MEASUREMENTS WITH A PILOT CELL

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To the user a single cell of a lead–acid battery provides only two items of information concerning its state and that of its components via its electrical connections. The first is the load-free voltage which is thermodynamic. The second item is the voltage under load: it describes, together with the load-free voltage, the internal resistance of the cell as the sum of the internal resistances of the components in its actual state. In the case of a battery of cells two analogous items of information can be obtained via the electric connections, but these only give an average of the individual cells. To obtain more information concerning a lead–acid battery in its different operational states we have developed the pilot cell concept. This is a cell which is able to give a number of independent items of information to the battery user with the condition of the cell representing the total number of cells.

For demonstration purposes a VARTA 5 OPzS 350 cell with tubular plates was equipped with an airlift pump to stir the electrolyte and thus to prevent stratification, an ion-exchange membrane (IAM 500) to measure continuously the average density over the depth of the plates, a state-of-charge indicator (IAM 30) to measure the density of the acid above the plates, a differential-recombinator to determine the stoichiometry of the electrolysis gases, and a sensor to measure the maximum and minimum positions of the electrolyte level.

In this paper the physical background of the different sensors, the construction, and the behaviour during more than 1400 cycles are reported. The effect of the stratification of the electrolyte on the cell capacity is described, as is the relaxation of the acid density due to the slow diffusion into and out of the pores of the electrodes, and how the recombination device shows the different states of gassing until the stoichiometry of the evolved hydrogen and oxygen gas is established, demonstrating clearly that the fully charged state of both electrodes is obtained. It is also shown how the signals of a pilot cell may be used to regulate the charging and discharging process in a self-controlling lead–acid battery.

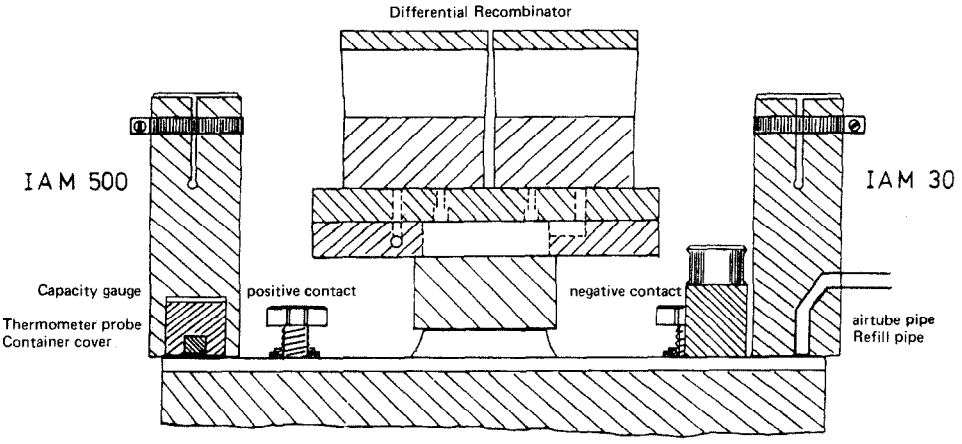

Fig. 1. Cross-section of the pilot cell.