Technology and Application of Salty Slurry Harmlessness Reduction and Resource Utilization Treatment

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Abstract: Salt slurry is a special sludge produced in the process of brine purification in chlor-alkali industry. In order to eliminate the harm of salty slurry to the environment and realize its economic value, a salty slurry harmlessness, reduction and resource utilization treatment method was proposed. Through this method, salty slurry will be transformed into desulfurizer with its water content and Cl^- content reduced to 15% and 0.5% respectively. This method has been applied to projects, bringing environmental and economic benefits.

1 Introduction

Brine purification is an important process in the salt production industry. And the "double-alkali method" or "flue gas method" [1] are often used to purify brine. The basic principle is to put an appropriate amount of CO_3^{2-} and OH^- into brine to transform Ca^{2+} and Mg^{2+} into precipitate to remove these impurities, and the salty slurry comes from this process. Salty slurry is composed of liquid phase and small particles in solid phase, and the main component of liquid phase is brine, and the main components of solid phase particles are CaCO_3 and $\text{Mg}(\text{OH})_2$ and some other insoluble [2]. The production of salty slurry is huge, which contains a large amount of soluble ions such as Na^+ , K^+ , Cl^- . So improper treatment will cause harm to the environment, and at present many salt production companies deal with salty slurry in improper way such as well injection [3], dehydration and storage [4], landfill, drainage into rivers. Salty slurry well

injection is to pump salty slurry back to the brine mine, which will pollute groundwater; landfill will salinize the land and pollute the soil; drainage into the river will cause harm to the river ecosystem. The content of calcium carbonate in the absolute dry salty slurry is more than 80%, so the salty slurry has economic value if it can be effectively used after treatment. There are several ways to recycle salty slurry such as used as coating material [5], used as building material [6], used to produce ceramsite [7], but these methods are currently in the exploration period. the salty slurry can be used as desulfurizer [8].

A salty slurry harmlessness, reduction and resource utilization treatment method was proposed, through which the Cl^- content and water content were reduced greatly and the salty slurry was transformed into desulfurizer. The proposal not only responded to the state's call for environmental protection, but also brought economic benefits to the enterprise.

2 treatment process for salty slurry

Fig.1. Chart of treatment process for salty slurry

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In order to meet the requirements for the use of salty slurry as desulfurizer, a treatment process chart as shown in Figure 1 was formulated. This process includes four main systems: salt mud washing system, salty slurry deep dehydration system, salt mud crushing and granulating system, and heat pump drying system.

The salty slurry washing system adopts three-stage washing and four-stage separation technology, which can reduce the Cl^- content to below 0.5%. The treatments are as follows after the salty slurry enters washing system: First place the salt mud in the washing tank to complete the first sedimentation, and the supernatant liquid is recovered by the brine recovery device to realize the first solid-liquid separation; Add an appropriate amount of water to the washing tank for the first washing, then the second sedimentation and the second solid-liquid separation are performed; Add an appropriate amount of water to the washing tank for the second washing, then the third sedimentation and the third solid-liquid separation are performed; Add an appropriate amount of water to the washing tank for the third washing, then the salty slurry will be sent to the special solid-liquid separation equipment to perform the fourth-stage solid-liquid separation. Cl^- in the salty slurry will be taken away by each washing and solid-liquid separation. After four separations and three-stage washing, the Cl^- content in the salty slurry will be reduced to meet the conditions for use as desulfurizer.

After three-stage washing, the salty slurry will be pumped into deep dehydration system in which the water content of salty slurry will be reduced from 85% to 50% by special solid-liquid separation equipment. However, the salty slurry with 50% water content still does not meet the requirements as desulfurizer, so further drying is needed.

The salty slurry crushing and granulating system is to crush the massive salty slurry with a water content of about 50% into granular particles with a particle size of less than 8mm. The salty slurry crushing and granulating system is set between the deep dehydration system and the heat pump drying system. This arrangement has the following advantages: firstly, it can improve the drying efficiency and save energy; after deep dehydration, the water content of the salty slurry is about 50%, so no dust is generated during the granulation process.

The heat pump drying system is to dry the salty slurry with water content of about 50% after crushing and granulation so that its water content is reduced to less than 15%. The heat pump drying system includes an air source heat pump and auxiliary heat units. A certain number of auxiliary heat units can be turned on or off according to

the temperature requirements, so no heat is wasted.

In addition to the above four main systems, the process has two auxiliary systems: brine recovery system and water recycling system. The liquid generated from the first solid-liquid separation is raw brine, which has great recovery value, so it can be recovered by brine recovery system for salt production. The salt content of liquid from second and third solid-liquid separation is less than raw brine, so it will affect the normal input-output ratio if it is directly used for salt production. Therefore, it will be recovered to the free storage pool through the brine recovery system for brine evaporation until it can be used for salt production. The liquid generated from the fourth-stage solid-liquid separation with very low salt content will be recovered by water recycling system and directly used for the first salty slurry washing.

3 Engineering application example

3.1 Design scale and salt mud parameters

The production of salt and nitrate of Hunan Xiang Li Salt Co., Ltd is 1 million t/a, and the production of absolute dry salty slurry is 13t/d which converted to 80% water content salty slurry is 65 t / d. The design scale of the salt mud treatment project is 80t per day with a margin of 15 t / d (calculated based on the water content of 80%). The parameters of salty slurry before treatment is shown in table 1, and the target process parameters is shown in table 2.

