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HARMLESS TREATMENT OF USED FOUNDRY SANDS AND DEWATERED MUNICIPAL SLUDGE BY MICROWAVE

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A new method to treat four solid wastes of sodium silicate used sands, dewatered municipal sludge, clay sands sludge and waste polyethylene, was discussed. About wt/ 50 % sodium silicate used sands and wt/ 50 % dewatered sludge were mixed, and then cured by microwave with a certain thickness film of clay sands sludge and waste plastic of polyethylene in the surface. The results showed that the compression strength of granulation sample with the size of Φ 50 × 50 mm was over 0,45 MPa. The waste plastic was the key factor for the durability, and curing temperature must be over melting temperature, so the thicker film could be coated in the surface of used sands and sludge.

Key words: foundry, sands, sodium silicate, clay sands sludge, microwave

INTRODUCTION

Metalcasting is one of the most recycle-intensive of all manufacturing industries.Nevertheless, it produces solid, liquid, and volatile wastes. Used sands is the main waste in the foundry. There are three main methods of sand reclamation: dry attrition, thermal reclamation and wet reclamation, but each of the methods have their limitations for re-use. In fact, the residual sodium silicate in the used sands is suitable for re-bonding with water in the heating process [1-2].

With the increase of wastewater treatment plants, a great quantity of dewatered sludge has been produced, commonly containing large amounts of water (including attached water, interstitial water, capillary water and internal water), unstabilized pathogenic microbes and other toxic and harmful substances [3]. Reduction of sludge water content usually by mechanical dewatering is crucial to reduce the costs of sludge management and handling.

The microwave heat technique with two frequencies of 2 450 and 915 MHz will destroy the microbes and stabilize the harmful substances in the dewatered sludge to achieve the environmental benefit. Also the microwave energy can re-bond the residual binder in the used sodium silicate sands to achieve adequate strength [4-6].

The aim of this experimental study was to search for optimal methods to treat four solid wastes of sodium silicate used sands, clay sands sludge, dewatered municipal sludge and waste polyethylene (PE). This paper determined the basic factors of this new waste treatment method: 1.Best ratio of sodium silicate used sands and dewatered municipal sludge to obtain high internal strength. 2. Optimal amount of clay sands sludge to absorb microwave to melt the external PE.

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METERIALS, MEASUREMENT METHODOLOGY AND MEASUREMENT EQUIPMENT

The used sodium silicate sand was obtained from the Steel Foundry of Changjiang Energy Corporation, Wuhan, Peoples Republic of China. The used sand was cured by CO_2 and the sodium silicate binder adding amount was 8 %. In the used sand there were three main ingredients: $Na_2O{\cdot}mSiO_2$ ($m > 2,5$), Na_2CO_3 and silica sand. The dewatered sludge was from Wuhan Bayilu Wastewater Treatment Plant. The clay sands sludge was obtained from the Guangxi Yucai Machinery Group Co., Ltd, and the carbon content was 24, 91 %. The waste plastic of PE was from one landfill.

For harmless treatment of used foundry sands and dewatered municipal sludge by microwave, the waste samples were prepared by the following steps: 1. the used sands were mixed with dewatered municipal sludge by a certain weight proportion in the miller mixer for 5min. 2.The mixture was shaped to cylindrical with the sprayed the clay sands sludge in the surface, and then the preliminary sample were put into the mould (Φ 50 × 50 mm) with the waste PE film in the surface of the mould. 3. The waste samples and mould were put into microwave oven to heat about 10 - 30 s and the microwave power can be 900 W, 1 800 W, 2 700 W, 3 600 W, 4 500 W, 5 400 W, and 6 300 W. 4. The waste samples were taken out, demoulded and then re-heated for another 50 - 100 s.

The samples temperature was measured by the Pt-Rh thermocouples in the microwave, and the compressive strength was tested on a lever-type universal strength testing machine.

