

Experimental Study on Preparation of Tailings Paste

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Abstract: It's universally acknowledged that paste filling is the best solution to solve the problem of filling slurry concentration and reduce the filling cost. The paper provides an experimental method to determine whether the mine has the basic conditions and the scientific basis for the feasibility of paste filling. Through this experiment, the main equipment, process parameters, economic and technical indexes of the new filling process are preliminarily determined.

1. Introduction

The paste filling is a brand-new mining model which is developed and promoted rapidly domestic and foreign. This filling method has high filling quality, rapid growth of filling body, low cost and high efficiency, and it is the main direction of the filling technology development. However, the paste definition is not clear, and there is no complete mining tail-paste test. Recently, domestic metal mines have gradually begun to promote the filling process of full tailings paste. At present, there is a great disagreement between the knowledge of paste filling and high concentration filling. Through the study of tailings filling in recent years, some views and understanding of the paste, as well as parameters must be understood in the preparation of the paste system are clarified here.

2. Knowledge of some paste concepts

The "high concentration" is a relative concept in the "high concentration filling" of tailings, and the paste concentration is 56-82 percent in actual production cases. This is mainly based on the flow state of the filling slurry. When the slurry concentration reaches a certain threshold, slurry turns from non-heterogeneous Newtonian into heterogeneous, which is the fundamental changes in the flow, and slurry is saturated to be treated as paste. The concentration of slurry near the limit can be considered as high concentration.

As the slurry concentration continues to increase, the yield stress of the slurry increases continuously, and the fluidity of the slurry gradually decreases until the flowability is lost. That is to say, paste is a special state of high concentration. For the mine, the paste must meet the liquidity requirement, so the yield stress must be at a certain range.

It is generally recognized that paste has three characteristics: non-segregation, non-settlement and non-bleeding. For the full tailings filling, it is required that slump is in the range of 15-25cm and degree of segregation is lower than 2cm. Combined with the views of scholar at home and abroad, the writer thinks the paste is the structural slurry that meets the maximum number of weights as well as the viscous force of the flow field is greater than the inertia force and reaches saturation.



3. The determination of several main parameters of the paste test

Based on the paste knowledge above and the production practice, a set of test procedures is designed to determine the feasibility of the tailing paste preparation. Mainly through the determination of tail grain size composition, concentration, bulk density, bleeding, degree of segregation, slump, filling material properties and ratio, slurry modifier and the strength indicators of filling body to determine whether the slurry is fit to prepare paste, and whether paste characteristics can meet the requirements of mine filling. Since the strength requirement is the main target of filling, the experiment is carried out to meet the core target of mine filling strength after determining the basic filling parameters.

3.1 Determination of the relationship between filling particle size and filling body strength

The test is to find the tailings gradation which meets the requirement of filling strength. The appropriate grade of granules is determined by measuring strength of different granule levels (grey sand ratio is 1:20, and the same below). The data is showed in table 1:

Table 1. Filling body strength of different tailings grade

Gradation	grey sand ratio	concentration (%)	Strength of 3 days (MPa)	Strength of 7 days (MPa)	Strength of 14 days (MPa)
classified tailings	1:20	70%	0.30	0.45	0.83
Full tailings	1:20	70%	0.31	0.50	0.95
+0.044 μm	1:20	70%	0.15	0.24	0.32
+0.038 μm	1:20	70%	0.12	0.18	0.21
-0.154 μm	1:20	70%	0.27	0.35	0.31
-0.100 μm	1:20	70%	0.26	0.25	0.22
-0.074 μm	1:20	70%	0.14	0.17	0.45

Because the tailings are gold ore flotation tailings, and the tailing productive rate is about 97%, it is appropriate to use tailings to determine the appropriate gradation but not external materials. All the following experiments are also based on a single variable. It can be seen from the experiment that the strength of full tailings body is the highest, while of others are lower. The next experiment will be carried on the filling body of full failings.

The result that the strength of full tailings filling is the highest can provide a basis for similar mine. Mainly the full tailings filling has problem in the operation process, and needs process improvement to meet the production requirements.

3.2 Determination of the relationship between filling body concentration and strength

The experiment data is as following:

Table 2. Filling body strength of different concentration

Mass concentration(%)	The usage of material C in 1m ³ slurry /kg	The usage of tailings in 1m ³ slurry /kg	Strength of 3d (MPa)	Strength of 7d (MPa)	Strength of 14d (MPa)
80%	75.66	1513.16	0.23	0.47	1.02
78%	73.24	1464.77	0.28	0.50	1.11
77%	70.67	1413.30	0.37	0.55	1.11
76%	68.73	1374.62	0.42	0.58	1.34
75%	67.21	1344.22	0.33	0.51	1.04
70%	59.25	1184.94	0.31	0.50	0.95
65%	52.12	1042.42	0.21	0.23	0.62

To represent relationship between filling body concentration and strength directly, here is a relation

curve in Figure 1.

