Study on the Land Reclamation of Oilfield of Gurbantunggut Desert in Junggar Basin

Liang LI[1]*, Xuezhong ZHENG[2], Xusheng SHAO[3], Caichuan WANG[3], Min Xu[3]

1. PetroChina Xinjiang Oilfield Development Company, Karamay 834000, China; 2. PetroChina Xinjiang Oilfield Company, Karamay 834000, China; 3. Beijing Geo. &Inv. Engineering Institute, Beijing 100083, China

Abstract The exploration and development of oilfield results in damages to land resources. Along with the further development of petroleum in the Gurbantunggut Desert, the fragile ecological environment and land resource was suffering much more damage. Vegetation degradation and desertification become more prominent. In response to the damage to the fragile ecological environment and oilfield in the Gurbantunggut Desert, limit condition method was used to evaluate the suitability of land reclamation suitability. Results suggested that the main restraining factors for land reclamation were soil condition and water resources. Based on the effect and shortage of oilfield in the Gurbantunggut Desert Oilfield, the reclamation of oilfield in the Gurbantunggut desert was discussed.

Key words Gurbantunggut desert, Oilfield, Land reclamation

1 General situation

The Gurbantunggut desert, the second largest desert in China, lies in the center of Junggar basin, east of Manasi River and south of Wulunguhe River. As the largest tixed and semi-fixed desert in China, the Gurbantunggut desert covers an area of 4.88×10^4 km^2 at an elevation between 300 and 600 m. The annual precipitation is between 70 and 150 mm. Most places within the desert were fixed and semi-fixed dune.

The hinterland of desert has rich oil and natural gas. There are Luliang, Shixi, Shinan, Mobei, Shanan and Kelameili oil and gas field within the desert. So far, the development of oil and gas within the desert has achieved certain magnitude. The damage to the land resource has seriously affected the fragile ecological environment. Vegetation degradation and land desertification became more prominent. How to effectively carry out the land reclamation of oilfield has become a very important subject in the work of oilfield production.

2 Natural geological characteristics

2.1 Meteorological and hydraulic characteristics The Gurbantunggut desert is influenced by typical temperate inland desert climate. It is dry and hot in summer and cold in winter. There is little precipitation, and large evaporation. The average annual precipitation in the desert is 123.4 mm. Precipitation . falls the most in summer, about 46.1 mm, which accounts for 37.4% of annual precipitation, while precipitation falls the least in winter, only 16.5 mm, which accounts for 13.4% [1] of annual precipitation.

2.2 Soil characteristics The soil in the desert mainly includes aeolian sandy soil, takyr and brown desert soil, *etc*. The sandy soil develops from aeolian sandy parent material. Most particles are fine sands and there are few sticky particles. The organic materials seldom accumulate. There is slight differentiation when the soil surface is 0.5 to 1 cm thick.

Precipitation is stable in Gurbantunggut desert and it would snow in winter. The rainfall and melted snow provide certain amount of water to the sand. The moist sand would keep plants survive in dry season and provide condition for the growth of plants.

2.3 Characteristics of plants The underground water is deep in the Gurbantunggut desert. Plants have to depend on the precipitation, and water in the moist sand. The major plant in the desert is temperate desert. There are more than 200 kinds of plants in the entire Gurbantunggut desert[2,3]. The most common vegetation is arbor, perennial grass, biennial grass and annual grass, as well as ephemeral plants such as Mongolian calligonum herb with fruit, sedge, *etc*.

The melted snow in spring intensified the humidity of aeolian sandy soil, which is conductive to the fast germination of plants in spring, among which the ratio of annual plants is the largest one. The arbor and grass covers less than 10% of most dunes during April and June. The coverage of ephemeral plant is between 13.9 and 40.2%.

2.4 Types of land use The land types in the desert are simple, mostly sandy land, grass land and forest.

3 Characteristics of the damage of oilfield development to the land

Compared with production projects in mountains, the damage of oilfield to land resources is complicated.

Firstly, the well field, road and station occupy large area of land resources. This would destroy the original vegetation com-

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* Corresponding author. E-mail: 281425658@qq.com

pletely and disturb the soil structure in the Gurbantunggut desert. The original stable surface is affected and the possibility of aeolian erosion intensified.

Secondly, the construction of pipeline requires a ditch of 2 m deep. The placement of cars and pipelines would damage the soil structure and lead to the destruction of vegetation and sandy soil.

Thirdly, the pollutants would penetrate and disperse to the underground, which would change the normal structure and component of soil.

Fourthly, in the development and construction of oil field, the sewage from drilling and washing leads to pollution of underground water, soil, vegetation and agricultural ecology.

4 Evaluation of soil reclamation

4.1 Choice of evaluation method Considering the characteristics of Gurbantunggut desert, extreme condition method was applied to evaluate the adaptability of soil reclamation in the mining area.

The formula is . The is the final value of the ith unit. The is the score of the jth factor in the th unit.

4.2 Division of evaluation unit The specific land type is used as division unit. The destroyed land type within the project is sandy land and other grasslands.

4.3 Choice of evaluated factors Based on the investigation, four factors that may influence the reclamation were analyzed, namely the effective soil thickness, soil structure, soil organics and irrigation condition. Evaluation model was constructed.

