Bulletin of Electrochemistry 6 (2) February 1990, pp 263–265

6V, 60Ah nickel-iron battery

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High reversibility of the charge discharge reaction leads to the longest service life. The iron electrode has low hydrogen overvoltage. Its ionisation potential and hydrogen evolution potential are very close in alkaline medium. As a result, the self discharge of this system is 1-2% of the nominal capacity at 300K [1]. The advanced Ni/Fe batteries with an energy density of 55-82 Wh/kg [2,3] serve as power sources for electric vehicles. The electrode fabrication techniques and the performance characteristics of the 6V, 60 Ah Ni/Fe battery are presented in this paper.

Key words: Nickel-iron battery, high reversibility, electric vehicles

Anode or negative electrode fabrication

The anode active material is a mixture of finely divided iron and ferrous hydroxide. In the presennt work, the negative electrode is prepared by sintering method. Commercially available electrolytic iron powder of an average particle size of 30 micro metre is used for sintering. Sintering is carried out in the temperature range 1123-1173K in hydrogen atmosphere. The porosity of the sintered plate is about 55-60%. The sintered porous iron plate is activated suitably [4] before the battery assembly. Sintered porous iron plates each of dimension 17.3cm × 13.8cm × 0.15cm are used to assemble the battery.

Cathode or positive electrode fabrication

The cathode active material is nickel oxyhydroxide. Carbonyl nickel powder (255) of an average particle size of 15 micro metre is used for sintering, following the same procedure adopted for the porous iron electrode fabrication. The porosity of the sintered nickel plate is about 85%. Nickel hydroxide containing very low quantity of cobalt hydroxide is loaded [5] into the pores by vacuum impregnation of the nickel nitrate solution followed by cathodisation in alkali. Positive plates, each of dimension 17.3cm × 13.8cm × 0.2cm, are used to assemble the battery.

CELL ASSEMBLY

The negative plates (6 numbers) and positive plates (6 numbers) are arranged alternately with nylon cloth as separator. The electrode stack is immersed into 30% KOH solution with 5% LiOH contained in a plastic container provided with a lid. The weight of the fully assembled battery is 12.85 kg.

RESULTS AND DISCUSSION

The assembled 6 V, 60 Ah Ni/Fe battery is charged at 30A and discharged at 60A (1 hr rate), 45A (1.3 hr rate), 30 A (2 hr rate) and 15 A (4 hr rate). The discharge voltage-time plots at different discharge rates are shown in Fig. 1. The plots clearly indicate that the output is almost the same, independent of the discharge rate. The battery is charged and discharged at 2hr rate in the temperature range of 283-303K.The discharge behaviour is shown in Fig. 2. The variation of capacity with temperature is shown in Fig. 3. It could be seen that the output increases with temperature without much loss in the low temperature region. In fact, more than 55% of the capacity is retained at 263K at the 2 hr rate of discharge.

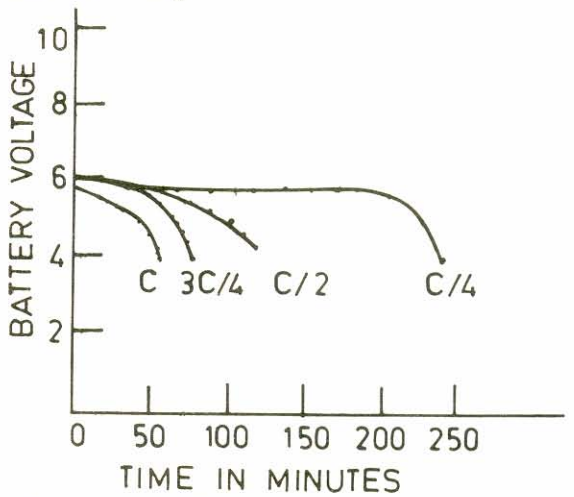

Fig. 1: Discharge at different rates

The self discharge rate is determined after keeping the battery under fully charged condition for 12 hr, 24 hr, 36 hr and 48 hr and the capacity values are presented. The self discharge rate-time plot is shown in Fig. 4.

Life cycle test is carried out automatically on BTS-500 at 2hr rate. Figure 5 shows voltage-time plots at different cycles. The charge-discharge behaviour at 1 hr rate is shown in Fig. 6.

