# "Effect of Plant Exudates on the Life (Total Discharge Time) of a Commercial Lead Accumulator"

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LIFE of a charged accumulator could be increased to about 20% by coating with Acacia gum (Max. 1.65% weight of the negative plate) the active part of the negative electrode of the cell. The increase in the life of the cell has been explained on the basis of electrochemical reactions involving corrosion of the metal lead and imbibed water resulting from breaking of the glycosidal bonds as well as polymerization of hydrol on a tetrad oxygen valence.

## INTRODUCTON

Available reports[1] on lead accumulator storage cell suggest many alternatives for improving their capacity of storing the current, but generally these alternations involve costly chemicals and other practical problems. Chaudhary[2] used plaster of paris and glycerine as electrolyte and zinc, carbon or copper as electrodes in forming a new chargeable cell, while attempts of Edwards[3], Kiehne[4] and Euler[5] have been confined to plant cells, lithium cells and $\gamma - MnO_2$ cells respectively.

Present study has been undertaken to explore the possibilities of increasing the life of the lead accumulators using cheap and easily available materials. Plant exudates[6] have been reported to function as good storage of electricity very recently, hence an attempt has been made in the present work to increase such capacity by adding Acacia gum at the negative plates of the cell.

## EXPERIMENTAL

A lead accumulator was prepared in the conventional way having 7 2 × 2.4 cm area and 100 gm weight lead plates. The cell was charged by Philips battery charger No. C 12/75. Initially the cell was charged and discharged without gum content and afterwards different amounts of purified Acacia gum (weighed by a chemical balance) were coated on the active part of the negative electrode and then again charged and discharged in the similar way. Following results were obtained.

## RESULTS

1. Fig. 1 shows the va iation between discharge time (in hours) and amount of gum acacia (in grams) added to the negative plate.

2. Life of the cell gradually increases and becomes maximum at 1.65 gm of the gum content.

3. Further increase in the quantity of the gum causes decrease in the life of the cell.

4. 1.65% by weight of the gum with respect to the negative plate increased the current storing hours from 15.66 to 18.4 (i.e. about 20% of original value).

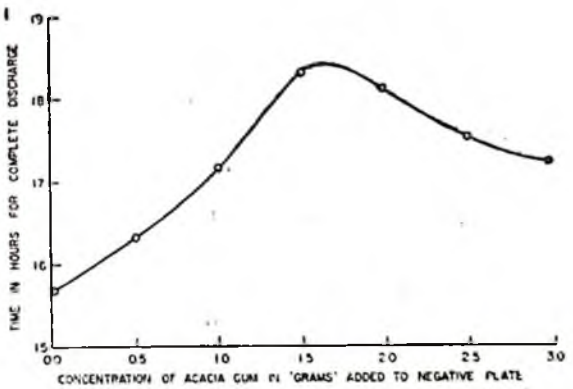



FIG 1- PLOT BETWEEN GUM CONCENTRATION & CORRESPONDING TIME FOR COMPLETE DISCHARGE

## DISCUSSION

The first attempt at formulating the electrode reactions during charging in general, are

At Cathode:- $Pb^{2+} + 2e \rightarrow Pb$ .... .... (1)

and at Anode:- $Pb^{2+} + 6H_2O \rightarrow PbO_2 + 4H_3O + 2e$ (2)

During discharge, the reverse of the above reactions occurs. Relatively high current densities can be

reached during discharge. Exchange current density for the discharge of $H_3O^+$ on lead is low. Importance of this fact may be clearly understood as,

At Cathode during charging, the reaction

$$Pb^{2+} + 2e \rightarrow Pb,$$

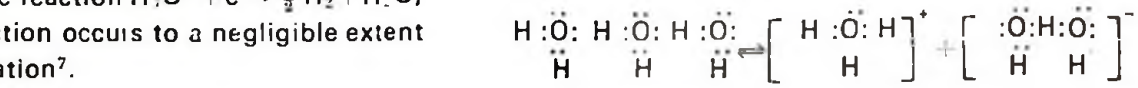
occurs, and not the reaction $H_3O^+ + e \rightarrow \frac{1}{2} H_2 + H_2O$, i.e. this latter reaction occurs to a negligible extent because of the relation[7].