Table 1. Parameters of salty slurry before treatment

Items	Parameters
Production of absolute dry salty slurry (t/d)	13
Production converted to 80% water content (t/d)	65
Water content of raw salty slurry (%)	85
Production of raw salty slurry (t/d)	87
Cl^- content of raw salty slurry (%)	4.5

Table 2. Target process parameters

Items	Parameters
Water content (%)	15
Cl^- content (%)	0.5
Granular size (mm)	10

3.2 Process design

Fig.2. Process flow chart

The treatment process is shown in figure 2. The salty slurry produced by the brine purification enters into the washing tank first, in which the washing and solid-liquid separation of salty slurry was performed three times. The liquid generated from first solid-liquid separation will be directly sent to the brine purification workshop for purification through the brine recovery system and then used for salt production. The liquid generated from second and third solid-liquid separation will be sent to the evaporation pond through the brine recovery system, and after being concentrated, it will be used for salt production. After washing process, the salty slurry will be pumped into a special solid-liquid separation equipment through a pneumatic diaphragm pump to reduce water content to about 50%. During this process, the liquid generated from fourth solid-liquid separation will be collected and used as the water the first washing needed, and the air compressor system will provide power for the pneumatic diaphragm pump. The salty slurry with water content of 50% and massive structure will be transported into the crushing and granulating equipment through a double-screw conveyor and a belt conveyor after coming out of special solid-liquid separation equipment and it will be crushed into particles with the size of no more than 10mm. Finally, the granular salty slurry with a water content of 50% will be sent to the heat pump drying system through a large-inclined belt conveyor to be dehydrated again to reduce the water content to 15%. And then the granular salty slurry with a water content of about 15% will be sent to the storage yard by a belt conveyor and be used as desulfurizer.

3.3 Main equipment and parameters

Salty slurry washing system: three washing tank with the dimension of $\Phi 9\text{m} \times 4\text{m}$. One pipeline pump with power of 4.5kw. One mud pump with power of 3kw. Two circulating pumps with power of 7.5kw. Six submersible mixers with a power of 7.5kw.

Salty slurry deep dehydration system: three pneumatic diaphragm pumps (2 for use, 1 for spare), and the model

is QBK80. One air compressor with the power of 45kw. A refrigerated dryer. Two special solid-liquid separation equipments with power of 7.5kw. Two multi-stage centrifugal pumps with a power of 3kw. A platform for special solid-liquid separation equipment.

Crushing and granulating system: one crushing and granulating equipment with power of 3kw. Two double screw conveyors with power of 2kw and with a maximum conveying capacity of 2.5t / h. One set of belt conveyor with power of 3kw and with conveying capacity of 3t / h.

Heat pump drying system: one heat pump drying equipment with auxiliary heating unit, and its power is 60kw, its size is $15\text{m} \times 2\text{m} \times 3\text{m}$. A set of large-inclined belt conveyor with a power 3kw. A set of belt conveyors in the stockyard with a power of 3kw.

workshop: plane size is $30\text{m} \times 10\text{m}$.

3.4 Investment and operating expenses and economic analysis

The total investment is 8 million yuan, and the operating cost is less than 100 yuan / t (calculated based on 80% moisture content, excluding depreciation costs). Based on the absolute dry salty slurry production of 4550t/a of Hunan Xiang Li Salt Co., Ltd, more than 1.5 million yuan can be saved because of the use of salty slurry as desulfurizer.

4 advantage analysis of the process

4.1 Low investment and low operating costs

The total investment of salty slurry harmless treatment project of Hunan Xiang Li Salt Co., Ltd is 8 million yuan, and the operating cost is less than 100 yuan / t, which is much lower than other slurry treatment project.

4.2 Energy saving and environmental protection

The pneumatic diaphragm pump is used to feed the solid-liquid separation equipment, and the compressed air is taken as needed in the storage tank, so there is no waste of energy. The heat pump system with auxiliary heating unit can turn on or off a certain number of auxiliary heat units according to the temperature which avoids waste of energy while meeting the needs of the project. And the process achieves zero emissions of harmful substances.

4.3 Short construction period

The process of harmlessness, reduction and resource utilization treatment is simple, and modularization has been formed for different systems, so the construction is fast. The project of Hunan Xiang Li Salt Co., Ltd took 3 months from design to completion. The short construction period can provide fast service for the enterprises.

4.4 High degree of resource utilization

This process collects the liquid from the first three solid-liquid separation to produce salt, which improves the input-output ratio of the enterprise and avoids waste of resources. The water recycling system collects the liquid from the fourth solid-liquid separation for the use of first washing, which realizes the recycling of water and saves a lot of clean water. At the same time, the treated salty slurry can be used as a desulfurizer in the self-provided thermal power plant, which reduces the cost of the enterprise.

5 Conclusion

Salty slurry is difficult to reuse and treat because of its high salt content. The process of harmlessness reduction and resource utilization treatment of salt mud was proved to have many advantages such as low investment, low operating costs, energy saving and environmental protection, short construction period, high degree of resource utilization. While the process solves problems of salty slurry for the enterprise, as a kind of desulfurizer, salty slurry can be consumed by the internal thermal power plant to save costs, and it can also be sold to other nearby thermal power plants to increase revenue and improve the profitability of the enterprise.

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