesium resistance of new type surfactant. Secondly, it is essential to strengthen the simulation test of compatibility with polymer, thermal stability and repair loss. In addition, it is also necessary to evaluate the regional performance of salt-resistant surfactant under reservoir conditions. By means of the preparation of perfect laboratory reaction and verification of experimental results, the formula and process parameters were further optimized to study the influ-

ence of the characteristics of these materials on the reaction process [6].

### 3.4 Industrialization of New Type Surfactant

In case the experimental results of the new type conform to the expected experimental objectives and results, the raw material ratio and process parameters can be carried out in the production process. Some advanced technical equipment can be introduced to improve the product conversion rate of surfactant and reduce the cost of surfactant. Suppose the production cost of surfactant is reduced, the production scale can be expanded and the industrialization of new surfactant can be realized. By improving the relevant supporting industry system of new surfactants, the quantitative production can be realized and a certain market share can be occupied. In the future development process, the industrialization of new surfactants will be further promoted by increasing the technology and capital investment.

## 4. Technical Analysis of New Type Surfactant

We need to analyze the technical difficulties of the new type, and master the key points of this new technology.

### 4.1 Innovative Technologies for the Application of New Type Surfactant

The new type mainly adopts a design of molecular structure with salt-resistance. Due to the high mineral concentration of formation water, it is necessary to develop a salt resistant surfactant. In the molecular structure design, the molecular structure of calcium and magnesium resistance are required as the goal. Secondly, the new surfactant also adopts a green synthesis design of surfactant. By using modern synthesis technology, the arrangement of molecular structure is optimized, which makes the synthesis process more economical. In addition, a highly effective compound surfactant used can reduce the cost of surfactant and further optimize the performance of surfactant [7].

### 4.2 Analysis of Key Technologies in the New Type Surfactant

Because of the high requirements on the performance of this new type, it is important to grasp the technical points. Mainly, it must be ensured that the tension of synthetic surfactant reaches a certain standard, with salt-resistance higher than 30000 mg / L, and resistance

to calcium-and-magnesium ions of 1800 mg / L. In addition, it should be noted that the interfacial tension requirements of surfactant complex system are different from various reservoirs. The interfacial tension of surfactant compound system needs to meet with higher standards. The other salt resistance is consistent with the resistance to calcium-and-magnesium ions. In addition, it also needs to meet the requirements of thermal stability and adsorption capacity.

### 4.3 Technical Difficulties of New Type Surfactant

Due to the complex petroleum system, the structure of surfactant is complex and diverse, the technology of new surfactant is difficult in the aspects of molecular structure, synthesis route and complex surfactant system:

#### 4.3.1 Technical Difficulties in Designing the Structure of New Type Surfactant

The main technical difficulty of the new surfactant lies in the structural design technology of the new type. It is more difficult to design the molecular of the surfactant which calls for stronger salt-resistance. Moreover, the interaction theory between surfactant and crude oil is not perfect, which are still not confirmed in the design. Molecular simulation needs to use molecular simulation theory to analyze model compounds and other means to analyze the structure relationship of surfactants. Thus, it is important to optimize the length of the carbon chain at the lipophilic end and the length and arrays of the molecules [8].

#### 4.3.2 Difficulties in Reducing the Cost of Surfactant

The increase in the cost of surfactant is due to the complex structure of the new surfactant compound system, which is widely used in oilfield exploitation and application, and can be used in all aspects of oilfield development. This brings about the difficulty in lowering cost. The solution lies in improving the synthesis technology of surfactant and expanding the source of surfactant raw materials. On one hand, green raw materials and newly developed catalysts are selected for the green process of new surfactants and the synthesis route of surfactants, which has high economic benefits. On the other hand, it can be solved by expanding the source of surfactant raw materials and some cheap raw materials

with extensive sources. Some ideal raw materials for surfactant have been found in China [9].

### 4.3.3 Difficulties in Designing the Performance of New Type Surfactant

Based on high requirements, the performance of new surfactants needs to be diversified. The high temperature resistance of oily surfactants needs to be improved in addition to its salt resistance. As the depth of oil field is increasing, the high temperature resistance of surfactant also needs to be improved. Besides, under different conditions, the concentrations of calcium and magnesium ions are different. It is necessary to give full play to the multiple performance of oily surface area with stability, sterilization and adhesion to soil. Because the structure of surfactant is very complex, it is not enough to rely on a single surfactant to drive oil. Some efficient compounding technology is often adopted to fully play the advantages of different surfactants and avoid disadvantages.

## 5. Application of Surfactant in Different Links of Oil field Exploitation

Surfactant can be used with large amount in many production links of oilfield exploitation, such as drilling and oil extraction. So it is important to analyze the application in different links:

### 5.1 Analysis of Application in Drilling

The surfactant used in drilling is called drilling fluid, which is also known as a complex chemical fluid. It is composed of a variety of chemical treatment agents. Firstly, it is the fluid loss additive, which may cause wall collapse in drilling. In order to reduce large-scale filtration water, this kind of fluid loss additive is widely used in deep wells, special wells and complex wells. For most of the oil exploration conditions are complex, increasing depth of drilling, the traditional drilling cannot meet the needs of operation. Viscosity reducer is a new type of viscosity reducer which can resist high temperature and salt. Another emulsifier is also a kind of drilling fluid which has a wide range of benefits, mainly for unstable drilling formation conditions and some deep drilling geological conditions [10].

### 5.2 Application in Oil Extraction

Surfactants are often employed in oil extraction. In case the phenomenon of water production occurs, two

kinds of surfactants, water shutoff agent and non-selective agent, can be used. According to different water layer conditions, non-selective water shutoff agent can be selected if it is a single water layer or a higher water layer. This kind of water plugging agent can effectively reduce the surface tension of water, with a higher effect on the water plugging. In addition, another kind of acidizing surfactant may also be used in the process of oil extraction. This surfactant is mainly used in the process of dissolving rocks and expanding oil-and-gas reservoirs, which can delay the rate of acidizing. In addition, surfactant for oil displacement is widely used in the stage of crude oil exploitation. Currently, for this kind of surfactant cannot meet the demand, it is necessary to improve the salt resistance and efficiency of oil extraction.

### 5.3 Application in Oil Transportation

Surfactant also plays an important role in the transportation of crude oil. The main applications are weak solvent for emulsified crude oil and viscosity reducer for crude oil gathering and transportation. The fluidity of crude oil needs to be changed for the transportation difficulty will be increased for the crude oil transportation conditions of high viscosity and poor fluidity. The use of emulsified viscosity reducing surfactant, a water-soluble surfactant, can change the tension of crude oil. This method is advanced in lower cost, larger-scale use, and more convenience.

## 6. Conclusion

Some natural advantages in the natural environment need to be utilized. But we should live in harmony with this natural resource, save energy in the environment and reduce dependence on imported oil and gas resources. We should correctly use this kind of oil and gas resources, reduce the waste of oil and gas resources in the process of exploitation, and correctly apply the oil and gas resources to the industry and manufacturing industry. In particular, we need to pay more attention to the resource exploitation in these fields than before, to the upgrade technology in the preparation process of surfactants, and take every opportunity to exchange and study abroad to enhance the independent research ability of technicians. Meanwhile, we also hope that the government and enterprises will increase investment to help us master the core technology of surfactant.

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