Figure 1 (a and b) presented the components and their distribution of the four wastes mixture in the circu-

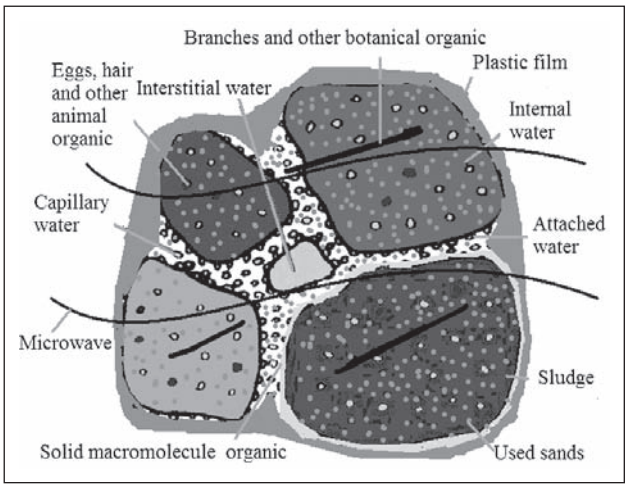

Figure 1 a The components in the dewatered municipal sludge

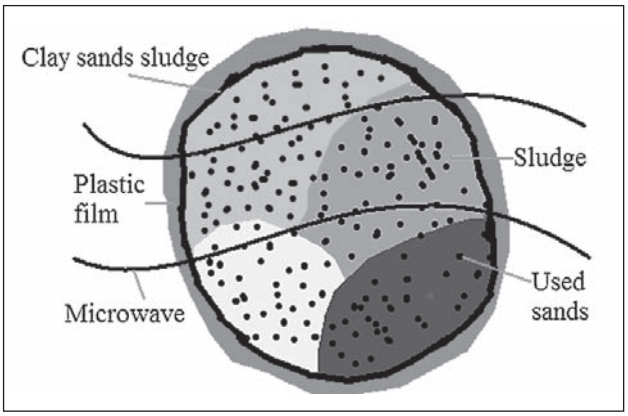

Figure 1 b The components in the sample after the microwave treatment

lar sample. There were many eggs (such as pinworms and hookworms, and tapeworms), bacteria, viruses, hair, branches and other organic matters in the dewatered municipal sludge as Figure 1.a showing, and the water content of the sludge was over 80 %. But the sample was compacter and high intensity in Figure 1.b, and many bacteria, viruses and other organic matters were killed by the high temperature energy of microwave.

RESULTS AND DISCUSSION

Best sands addition in the sludge

The diagram showing the different mixing ratios of sodium silicate used sands and dewatered municipal sludge with respect to strength was presented in Figure 2, and the microwave power was 6 300 W and the curing time was 90 s. The sodium silicate used sands addition was 0 %, 20 %, 40 %, 50 %, 60 %, 80 % and 100 %, respectively, by weight percent of dewatered municipal sludge. From Figure 2, it was noted that the compression strength increased with increasing sodium silicate used sands firstly because the re-bonding binder of sodium silicate was more. But the strength would decrease when little dewatered municipal sludge was in the mixture because there was not enough water to re-bond the binder. And the strength increasing rate was

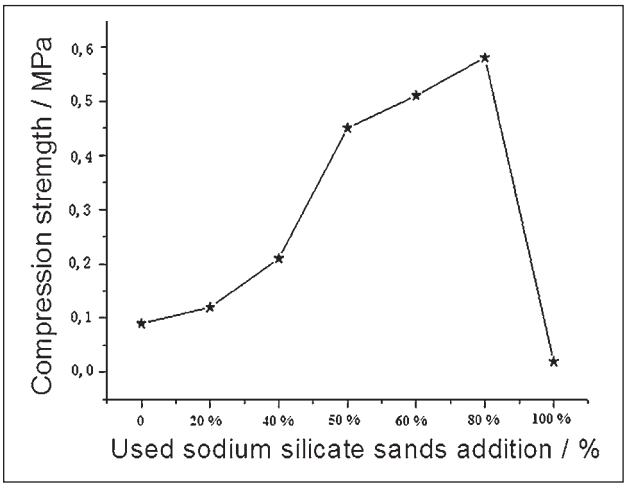

Figure 2 The effect of used sands addition on the compression strength

highest when the used sands addition was 50 %, also the cylindrical sands samples were compacter than others at this time. It can be observed that the sample expanded to crack when the sodium silicate used sands addition was blow 50 %. So the optimal ratio of sands and sludge was 1:1 according to the strength and density.

