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Research on Oily Mud Treatment

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Abstract:—The oily mud waste is one of the main wastes in oil field production process, which also stands as a critical negative factor that impedes the improvement of oilfield environment. The oily mud, which is rich in oil and black viscous compound in appearance, is the solid waste that comes along with the oilfield production. The oily mud mixture has huge amounts in magnitude, and it contains a certain amount of BTEX, phenol compounds and other organisms that affect the human body and surrounding animals and plants. Hence it is necessary to operate appropriate disposal and achieve a lower negative effect to the environment. The current prevailing method for waste treatments is harmless and resource utilization, including the extraction separation technique, hot water-washing method, demulsification method, carbonization, incineration, and biological treatment.

Keyword:— oily mud, waste treatment, harmless, comprehensive utilization.

I. INTRODUCTION

The oily mud of oil field pollutes the environment without effective treatment. After the oil goes into the soil to form oily mud, it is difficult to remove oil from the soil. This will lead a carbon and nitrogen ratio imbalance and pH value changing. On the other hand, the soil structure and condition are destructed and soil microorganisms and the soil itself plant ecosystem are harmed [1]. It is important that some polycyclic aromatic hydrocarbons (PAH) are carcinogenic and mutagenic substances threaten the survival of mankind and health. Therefore, it is necessary to research on the harmless treatment. As an extremely stable emulsion of the suspension system, the composition of oily mud is extremely complex. It contains a large number of aging oil, waxy, asphaltene, colloid, suspended solids, bacteria, salts, acid gases and corrosion products. In addition, there are abundant flocculants, corrosion inhibitors, scale inhibitors, and fungicide in the system. Oily mud treatment and recycling is one of the problems in oil field chemistry because of complex composition and difficult separation [2]. The principles of oil oily mud treatment are quantitative reduction, resource and harmless. In this paper, an overview is presented with advices on application of these oily mud treatment technologies.

II. COMPREHENSIVE UTILIZATION

A. Thermal Decomposition

Thermal decomposition is a modified method of high temperature treatment of oil sands. Hydrocarbons and organic matter of oil sands are dissociated by heating without oxygen. With rapid development, this technology is applied to oil fields broadly. Wang, et al[3] observed some influence factors of oil sands thermal decomposition, including a heating rate, the final temperature of thermal decomposition, regional holding time and catalysts. The results showed that the thermal decomposition of oil sand started at 200℃ and the maximum of the decomposition rate occurred from 350℃ to 500℃. Higher temperature, longer regional holding time and more catalyst addition can accelerate thermal transition. Keeping 400℃ for 20 minutes, it does not only increase the oil production rate, but also improves oil quality. Shie, et al. transmitted oil sands to useful resources such as small molecular compounds and carbonaceous residues by heating N_2 [4]. They explored that potassium compounds and sodium compounds impact thermal decomposition of oil sands. They found thtat the the additive order of increasing the conversion rate is K_2CO_3>KOH>NaOH>Na_2CO_3>KCl>NaCl>no additive. They supplied a large amount of useful information to the oxidation thermal decomposition processing system of oil sands by their kinetic equations.

The thermal decomposition technology is a new harmless treatment method of oil sands with high technological content. Although it highly requires more elaborate reaction conditions with difficult operations, this technology still has great potential. We need do more research work on thermal decomposition.

B. Making Brick

Shie J L, et al. used oil sands to make environmentally acceptable bricks [5]. They studied plasticity of oil sands and other brick materials. In addition, the most of toxic metals were immobilized in toxicity and leaching tests. The bricks made by oil sands have high compressive strength. Mansurov, et al. [6] heated the oil sands until the organic components reduced to 15%-20%. Then they mixed solid residue of oil sands, asphalt, concrete and stones as roadbed materials.

III. HARMLESS METHOD

C. Bioreactor

A bioreactor can mix the oil sands and substrate to the slurry and manual optimums of the oxygen, temperature and nutriment, which make the biodegradation faster than other biological treatment. In addition, the tamed effective oxidizing bacteria can speed up the biodegradation .The oil recovery has adopted the Preheat- Solvent Extraction technology, so most of microorganisms keep inactivate, which handicaps the bioremediation . Guo [7] reported that the microbial population could be enhanced by the addition of the solid microorganisms, and then the nutriment and the living condition was adjusted, such as the soil, fertilizer, water and pH. The result showed that the amount of soil is the important factor and the removal reached more than 49% after sixty days treatment when the initial concentration of total petroleum hydrogen was 20.6~22.3

g/kg .And the optimum condition was the 10%~20% soil, 5% fertilizer, bacteria 5% (wet weight), water 30% (base drying) and Ph 7.0 . Shi [8] reported that in a Shengli Oil Field the dewatered oil sands of 960 m3 were treated by indigenous and new soil microorganisms with bioremediation. Furthermore, the result showed that 52.75% was degraded at room temperature in comparison with the 15.46% degradation without bioremediation. Gallego [9] researched the co-metabolism, emulsifying property, colonization and degradation, and then the microbial population was developed .The microbial population was made of four microorganisms (three are kinds of bacteria and one is yeast), and could degrade chain hydrogen deeply (100%), the ring hydrogen(85%), branch chain hydrogen (44%), aromatic hydrocarbon and sulphur-aromatic hydrocarbon (31%~55%).

D. Composting

The composting method places the oil sands and appropriate material for a period in order to degrade petroleum hydrocarbons with natural microbial. This method needs oxygen, bacteria and nutrients provided. For keeping soil loose, the filler is necessary, too [10]. Ling, et al. [11] ascertained the ratio of oil sands and polluted soil by their experiments. They estimated the composting method efficiency and affecting factors of biodegradation. Six experiments were performed at the same size composting boxes, respectively. There was 5 kg soil in each composting box at 23~25℃. The mass ratio of oil sands and soil was 1:0.1, 1:0.3, 1:0.5, 1:0.7 and 1:1, respectively. The data showed that petroleum hydrocarbons biodegradation was improved.

