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Pilot application analysis of used sodium silicate sand wet reclamation sewage treatment and cyclic utilization process

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Abstract: The pilot application results of the sewage treatment and cyclic utilization process of used sodium silicate sand were introduced in detail. The feasibility of the sewage treatment and water cyclic utilization process of the used sodium silicate sand was analyzed from three aspects: the removal rate of harmful components in sewage, the balance of circulating water, and the strength of reclaimed sand.

1. Introduction

The CO_2 sodium silicate sand process was one of the three molding sand technologies mainly used in the foundry industry, but the sodium silicate adhesive film on the surface of the used sand was difficult to remove, and the accumulation of carbonate and silicate would affect the reclaim of the sand[1,2]. In the centralized reclamation method that has been invented, only wet reclamation can reclama used sodium silicate sand with high quality and low cost, but it would produce a large amount of sewage, which needed to be neutralized with acid and then discharged after flocculation and sedimentation, but the treated water contains a lot of sodium chloride[3,4]. Aiming at the problem of large amount of sewage in wet reclamation, this research group proposed a used sodium silicate sand wet reclamation process for water recycling, which can achieve the goal of zero discharge and recycling of sewage.

Based on the above process, the equipment selection of the pilot test and the design of the sewage treatment equipment were expected to realize the wet reclamation and water treatment of a single 200kg CO_2 used sodium silicate sand. The pilot test results of the sewage treatment and recycling process of reclaimed used sodium silicate sand were introduced in detail, and the treatment effects of different reagents on the recycled sewage of used sodium silicate sand were compared to determine the reagents. Combined with chemical theory, the influence of calcium oxide addition was analyzed, and the scheme of lime milk treatment of sewage was determined[5]. The feasibility of the recycled sewage treatment and recycling process of sodium silicate used sand was introduced from three aspects: the removal rate and precipitation of harmful components in sewage, the balance of circulating water, and the strength of recycled sand.

2. Materials and their properties

The used sodium silicate sand was the carbon dioxide sodium silicate hardened used sand after steel castings were produced by an enterprise in Jiangsu; the quicklime was industrial grade calcium oxide with a content of 85% of 200 mesh; the clean water in the test was industrial tap water.

The CO_2 used sodium silicate sand was subjected to secondary wet strong scrubbing according to the sand-water mass ratio of 1/2. The initial concentration and pH value of the wet regenerated sewage, as well as the concentration of total alkali, silicate and sodium carbonate and other harmful components such as shown in Table 1.

Table 1: Sewage from wet reclamation of CO2 used sodium silicate sand

Sand/water mass ratio	Initial turbidity NTU	pH	Na_2O (g/L)	SiO_3^{2-} (g/L)	Na_2CO_3 (g/L)
1/2	1045	10.19	6.2	1.44	9.54

3. Experiment method

The used sodium silicate sand wet reclamation process was shown in Figure 1. The used CO_2 sodium silicate sand for casting was crushed and screened to obtain small particles of used sand. In the sand washing machine, added 200kg of used sodium silicate sand and 400L of clean water in a ratio of 1/2 of the sand-water mass ratio, and scrubbed with stirring. The mixed and stirred mortar was rinsed with 40L of pressurized water on the dewatering device, and dehydrated to obtain sewage and wet sand. The dehydrated wet sand was dried, screened and dedusted to obtain reclaimed sand that meet the requirements of 20-140 mesh. Calculated the 14kg quicklime to be added according to the total alkali content in the sewage, added 42kg clean water in a certain proportion, and slowly stired to accelerate the compound reaction to make lime milk. The sewage was added with lime milk prepared in advance, and after mixed and stirred, the reaction was completed, and the circulating water and sediment were obtained by filtration. Circulating water was used instead of clean water for the next wet reclamation of used sodium silicate sand, and the number of water cycles was the number of reclamations of the reclaimed sand.

