

Study on the Stabilization/Solidification of Tannery Sludge for Building Materials

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Abstract : This paper introduces the method of solidification and stabilization tannery sludge, and studies the potential of tannery sludge resource recovery. It is the objective that the Cr of tannery sludge is stabilized in the cement block and isn't leached to pollute the circumstance. By orthogonal design method the best ratio of cement, tannery sludge, Calcium Oxide and slag was selected, which was slag 35%, sludge 5 %, cement 45% and gypsum 15 % ultimately. By curing 28 days after the compressive strength was measured 20.39 MPa, and leaching toxic heavy metals Cr concentration was less than 0.004 mg/l which was far below the national standards (1.5 mg/l). This paper would supply the basic data to suggest how to apply this technique of sludge solidification / stabilization for building material.

Key words : tannery sludge; Cr; solidification / stabilization

1 Introduction

At the present time there has not yet effective method to tannery sludge in majority tannery. The only method is taken by stacking and drying simply which still can bring a lot of secondary pollution of hidden dangers, so looking for the new effective processing method of tannery sludge is very urgent^[1].

We study and apply the method of solidification / stabilization to tannery sludge which mainly use cement-based^{[2][3]}, that can reduce the dangerous component in the sludge to low solubility, low migration and low-toxic substances by the action of coagulant to the tannery sludge, and reduce the adverse effects of the environment for a long time as well as given the curing block the compressive strength, the flexural strength as building materials which increase efficiency and economic benefits of the environmental governance.

2 Experiment details

2.1 Materials

(sym-) diphenylcarbazine, (30%) hydrogen peroxide, (40%) Hydrofluoric acid, (70%) perchloric acid and calcium oxide were produced from Tianjin No.1 Chemical Reagent Factory (Tianjin, China), all of above were analytical reagents. Cement was produced from Xi'an Cement Factory.

2.2 Determination the component of the sludge

The sludge was provided by Xu Zhou Tannery which was dried. Firstly, the sludge was skived for 8h in the boll mill, and then screened it by 100 screen mesh that has 100 holes per inch, which can get uniformity sludge. Secondly, the mainly Chemical component of the sludge was got such as tab. 1.

2.3 Preparation of test block

The sludge, a kind of stabilized reagent and the cement were mixed together uniformly and injected into mould (high? mm, long ? mm and wide ? mm), and then the mould was stripped and the test block was got. Secondly, the test block was curing in the water for 7days and 28days, which compressive

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strength (CS) and flexural strength (FS) was determined. Finally, it was broken to pieces less than 5mm, shocked in the solutions for 8h, then settled for 16h and determined the Cr of Leaching Solution. Fig.1 demonstrates these processes of making test block.

Tab.1 Essential components of the sludge	
Chemical component	Content (%)
Moisture	8.62
Volatile solid and ash	45.31
Total Nitrogen	20.07
Total Chromium	4.00

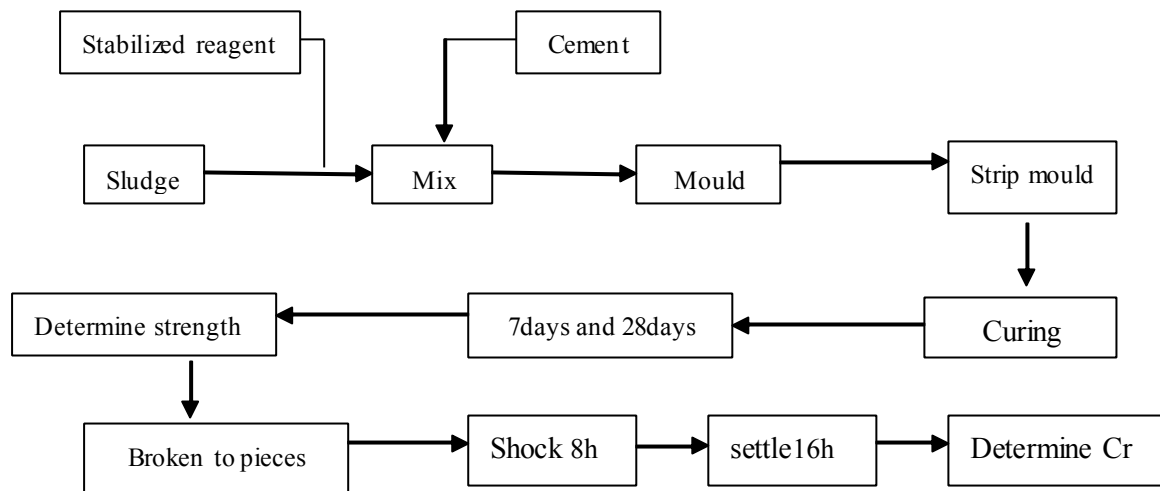


Fig.1 the process of test block

The method of determination compressive strength and flexural strength of test block was from the national standard 177-77 “The Detection of Cement”. The method of preparation of leaching solution was from the national standard 5086.2-1997 “the standard of leaching toxicity of dangerous waste”. The way of determination the total Cr was from the national standard T15555.5-1996 “the solid waste, the total Cr, the diphenylcarbazine Spectrophotometry”.