E. Carbonization

From the 1990s, many refineries used a Mobil carbonization process to treat the substrate sands of the oil-separating tank. The carbonization technology is actually a depth heating method on cycloalkanes, alkenes, colloid and heavy bitumen of oil sands. Under a high temperature, oil sands are thermally cracked or thermally condensed into the liquid phase oil, non-condensable gas and some cokes. The main effect factors of this technology are material properties, reaction temperature, reaction pressure and heating time. Zhao et al. [12] did lots of experiments to confirm the best reaction conditions of oil sands treatment. The data showed that when the reaction time is 60 minutes at 490℃ under normal pressure, the washing oil efficiency is 88.23%. The main productions are gasoline, diesel and waxy oil. According to economic calculations, this technology can be applied in industry.

F. Oily solid Immobilization

In order to transport, use or disposal, immobilization treatment of oil sands is a harmless process by using a physicochemical method to immobilize oil sands or use inertia material to contain oil sands. Mater, et al. [13] used a two-step method to treat oil sands. The result showed that the clay, calcareousness and cement are very effective. Karamalidis, et al. [14] employed a different kind of cement to stabilize and immobilize oil sands. The result showed that oil sands were limited into the cement-based body. Feng, et al. [15] applied cement as a curing agent to immobilize the oil sands. He estimated the environmental safety of cured sands through researching of the compressive strength, COD, oil content and toxic element content of cured sands. The results indicated that the mass ratio of cement and oil sands is 2:1, and the compressive strength can reach 16 MPa, when the mass ratio is 0.972, COD is less than 150mg/L at 50℃ after 12 hours immobilization. As the mass ratio is from 1 to 1.8, the toxic element content achieved emission requires at 25℃ after 120 hours immobilization. This technology can reduce soil erosion and leaching from the hazardous ions and organic matter of the oil sands leading to reducing the environment impact and hazards. With more attention in recent years, this technology is expected to replace the backfill technique.

IV. RESOURCES TECHNOLOGY

G. Thermochemistry

Thermochemistry is an early resource technology to treat oil sands. Because of a high content of waxy material and a strong sensitivity to temperature in the oil sands, the thermochemistry technology heats the oil sands to reduce viscosity and increase the density difference between the oil phase and water phase. Then a certain amount of specific surfactant is added into oil sands in order to destroy the original stable oil-water interfacial film. This makes the original emulsion water droplets to assemble together. Finally, these droplets are separated from oil sands. Chang, et al. [16] developed a new thermochemistry-washing-settling process. This process separates the oil phase, water phase and solid phase first before oil recovery. The oil sands can achieve emission standards for agricultural use by this process.

However, a thermochemistry device is so expensive and operation expenses are too high. In addition, the secondary pollution occurs easily in this process. With improving the thermochemistry device and optimizing the process continually, this technology also has a great application potential.

H. Hot water washing

A hot-washing technology uses hot water to wash the oil sand repeatedly. The hot water has been added to certain amount of alkali (NaOH or Na_2CO_3) and a bit of surfactant which is applied to change wettability of the oil sand to be more hydrophilic. After washing, solid and liquid are separated by air flotation facility. The United States Environmental Protection Agency believes that the hot-washing method should be taken into account to treat oil sand. The best conditions are the hot water at 70℃, a solid-liquid ratio of about 1:2 and washing for 20 minutes. The oil recovery can be 99% under these conditions [17]. The content of NaOH or Na_2CO_3 in the hot water strongly affects washing oil efficiency. The advantages of this method are low cost, high washing oil efficiency and reducing environment pollution obviously. For reducing cost further, the inorganic base or laundry soap powder is applied with good treatment results. At present, this hot-washing technology is used in some oil fields.

I. Solvent Extraction

Using the theory of similarity intermiscibility, this method separates any organic principle from oil sand by choosing a suitable organic solvent as an extractant. Then it employs a distillation technology to extract oil from the extracted liquid. Before applying this method, it is necessary to ascertain a reasonable extraction temperature, a solid-liquid ratio and the type of extractant. Huang [18] used the multistage separation extraction and first order thermo washing method to treat the oil sands. Treated oil sands can achieve emission standards and the extractant can be recycled. Withal, the supercritical fluid extraction technology which is presently studied is a new type of oil sand extraction technology. It uses a high pressure technique to process gaseous methane, ethylene, ethane, propane and other gases to liquid at normal temperature and pressure using liquid as a kind of extractant. This kind of extractant has a high dissolving ability, low density, easy-to-separated and recyclable recycling.

Solvent extraction is easy to operate and can recycle most of oil from oil sand. Moreover, the extractant is recycled. As a result, oil sands can achieve a standard of agricultural sludge. However, the cost of this solvent extraction method is very high with extractant losing in the treatment process. Therefore, this technology is currently only at the research stage in laboratory. With developing a new and cheaper extractant, we believe the solvent extraction method will have a great development and application potential.

V. CONCLUSION

Oil sands are a valuable secondary resource. A large number of oil was recovered from oil sands by effective collection and resource processing. This is not only economic benefiting but also protects environment of oil fields. The huge costs of oil sands treatment are reduced substantially. Thus resource and harmless treatment of oil sands is very necessary and urgent. There are various treatment technologies of oil sands. And these technologies have advantages, disadvantages and scopes of applications, respectively. It is impossible using a single technology to treat all kinds of oil sands because of complex component of oil sands. Therefore, it is very necessary to classify oil sands. It will be an irresistible trend to treat oil sands by resource, harmless and comprehensive utilization.

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