The 6V, 60 Ah battery has so far completed 200 cycles

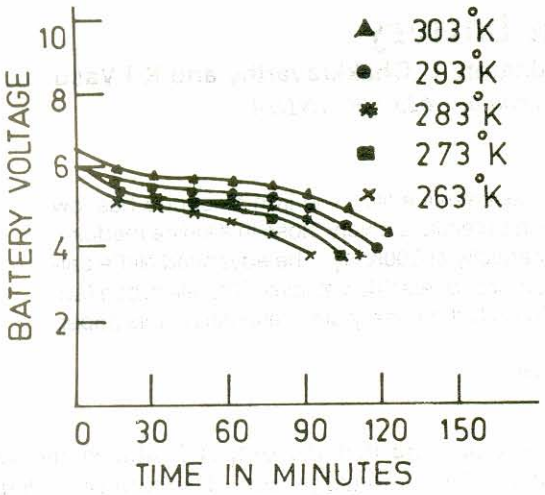

Fig. 2: Discharge (C/2) rate at different temps

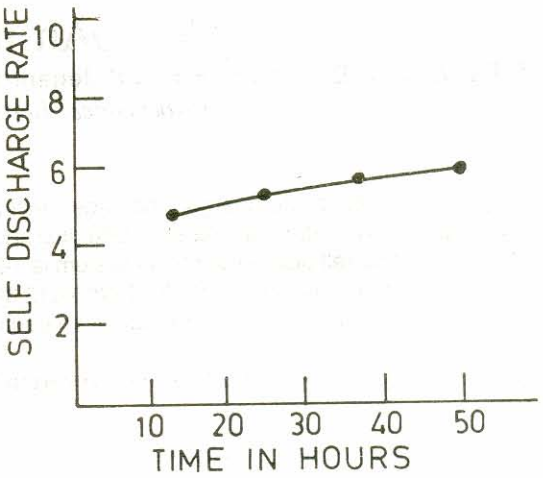

Fig. 4: Charge-discharge at C rate

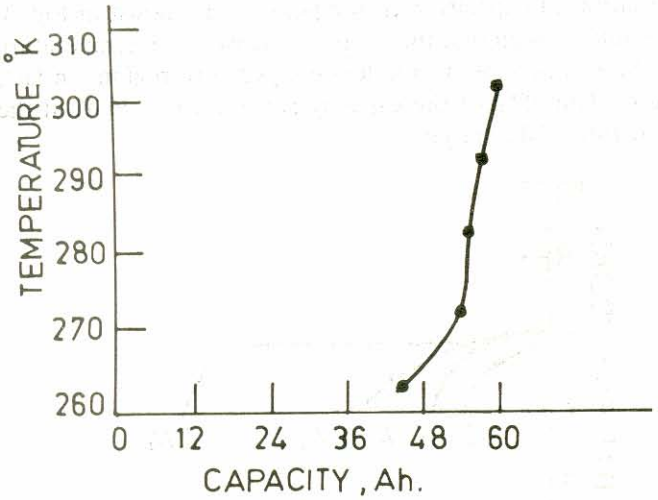

Fig. 3: Capacity variation with temperature

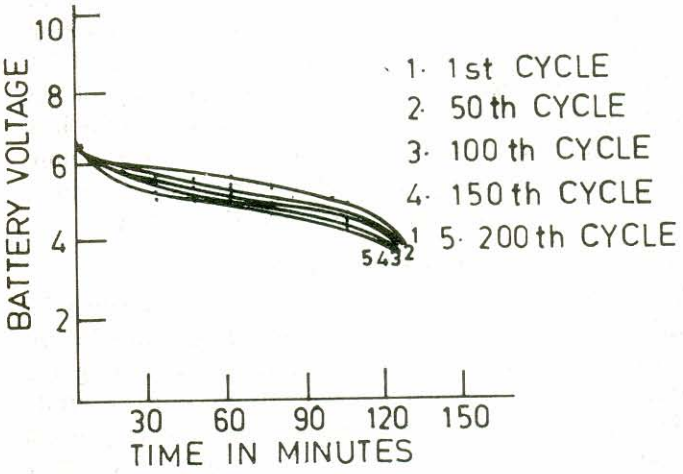

Fig. 5: Discharge after different cycles

of charge-discharge at 2 hr rate. The realized performance characteristics are as follows:

Open circuit voltage	= 1.37 V
Output	= 60 Ah (2 hr rate)
Energy density	= 28 Wh/kg
Energy efficiency	= 80%
Number of cycles completed	= 200

CONCLUSION

The performance of 6V/60Ah battery is fairly good with regard to charge acceptance, energy efficiency, low temperature performance, charge retention and cycle life. The energy density is low, mainly due to the low utilization coefficient of iron.

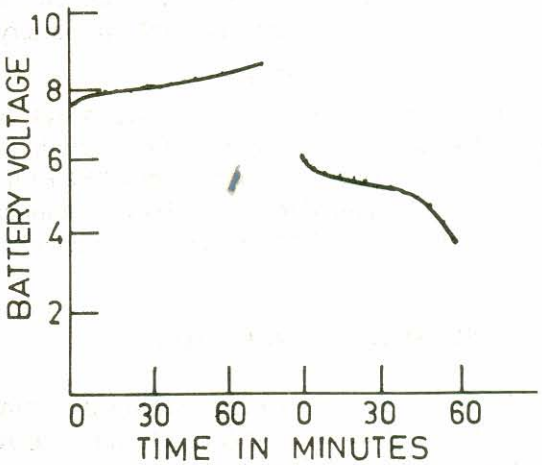

Fig. 6: Charge-discharge behaviour at 1 hr rates

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