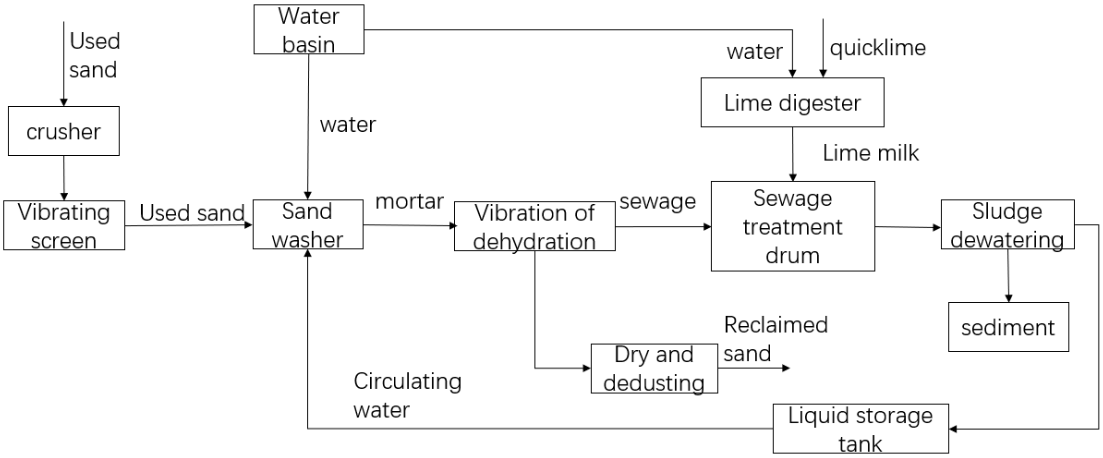

Figure 1: Process of used sodium silicate sand wet reclamation sewage treatment and cyclic utilization

4. Treatment effect of sewage and used sand in process cycle

4.1 Removal rate of harmful components in sewage

Figure 2 showed the changes in the total alkali content, carbonate, and silicate concentrations during the six cycles of the reused liquid when using lime milk to treat the sewage of used sodium silicate sand wet reclamation. During the recycling process, the concentration of sodium carbonate and silicate in the recycled liquid varied very little, and the concentration range of sodium carbonate was 0~2g/L, and the concentration range of silicate was 0~0.1g/L. With the increase of the number of water cycles, the concentration of the total alkali content also increased gradually, and the single increment was relatively significant, mainly because the carbonate and silicate reacted with calcium hydroxide after the lime milk treats the sewage, both carbonate and silicate precipitated as insoluble calcium salts[6-8]. The sodium hydroxide produced by the reaction has a large solubility in water. The concentration of sodium hydroxide accumulated with the number of cycles, and sodium hydroxide was also a part of the total alkali content, resulted in the accumulation of the concentration of the total alkali content.

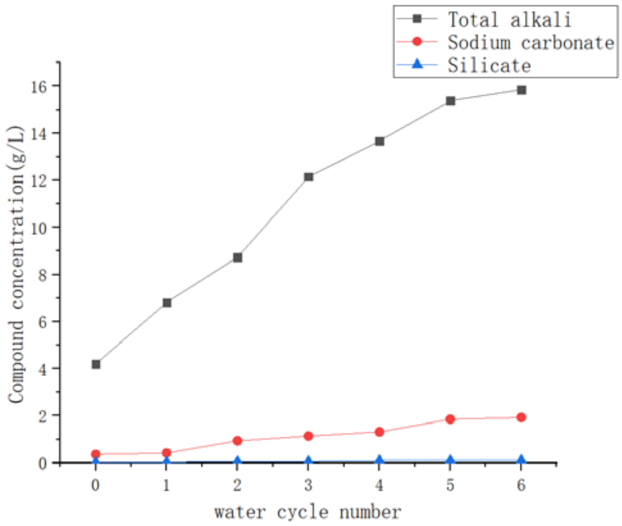

Figure 2: Relationship between harmful components of circulating water and the number of cycled

4.2 The volume of circulating water

In the twice wet reclamation process, under the condition of 40L of clean water supplemented by the spraying process, after the sludge was separated by the stacked screw sludge dewatering machine the changed of the circulating water volume was shown in Figure 3. It can be seen from the figure that the circulating water volume was between 395 and 405L during the six cycles, and the average circulating water level was 401L. Compared with the 400L water that needs to be added for the wet reclamation of used sand, the difference was not large. In the process of water recycling, the water consumed by the process fluctuated, mainly because the uncontrollable factors in vibration dewatering and sludge dewatering leaded to different moisture contents in wet sand and sludge. Therefore, the circulating water volume of the final desliming fluctuated slightly, but the circulating water loss ratio fluctuated within ±1.25%, and there was no gradual upward trend, showed different fluctuations around 400L, and there was no cumulative loss. Compared with the amount of water required for wet reclamation, the loss of circulating water was not large. Within the acceptable range, it was more appropriate to set the amount of spray water at 40L.