Optimal amount of clay sands sludge

There were many carbon atoms and bentonite binder in the clay sands sludge, so they can increase the curing temperature and strength by absorbing microwave energy, especially for melting the PE film in the surface of the sample. The experimental research on curing temperature of used sand and municipal sludge with different clay sands sludge addition was conducted in Figure 3, and the clay sands sludge was sprayed in the surface of the waste sample. The clay sands sludge addition amount was 0 %, 2 %, 4 %, 6 %, 8 % and 10 % by weight percent of sodium silicate used sands and dewatered municipal sludge. The sodium silicate used sands addition was 50 %, and the microwave power was 6 300W and the curing time was 90 s. Analyzing Figure 2,

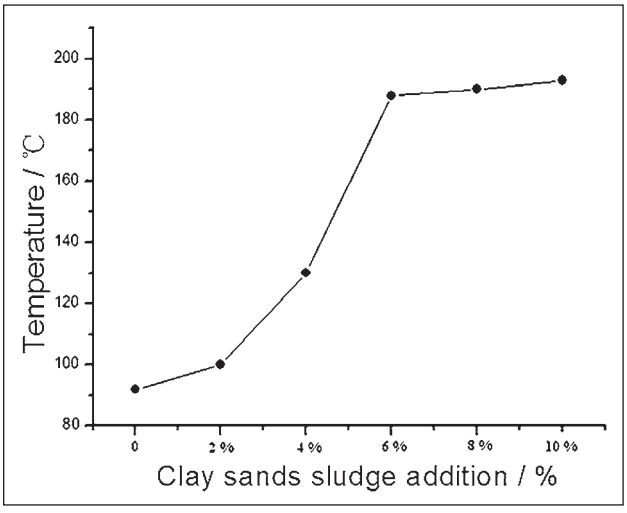

Figure 3 The effect of clay sands sludge addition on the temperature

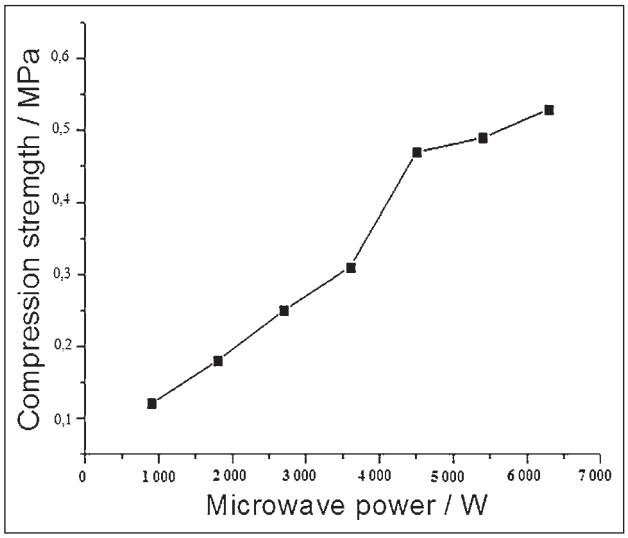

Figure 4 The effect of microwave power on compression strength

it can be observed that the mixture temperature was 188 °C when the clay sands sludge addition amount was 6 %,and this temperature was higher than the melting temperature of 120 - 136 °C. But the mixture temperature did not significantly increase when the sludge addition amount was over 6 % because the saturated carbon microwave absorption was achieved this time.

The effect of microwave power on the compression strength

When the sodium silicate used sands addition was 50 %, the clay sands sludge addition amount was 6 % and curing time was 90 s, the influence curves of different microwave power on compression strength of mixture samples were presented in Figure 4. The microwave power was 900 W, 1 800 W, 2 700 W, 3 600 W, 4 500 W, 5 400 W, and 6 300 W respectively.

Figure 4 showed that higher microwave power would bring greater compression strength when the microwave power increased from 900 W to 4 500 W because higher microwave power would cause faster heating speed. But the strength increment was very slow when the power rose from 4 500 to 6 300 W because the losing water speeds of these powers were nearly the same when the steam was saturated in the oven. So the lowest cost power in this experiment was 4 500 W.

CONCLUSIONS

This new method to treat those four solid wastes of sodium silicate used sands, dewatered municipal sludge, clay sands sludge and waste polyethylene can re-bond the residual sodium silicate in the used sands, stabilize the all the waste in the mixture with treating high-efficiency, and the treated mixture can be used in the municipal engineering. The best ratio of sodium silicate used sands and dewatered municipal sludge was 1:1, and the optimal amount of clay sands sludge was 6 %.And there was the lowest cost power for this new method according the mixture amount.

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Note: The responsible for English language is lecturer from Wuhan Textile University