Analysis and Design of A Novel Control Method for Aluminum/Air Battery System

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An electric vehicle (EV) can be provided power by an Aluminum/Air Battery System. This research work focuses on the Al/Air Battery System, which is actually a small chemical plant. The Al/air battery has been identified as offering high energy density and having sufficient peak power for an electric vehicle. In addition, the Al/air system offers rapid mechanical recharging, and a range that is compatible with internal combustion engine vehicles [1-3].

The typical structure of a conventional Al/air battery system is illustrated in Fig. 1. Its output power is fixed and determined by its structure. When driving an electric car, we need to change the speed to match the driving conditions. Thus, it is necessary to regulate the output power of the battery system. A novel structure of the battery stack is proposed in this research to provide the required output power. As shown in Fig. 2, the proposed battery structure for the electric vehicle consists of several sub-batteries that are in parallel to form the whole battery. The purpose of sub-batteries is to regulate the output power of the aluminum/air battery system and prolong the lifetime of the whole battery system by making the sub-batteries work in shifts. Each sub-battery is comprised of a number of cells that are responsible for a certain percent of the whole battery power. The electrolyte flow rate and current of a single cell in a sub battery is kept at a constant value to reduce the effect of polarization and corrosion. The output power of a single cell is constant. The output power of the whole battery system is proportional to the number of the working sub batteries. If the power demand of an EV is increased, e.g. in the process of acceleration, more sub batteries are working. The electrolyte flow rate of the whole battery should be varied in proportion to the number of working sub-batteries. If the output power of the battery system increases, the electrolyte flow rate of the whole system should also be increased proportionally keeping the electrolyte flow rate within a single cell at a constant value. Thus the regulation of the output power of the Al/Air battery system turns into flow rate control problem.

The use of sub-batteries is a break-through in this project, which not only makes it possible that the output power of the aluminum/air battery system vary with different demand, but gives a way for optimum use of aluminum and minimization of corrosion. Determining how to size the sub-batteries is a practical problem for the whole battery system design. Driving patterns gives the basis for sizing these sub-batteries. Different driving patterns including modified SAE dynamic capacity test profiles [4] are considered in this sub-battery sizing problem. Fig. 3 illustrates an example of a driving pattern.

The improvement of sub-battery sizing and optimal operation and implementation of this Al/Air battery system with hardware requires additional research work.

REFERENCE