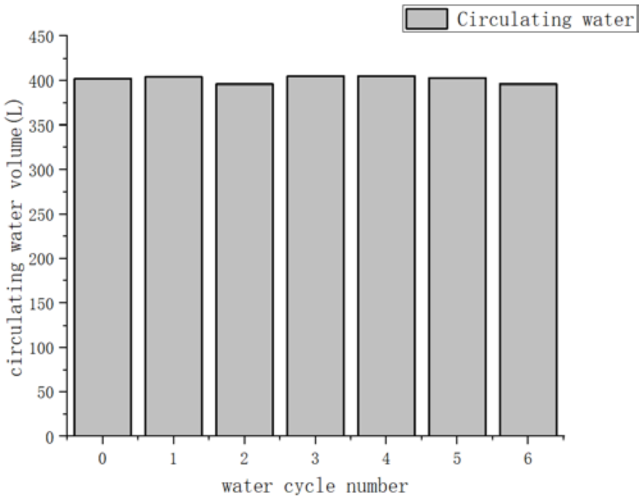

Figure 3: Changes in circulating water volume

4.3 Strength of reclaimed sand

After the sewage was treated with reagents and deslimed, it was used as circulating water for wet reclamation hydraulic scrubbing. The results of initial strength, 24h compressive strength, and collapsibility strength of reclaimed sand based on recycling were shown in Figure 4. It can be seen from the figure that during the water circulation process, the initial strength of the reclaimed sand has increased, from 1.2 MPa to 1.8 MPa, and this strength of the reclaimed sand using circulating water for wet reclamation was greater than 1.4 MPa. The 24h compressive strength of the reclaimed sand was basically unchanged, between 1.6 and 2.0 MPa, but the collapsibility strength still increased with the increase of the number of cycles[9]. The reclaimed sand has higher initial strength and collapsibility strength than new sand due to the recovery of the activity of residual sodium silicate during the scrubbed process with aqueous sodium hydroxide solution. And with the increased of water circulation times, the concentration of sodium hydroxide in the recycled liquid increased, and more residual sodium silicate was activated, with higher strength and worse collapsibility[10].

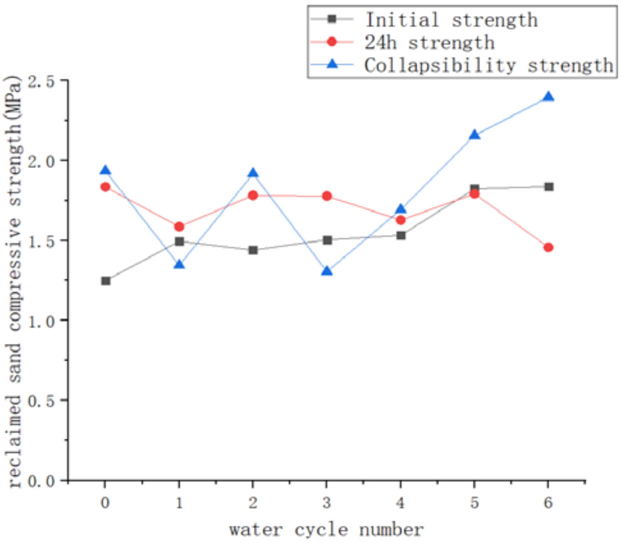

Figure 4: Strength of reclaimed sand

5. Conclusion

(1) In the process of water recycling, lime milk treatment sewage can effectively convert more than 80% of carbonate and more than 90% of silicate into calcium carbonate, calcium silicate and sodium hydroxide, sodium hydroxide gradually accumulation.

(2) It was more appropriate to set the amount of supplementary spray water at 40L, and the loss ratio of circulating water fluctuated within ±1.25%, but there was no cumulative upward trend, and the amount of circulating water basically reached a balance.

(3) Trial production was carried out according to the optimized parameters, the initial strength and 24h compressive strength of the obtained reclaimed sand met the strength requirements, and the collapsibility strength increased slightly with the increase of the number of cycles.

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