Firstly, the soil component (soil structure, soil organic material, and effective soil density) directly influences the choice of species and is the most decisive factor. Secondly, the irrigation condition is the most important factor for the growth of plants.

According to the classification standard for the suitability of agricultural husbandry, there are four levels, first level (very suitable), second level (suitable), third level (barely suitable), fourth level (inappropriate). The exact plan is shown in Table 1.

Table 1 Standard of agriculture, forestry and husbandry

Division of limiting factors		Agriculture	Forestry	Husbandry
Organic materials in soil(g/kg)	>10	First level	First level	First level
	10 – 6	Second level or Third level	First level	First level
	<6	Third level or inappropriate	Second level or Third level	Second level or Third level
Soil structure	Loam	First level	First level	First level
	Clay, sandy soil	Second level	Second level	Second level
	Heavy soil, sandy soil	Third level	Third level	Third level
	Sandy soil, gravel	Inappropriate	Inappropriate	Inappropriate
Irrigation	Dry and semi-dry land with stable irrigation condition	First level	First level	First level
	Dry and semi-dry land with good irrigation condition	Second level	Second level	Second level
	Dry and semi-dry land with poor irrigation condition	Third level	Third level	Third level
	No irrigation condition	Fourth level	Fourth level	Fourth level
Effective soil density(cm)	>100	First level	First level	First level
	99 – 60	Second level	First level	First level
	59 – 30	Third level	First level	First level
	30 – 10	Inappropriate	Second level	Second level
	<10	Inappropriate	Third level	Third level

4.4 Evaluation result of land suitability The project is in the bordering of desert and hinterland and the major limitation factor is soil condition and water resources. The well and surrounding soil type is aeolian soil and the content of organic material is low. The biological effect is weak, which leads to less organic materials and weak soil process. The content of organic material is higher than the lower one. The microbiotic crust is an important mater that fixes the sand. The content of organic matter is low, between 0.1 and 2.3 g/kg. There is no ground water source in the well and the underground water is very deep. The land coverage is low in the project area. The measured value of evaluated factor is shown in Table 2.

By dint of extreme method, the result of evaluation on the suitability of land reclamation is obtained based on the comparison of land quality, irrigation condition and evaluation standard within each reclamation unit.

Table 2 Observed value of evaluation factor of the suitability of reclamation

Evaluation unit	Evaluation factor	
	Sandy soil	Other grassland
Soil organic materials	– –	0.1 – 2.3g/kg
Soil structure	Sandy soil, gravel	Sandy soil, gravel
Irrigation condition	Poor	Poor
Effective soil density	<10cm	<10cm

According to the above evaluation result, the land suitability is of the fourth level. The development of oilfield is mainly in the hinterland of desert. The deteriorating geological environment and fragile land resources are difficult to recover. The soil condition and water source limited the land reclamation.

The soil in the desert is mainly aeolian soil. The biological effect is weak, which leads to less organic materials and weak soil

process. The content of organic material is higher than the lower one. The microbiotic crust is an important mater that fixes the sand. The content of organic matter is low, between 0.1 and 2.3 g/kg. Once the surface soil structure and ground vegetation is destroyed, it is easily to cause desertification.

The vegetation in the hinterland of desert is mainly desert plants who can withstand tough weather.

4.5 Determination of final reclamation orientation The project is in northwest China. The natural environment is poor and land use is simple. The destroyed land is sandy land and other grassland. The suitability of reclamation unit is in the fourth level. Considering the actual situation and existed reclamation, the final reclamation is the original ecological sightseeing and sand prevention.

Table 3 Evaluation result of the suitability of reclaimed soil

Evaluation unit	Crops		Forestry		Husbandry	
	Level	Limited factors	Level	Limited factors	Level	Limited factors
Sandy land	Fourth level	Soil and irrigation condition	Fourth level	Soil and irrigation condition	Fourth level	Soil and irrigation condition
Other grassland	Fourth level	Soil and irrigation condition	Fourth level	Soil and irrigation condition	Fourth level	Soil and irrigation condition

5 Conclusions

In response to the fragile ecological environment in the Gurbantunggut desert and the influence of oilfield on land resources, and considering the achievement and mistakes in the reclamation of oilfield in the Gurbantunggut desert, the reclamation of oilfield in the Gurbantunggut desert is concluded as follow.

Firstly, generally speaking, the decision - maker of the oil company should be aware of the environment protection and create a pleasant atmosphere. The land protection should start from scratch. The importance of land reclamation needs to be emphasized so as to make more people aware of environment protection.

Secondly, during the design of oilfield development and actual construction, designers should try to avoid the arbor forest, well field and station as much as possible. While drilling, the penetration of mud should be prevented so as to use green water. The original oil should be processed in time and the polluted soil should be treated by professional companies.

Thirdly, reclamation direction and target should be determined. To recover the original land should be the primary purpose of reclamation. In order to prevent desertification, reed should be planted to solidify the sand and guarantee the coverage.

Fourthly, during the reclamation, various kinds of vegetations should be mixed at corresponding percentage to recover the original vegetation coverage.

Fifthly, the characteristics of natural geology and desert vegetation should be utilized to reinforce the protection of reclamation. The effective protection policy should be built to intensify reclamation. It is feasible to use internet to manage data so as to deal with problems in time.

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