$$\overrightarrow{i} = i_o\, e^{\frac{-\beta.F.\eta}{R.T}}$$

(where i = electron current density, $\eta$ = over potential, $\beta$ = symmetry factor, F = Faraday for a gram ion of ions), and because the exchange current density for the reaction of hydrogen evolution on the lead is particularly low. In this connection theoretical value of energy density is 0.18 Kwh $Kg^{-1}$, but the practical value lies between 0.022 – 0.026 kwh $Kg^{-1}$, but when gum is intimately placed on the negative plate it is observed that hydrogen evolution on lead plate becomes relatively greater and increases with increase in the weight of the gum content. Energy density[6] of gum acacia lies within 0.28 → 0.32 kwh $Kg^{-1}$ thus practical values of the energy of the gum added cells may have an average densities increases with gum content.

Gum Acacia is also found to reduce sulphation (i.e. spontaneous discharge of the storer when it is not supplying electricity). This was verified when the storer with gum was kept in open circuit to restore the energy lost during closed circuit by a little amount, in few minutes; unlike the storer without gum which caused sulphation. Also, the lead and lead dioxide, (which gradually corrode in the presence of sulphuric acid) are inhibited due it presence of Acacia. Thus the part of the current that generally goes in waste during corrosion in ordinary accumulators is utilized in the gum added cells hence they work for a longer time than the cells without gum coating. Acacia has been observed to be corrosion inhibitor very recently[11].

Increase in the life of the cell in presence of gum acacia may also be understood by the released imbibed water of gum Micelles (under the charging dc. potential) which produces active water molecules like hydrone (HOH) or hydronol ($H_2O < \frac{H}{OH}$) to take part in chemical reactions. This water being ionised, because of arabic acid naturally present in the gum acacia causes to suffer self ionization[9] of the water formed in the cell electrolyte. while its discharge. Thus→



This self ionization of water formed during discharge causes the storer to work for a longer time reducing surface projections on the negative plate.

In addition to the above facts the amount of gum material when added more than a definite quantity, resulted in the reduction of discharge hours. This might be due to migration of gum molecules to the upper part of the plate which generally remains inactive because it does not react with acid, being above its level. This was verified when the cells containing 2 gm, 2.5 gm and 3 gm. gum acacia were charged (Fig. 1).

There was evolution of hydrogen with large boubles and at the faster rate. The gum molecules come out with the gas got deposited on the upper part of the cell or even out sides of the wrapper, of the cell. This indicates that the gum content on the active part decreases than the necessary amount to take part in maximum storing of the electricity, hence the curve shows decrease in the life of the cell.

## CONCLUSIONS

1. Gum Acacia has been found to inhibit corrosion of the metals. Other exudation products may therefore be tested in this field to overcome the challange of the corrosion today.

2. Gum Acacia may be utilized in storage batteries to increase their lives which is cheaper than any chemical used so far in this respect, as well as easier to obtain from the forests.

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## REFERENCES

1. Robert. W. Graham, *Secondary batteries-Recent Advances : Chemical Technogical Review No. 106, Novas Data Corp. New Jersey* (1978).

2. M.M. Chaudhary, *Acta Cienc. Indica. Vol. 4 No. 4 P. 440* (1978).

3. W.H. Edwards & N.A. Hampson, *J. Appl. electrochem. (GB) Vol. 9 No. 3 P. 281-7* (May 1979).

4. N.A. Klahne & H. Hess, *Mundo Electron. (Spain) No. 85 P. 69-72* (May 1979).

5. K.J. Euler, *J. Appl. Electrochem. (GB) Vol. 9, No. 3 P. 395-8* (May 1979).

6. T.R. Sukul & A.P. Srivastav, *J. Electrochem, Society U.S.A. (In Press)*

7. J. Bockris & A.K.N. Reddy, *Modern Electrochemistry Vol. 2 P. 88 Planum Press. N.Y.* 1970.

8. H.J. Strauss, *U.S. Patent 2,692,9J4* (1954) *chem abstr. 42, 2222* (1955).

9. A.S. Crafts, *Water in the Physiology of Plants : Waltham Mass USA Published by Chronica Botanica Company* (1949)