Proceedings of the 8th *International Conference on Environmental Science and Technology*
Lemnos Island, Greece, 8 – 10 September 2003
Full paper Vol. A, pp. 294 - 301

ASSESSMENT OF ELECTRIC VEHICLE BATTERY TECHNOLOGIES USING FUZZY LINGUISTIC AND AHP APPROACHES

A. HALOG, M. SAGISAKA and A. INABA

Research Center for Life Cycle Assessment, AIST
16-1 Onogawa, Tsukuba, Ibaraki 305-8569 Japan
E-mail: halog-anthony@aist.go.jp

EXTENDED ABSTRACT

Introduction of zero emission concepts nowadays has opened the way for possible commercial markets for battery-powered electric vehicles (EV). In comparison to gasoline-powered cars, these vehicles produce CO_2 emission half of that gasoline-powered and almost similar amount in comparison to hybrid electric vehicles over their useful lives. Since most of the emissions in electric vehicles are most likely attributable to production of their very large batteries, environmental consequences of producing and disposing of EV batteries may be significant.

The present study aims to analyze environmental impacts associated with recycling and waste management of four electric battery technologies likely to be used in the near future using abridged life cycle assessment (LCA) which produces easily comprehended information about each life stage of a product. Secondly, it aims to select the most environmentally benign battery technology by considering their manufacturing issues (e.g. process and materials compatibility, resource consumption, cost/economic feasibility), political and social viability (e.g. regulatory status, community impacts, global impacts), environmental impacts (e.g. local air, water, soil, solid waste) and exposure and toxicity potential (e.g. community exposure, occupational exposure, environmental exposure, human acute and chronic toxicity). The EVs' battery technologies considered here are lead acid (PbA), nickel-cadmium (NiCd), nickel metal hydride (NiMH) and sodium-sulfur (NaS). In this study, we compared potential health and environmental impacts of four battery technologies and focused on recycling and waste disposal life stages, with an emphasis on design factors that could prevent or increase impacts.

With regard to the evaluation of battery technologies, since the data used are often contradictory, variable, uncertain and sometimes impossible to validate independently, fuzzy linguistic approach is applied here to address this data ambiguity and its results are also being compared to the ranking obtained using the well-known analytical hierarchy planning (AHP) approach. Based on AHP evaluation, the recycling assessment ranks the batteries studied in the following preferential order: NiMH>NaS>PbA>NiCd. In terms of disposal, NiMH and NaS batteries are of greater concern because of landfill impacts while both NiCd and PbA batteries are considered the most favourable. Almost similar results were also obtained using fuzzy linguistic approach.

Key words: electric vehicle batteries, abridged life cycle assessment, analytic hierarchy process (AHP), fuzzy linguistic approach, and zero emission