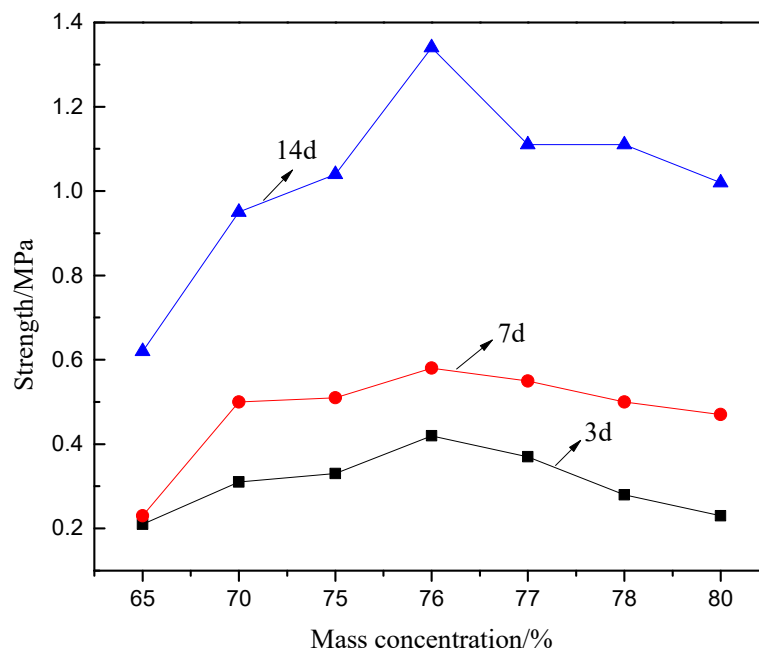


Figure 1. Relation curve between filling body concentration and strength

It can be seen from Figure 1 that the filling strength increases with the increase of filling body concentration, but the inflection point is present. It is indicated that the strength of the filling body is not rising after a certain value. The author thinks that there must be a certain proportion of reaction water in the filling body. But before reaching the inflection point, the filling strength and filling body concentration are positively correlated. It is important to note that different tailings inflection points are different.

3.3 The parameters determination of the paste preparation process

The experiment data is as following:

Table 3. The parameters of the paste preparation

Mass concentration (%)	Yield stress (Pa)	Viscosity (Pa·s)	Divergence (mm)	Bleeding rate (%)	Effective volume to the underground (%)	Degree of segregation (cm)	Slump (mm)
80%	\	\	58	3.25	98	0.4	90
78%	1282	1262	61	3.33	98	0.4	150
77%	350	332	63	5.00	97	1	159
76%	300	249	65	6.00	96	1.2	195
75%	128	130	71	6.25	94	3	250
70%	67	103	193	19.84	84	12	277
65%	18	26	203	28.51	82	\	\

It can be concluded from Table 3 that the concentration of 76% is the best. Under this concentration, yield stress is higher, which result in high on-way resistance. But it can be solved by lowering concentration or adding rheological modified agents in practical production. Combined with the determination and data, the author thinks that yield stress, slump and degree of segregation must be determined to guide production. Therefore, after determining the composition of the material and above three parameters according to the downhole filling strength requirement, it is possible to determine

whether the materials can be prepared into paste.

3.4 The influence of filling material in filling body

In the experiment of different filling body of different filling materials, the influence of the strength of tailings filling body is shown in Table 4.

Table 4. Filling body strength of different additive

Binder type	solid concentration (%)	Height of filling body (mm)	Strength of 3d (MPa)	Strength of 7d (MPa)	Strength of 14d (MPa)
1#	77	70	0.45	0.64	1.35
2#	77	70	0.56	1.17	1.91

From the table, the influence of filling materials on strength is great. Cement 1# is configured for graded tailings, and cement 2 # is tailored for the tail arrangement of the material. It is necessary to configure a specific binder according to the different tailings.

4. Conclusion

(1) The paste has “three no” features, which are more stable and easy to control in production, preparation, delivery and filling. In addition, it is more advantageous to maintain the stability of surrounding rock, reduce surface subsidence, improve recovery of mineral resources and protect the environment. The most important is that the integrated filling cost is more advantageous than other processes, and the paste filling is the most potential filling technology.

(2) The filling grade and concentration have a great influence on the filling strength, which is an important factor to determine whether the tailings of the mine can be used for paste filling. In the determination of the preparation parameters of the paste, the yield stress, slump and degree of segregation are parameters that must be determined. It is necessary to prepare cementing material according to material properties in the filling body.

(3) The design of the loop tube test and pipeline are the two necessary steps in the production.

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