BATTERY PLATES FOR LEAD ACCUMULATOR

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Introduction

The composition of antimonial lead[1] grid fillers for positive as well as negative plate has a far-reaching influence on the storage capacity and the efficiency of a cell. In view of the previous work, it has been established that the negative[2] plate should not develop negative charge ahead of positive charge during charging, as it adversely affects the adhering property of the filler. This necessitates the adjustment of the composition in such a way that the positive and negative charges develop simultaneously.

Besides composition, the incorporation of a suitable binder is of vital importance. Various workers have mentioned a variety of binders of both organic and inorganic nature. The former, being non-polar, inhibit the passage of current and thus retard the efficiency of the cell. In addition, sulphuric acid violently attacks these organic binders, which eventually results in the disintegration of the grid fillers. It is, therefore, apparent that it is only the inorganic binders that can fulfil the requirement. With this in mind, only the inorganic binders have been employed. Best results have been achieved by using sodium silicate and sulphuric acid in definite proportion.

Theoretical Calculations.—On the basis of Faraday's Law, and in view of the oxidation-reduction behaviour of the oxides of lead, the theoretical value of amp-hour has been calculated and given in Table 1. It is apparent from the calculations that composition of the negative and the positive plates should be adjusted in such a way that the former maintains a higher value of amp-hour as compared to the latter.

Experimental

Composition.—A series of compositions were tried as grid fillers incorporating lead sulphate and sodium silicate, as binders. Lead sulphate[4] did not prove a good binder as its incorporation invariably resulted in very poor binding. The work was, therefore, abandoned.

In another series of experiments, lead sulphate was replaced by sodium silicate as binder. The compositions evolved are given in Table 2. It was observed that though good tackiness developed with this binder, yet a defect appeared as the mix dried up at a very rapid rate, making the application inconvenient. To obliterate this draw-back, 50 cc. of 10% sulphuric acid was used for 300 g. of the mix which helped the applicability of the mass. The grids were then filled up with this semi-plastic mass and were pressed mechanically to obtain smooth finish. These were then left to dry.

Effect of Binder on Capacity.[5]—With a view to determining the effect of binder i.e. sodium silicate on the capacity of the cell, experimental work was carried out to study the rate of discharge with two-plate cell, having different percentages of the binder, shown in Fig. 1.

Results and Discussion

1. *Porosity and Expander.*—It is well known that the capacity of the storage batteries primarily depends upon the rate of chemical reaction both at the cathode and the anode. The rate of reaction in turn is governed by a number of factors, such as porosity, area of reaction, concentration of the electrolyte and rate of discharge.

The area of the plate is important as it affords the maintenance of the chemical reaction. In other words, the greater the area the more will be the reaction. But the area itself is a function of porosity, because if the plate is porous then the area gets multiplied manifold. Moreover, the plate being porous, it ensures the deep penetration of the electrolyte. Various materials have been referred which act as an expander or porous aid. These are generally of organic origin and are invariably of considerable cost. As already referred in the discussion under the "composition", carbon black[6] has been used upto 0.5 percent, the addition of which has proved very beneficial, as the porosity of the negative plate has been found to be enhanced appreciably.

Rate of discharge is also of considerable importance and has strong influence on the life and the smooth working of a cell. It is well established that the rapid discharge of the cell brings about a steep fall in the voltage, and as a consequence, the cell becomes inactive very soon. The reason

TABLE 1.—SHOWING THE THEORETICAL CALCULATION OF AMP/.HOUR FOR THE GRID FILLER (200g.)

Polarity of Plates	Composition of filler			Amount of total Pb g.	Amp./ hour
	% PbO	% Pb_3O_4	% Pb		
Negative ..	95	—	5	186	48
Positive ..	85	15	—	167	45

(Electrochemical equivalent for $Pb_3 = 3.866$)

TABLE 2.—EFFECT OF SODIUM SILICATE ON PASTE FORMATION.

% of Binder	2%	3%	4%
Effect on the filling of plates	Becomes hard after some time	Grids can be filled but with difficulty	Very soft and easy to fill the grids

for this behaviour has been studied and it has been found that the pores of the negative plate get clogged with the rapid formation of lead sulphate which inhibits the penetration of the electrolyte and thus renders the active material ineffective.

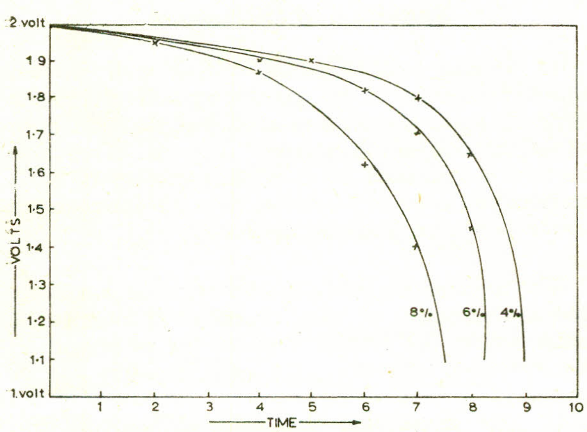

Fig. 1.—Showing Discharge of the Cell at Two Amperes.

2. *Effect of Binder on Capacity.*—It is evident from Fig. 1 that the capacity of a cell has an inverse relationship with the quantity of the binder used. The behaviour of three compositions containing 4, 6 and 8 percent of the binder was studied and it has been found that the best results are possible only if the amount of binder is limited to a maximum of 4 percent. With the increase of binder, the rate of fall of voltage gets enhanced, which is quite obvious from the graph.

3. *Compositions.*—On the basis of the theoretical considerations, it is possible to maintain the same rate of conversion of lead oxide to lead and lead dioxide in negative and positive plates, respectively. The experimental work has, however, proved the contrary. This means that the chemical reaction on both the plates cannot be maintained at an equilibrium without the addition of certain chemicals. Red lead has the inherent capacity, because of 4 atoms of oxygen, to take more time when reduced to lead as compared to lead-dioxide. The grid filler composition has, therefore, been adjusted with the incorporation of red lead and lead powder which consumes more amp-hours in the case of negative plate as compared to the positive, and thus maintains the relative development of positive and negative charge at the same level. The optimum quantities of red lead required for positive plate have been found to be 15 percent and lead powder for the negative plate to be 5 percent. This adjustment has yielded appreciably good results.

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