Abstract

It is estimated that the demand for electric vehicles will increase in 2050. This increase will lead to social and environmental benefits. However, the increase in electric vehicles will also lead to an increased demand for charging systems. Knowing the time needed to charge a single electric vehicle, an optimization method is needed to sustain the increase of electric vehicles. This battery charging optimization will optimize the power that the battery uses through charging and optimization methods. Among various charging solutions, battery charging with high current is commonly used because of the speed at which the battery is charged. Although the speed of battery charging is desirable, using a high current to charge the battery will heat the battery to a very high temperature. Using a battery under this condition can significantly reduce the health of the battery used. With the decrease in health, the battery capacity will also decrease alongside the increase in battery charging time due to the decrease in the active cathode. Therefore, a fast battery charging method is needed but does not reduce battery health too much. The problem can be handled by the adaptive multi-stage constant current-constant voltage (MCCCV) method with the help of multi-agent particle swarm optimization (MAPSO). Using this method, it is expected that battery charging can minimize the charging time and affect health, whose parameters can change according to the battery's health. The adaptive observer can estimate the changing parameter of the battery model after the battery SoC is equal to 60%. The MCCCV using MAPSO had a constant temperature during the constant current phase at 35^{O}C with an overshoot of 0.31% or 35.11^{O}C. The constant temperature translates into an expected capacity loss of 0.097%. The MCCCV using MAPSO require 7409 seconds or 2 hours 3 minutes and 29 seconds to charge from 0% SoC to 80% SoC. The time required is more than the 2 hours specified in the research objectives with an overshoot of 3 minutes and 29 seconds or 2.9% late from the intended charge time. This higher than expected charging time is because of the current drop during charging but because of limitation of charge current and temperature impose to battery charging in this research, this is the lowest time needed for MCCCV with MAPSO can achieve. The charge time can be minimized with a higher initial current or a more lenient safe temperature threshold.