2.4 selection of optimum ratio

The optimum ratio of Calcium Oxide, slag, cements and sludge was selected by orthogonal optimization test. There had 3 influence factors that were the adding amount of Calcium Oxide (H), cement (G) and sludge (F), and the different factor had the 3 different levels as tab.2 showed. Orthogonal experimental design $L_9 (3^4)$ was applied to the selection of optimum ratio, such as tab.3 which assessment Index was the CS and FS.

3 Results and Discussions

3.1 Result of range analysis

The influences of the adding amount of Calcium Oxide, cement and sludge on the compressive strength and flexural strength of test block were studied by the range analysis. The results and the range analysis are shown in tab.4.

Tab.2 the influencing factors and different adding levels

	F	G	H
level	sludge (%)	cement (%)	Calcium Oxide (%)
1	5	15	5
2	15	30	10
3	25	45	15

Tab.3 L9(3⁴) orthogonal experimental design

serial number	F	G	H	Z
	sludge (%)	cement (%)	Calcium Oxide (%)	empty Column
1#	1	1	1	1
2#	1	2	2	2
3#	1	3	3	3
4#	2	1	2	3
5#	2	2	3	1
6#	2	3	1	2
7#	3	1	2	2
8#	3	2	1	3
9#	3	3	3	1

The tab.4 demonstrate that K_1 , K_2 and K_3 is the sum of results dates of different level which average is $\overline{K_1}$, $\overline{K_2}$ and $\overline{K_3}$ respectively.

Firstly, the tab.4 demonstrates the optimum ratio in the different indexes as follows:

FS 7day (MPa) : F1G3H3

FS28day (MPa) : F1G3H3

CS28day (MPa) : F1G3H3

The conclusion is that the different indexes have the uniform optimum ratio.

Secondly, there is the order of influence on FS and CS of test block as follows:

FS 7day (MPa) : F>G>H

FS28day (MPa) : F>H>G

CS28day (MPa) : F>H>G

So this range analysis shows us that the adding amount of sludge have the effect on the compressive strength and flexible strength mostly, and the optimum ratio is F1G3H3 which is the sludge5%, cement45%, Calcium Oxide 15%.

3.2 The Cr of leaching

Finally, the total leaching Cr of the test block 3# was tested under 0.004mg/l which is far less than 1.5mg/l of the national standard.

Tab.4 the range analysis of the results

Serial number	Influence factors				Index(result)		
	F Sludge (%)	G Cement (%)	H Calcium Oxide (%)	Z empty Column	FS 7day (MPa)	FS28day (MPa)	CS28day (MPa)
1#	1 (5)	1 (15)	1 (5)	1	1.72	5.38	7.74
2#	1 (5)	2 (30)	2 (10)	2	2.91	5.19	12.31
3#	1 (5)	3 (45)	3 (15)	3	6.06	7.24	20.39
4#	2 (15)	1 (15)	2 (10)	3	1.53	2.22	4.68
5#	2 (15)	2 (30)	3 (15)	1	2.86	3.72	7.75
6#	2 (15)	3 (45)	1 (5)	2	2.50	3.20	6.50
7#	3 (25)	1 (15)	2 (10)	2	1.55	2.73	7.04
8#	3 (25)	2 (30)	1 (5)	3	1.28	2.49	5.54
9#	3 (25)	3 (45)	3 (15)	1	0.51	3.57	3.80
FS 7day	K1	10.69	4.8	5.5	5.09	$\Sigma = 20.92$	
	K2	6.89	7.05	5.99	6.96		
	K3	3.34	9.07	9.43	8.87		
	$\overline{K1}$	3.56	1.6	1.83	1.70		
	$\overline{K2}$	2.30	2.35	2.00	2.32		
	$\overline{K3}$	1.11	3.02	3.14	2.99		
	R	2.45	1.42	1.28	1.29		
FS 28day	K1	17.81	10.33	11.07	12.67	$\Sigma = 35.74$	
	K2	9.14	11.4	10.14	11.12		
	K3	8.79	14.01	14.53	11.95		
	$\overline{K1}$	5.94	3.44	3.69	4.22		
	$\overline{K2}$	3.05	3.8	3.38	3.71		
	$\overline{K3}$	2.93	4.67	4.84	3.98		
	R	3.01	1.23	1.46	0.51		
CS28day	K1	40.44	19.46	19.78	19.29	$\Sigma = 75.75$	
	K2	18.93	25.6	24.03	25.85		
	K3	16.38	30.69	31.94	30.61		
	$\overline{K1}$	13.48	6.49	6.59	6.43		

	$\overline{K_2}$	6.31	8.53	8.01	8.62
	$\overline{K_3}$	5.46	10.23	10.65	10.20
	R	8.02	3.74	4.06	3.77

4 Conclusion

The compressive strength must reach 10MPa at least in our national standard if the curing block applies to building materials [4]. The test block with the optimum ratio that is the sludge5%, cement45%, Calcium Oxide15% and slag35% was curing for 28days, and which compressive strength was 20.39MPa. Its compressive strength is 2 more than the national standard, and the Cr of leaching of it is far lower than the national standard. So the tannery sludge has the potential to building materials.

Reference

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