are the best. Even when decomposed at lower temperature than 300°C, if oxidising ion can be removed, plates of high capacity may be obtained.

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Literature :

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Study on Paste Preparation of Lead Acid Battery

Toshio ISHIKAWA, Hiroshi TAGAWA and Yoshio NAKAMURA

The Furukawa Battery Co., Ltd., Hodogaya-ku, Yokohama, Japan

Introduction

Pastes used for active material of lead acid battery have been manufactured by mixing lead oxide with a comparatively dilute sulfuric acid. The object of this study is to obtain paste, different from the above mentioned, by mixing lead oxide with water and then by adding sulfuric acid solution with a comparatively high specific gravity. By this new preparation two main factors in controlling the properties, i. e. the hardness and density of the paste, can be freely adjustable.

Experimental

1. Methods of preparing paste By mixing active material with water, the hardness of the paste is adjusted. Next by adding sulfuric acid solution of an appropriate concentration, the density is adjustable. With use of a penetrometer as shown in Fig. 1, the hardness is gauged by measuring the depth of the load needle entering into the paste within a period of five seconds.

A hemispherical receptacle with a capacity of 32.8 cm³ is used, and the vessel was packed firmly, then

Top of needle

Apparatus is in accordance with the method of test for penetration of Asphalt (JIS-K 2350), except as specified in needle size and load 70g.

Fig. 1 Penetrometer

Table 1 Characteristics of Lead Powder and Litharge

	Lead powder	Litharge
Apparent density (cc/g)	0.48	0.44
Distribution (%)		
< 1μ	13.1	4.3
1μ < < 2"	16.4	17.2
2" < < 4"	26.7	32.2
4" < < 6"	21.4	23.5
6" < < 8"	14.6	12.0
8" < < 10"	6.5	6.1
10" <	1.3	4.7
Oxydation (%)	4.03	—

Fig. 2 Water paste (Lead powder)

Fig. 3 Water paste (Litharge)

Table 2 Effect of Acid Concentrations (Lead powder)

Sp. Gr. (20°C/4°C)	Density(g/cm³)	Penetration
No addition	4.67	72
1.050	4.24	138
1.100	4.26	122
1.150	4.25	87
1.200	4.30	87
1.240	4.30	76
1.250	4.30	72
1.260	4.30	68
1.270	4.30	65
1.300	4.32	60
1.350	4.31	52
1.400	4.32	50

Table 3 Effect of Acid Concentration (Litharge)

Sp. Gr. (20°C/4°C)	Density(g/cm³)	Penetration
No addition	5.70	62
1.200	5.21	97
1.250	5.23	68
1.260	5.22	72
1.270	5.23	69
1.280	5.23	61
1.290	5.21	53
1.300	5.22	44
1.350	5.22	37
1.400	5.27	30

the density was calculated in g/cm³ by weighing the weight.

2. Manufacturing of water paste 200g active material is poured into a mortar, and water is added at a various rate, then this is well kneaded with a rod and hardness and density are measured. Fig. 2 shows an example of the usage of lead powder for positive plate and Fig. 3 indicates that for the negative plate by using litharge. The characteristics of lead powder and litharge are shown in Table 1.

3. Selections of appropriate density of sulfuric acid solution

When adding a solution of sulfuric acid into water paste, if the concentration is too small the paste will be gradually softened and if too large the paste will be hardened gradually. Sulfuric acid solution with appropriate density will give almost no changes. Results obtained for the paste which is made by mixing 5cc sulfuric acid of various specific gravity with 200g water paste of suitable hardness, are shown in Tables 2 and 3. Sulfuric acid of 1.250 in specific gravity at 20°C was shown to be suitable in changing only the density without changing the hardness of the paste to prepare water paste using lead powder and in using litharge of 1.280 in specific gravity.

4. Changes of paste density by addig sulfuric acid solution

If the pre-mentioned acid of appropriate specific gravity was added to water paste of 200g, the density of the paste will decrease as shown in Fig. 4.

Fig. 4. Paste density decrease on addition of acid

Fig. 5. Relation between paste density and battery plate performance

5. Example of preparing paste

An example of paste preparation for a positive plate having a hardness of 25 and density of 3.95 g/cm³ suitable for pasting machine was as follows. In order to get water paste with a hardness of 25, lead powder was mixed at the ratio of 26cc water to 200g lead of powder in accordance to Fig. 2. Density of the paste is 5.05g/cm³ (same as Fig. 2.). To decrease 1.10g/cm³ in density, 22cc of 1.250 (20°C/4°C) acid was added to the 200g water paste as shown in Fig. 4. The results obtained by this experiment showed the success of our purpose.

6. Relation between paste characteristics and performance of plate

Pastes of several types in hardness and density were prepared with use of lead powder as positive active material. After pasting in a grid of 50(W)×60(H)×2.5(T)mm, each sort of plates was finished by the usual method and combined with two negative plates which have large capacity enough to test the positive plate and these plates were hanged in the glass container having the capacity of 80(W)×125(H)×45(L)mm. Then the test of initial capacity and of room life were carried out. Each cell had 380cc of 1.280 (20°C/4°C) acid. Capacity test was carried out by a 10 hrs. discharge and a room life test at a cycle consisting of 1 hr. discharge at 750 mA and a 2 hrs. charge at 490 mA and a capacity test every 25 cycle at 5 hrs. As a result of these tests any changes were not recognized in the paste hardness and in the capacity and life of the plate.

On the other hand, the difference between the density of the paste and the performance of the plate were clearly indicated as shown in Fig. 5.

Conclusion

1. To obtain acid paste, prepared water paste is added with sulfuric acid of a comparatively high specific gravity and this makes the control for paste easier.

2. As for the density of sulfuric acid solution to be used for acid paste, there are certain special density which does not alter the hardness although it depends on the kind of lead oxide. It is necessary for controlling to select the density.

3. Paste density indicates the performance of the plate. Paste hardness indicates the proper controlling operation.

4. The authors have shown an example of preparing paste by these methods, and explained the relations among the densities of pastes, the discharge capacity and the shedding life of the positive and negative plates.

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