The 21st IEEE Convention of the Electrical and Electronic Engineers in Israel

IEEE

Proceedings

The 21st IEEE Convention of the Electrical and Electronic Engineers in Israel

11-12 April 2000

Tel Aviv Israel

Proceedings

RESULTS OF ELECTRIC VEHICLE DEMONSTRATION PROGRAM

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oduction

ctric vehicles (EV) for urban transportation can be expected to become widely used during next decade [1]. The introduction of electric vehicles will reduce the air pollution and the se level in cities. Many countries and companies around the world are supporting and eloping zero emission vehicles (ZEVs), [2-4]. These efforts reflect legislative and other ernment actions that result from the growing public awareness of the damaging effects of pollution caused by automotive emissions. For example, California legislation sets a inite timetable for introduction of ZEVs on local markets; it is mandated that 10% of the s sold in 2003 will be zero-emission.

spite of recent developments, the most significant technology barrier postponing the nufacturing of commercially acceptable electric vehicles is the development of a suitable rgy source. The Zinc-Air battery that is being developed by Electric Fuel Ltd. is one of the anced technologies under development today [5].

December 1996, the Israel Electric Corp. (IEC) signed an exclusive license agreement to ize the Electric Fuel Zinc-Air battery technology in the Middle East. The first stage of plementing this agreement was the development of and carrying out a demonstration gram based on a Mercedes Benz MB 410 van that was converted to EV operation. The nicle was equipped with a computerized data acquisition system. The battery data is lected via the battery controller, the data concerning the regeneration of the zinc anodes is lected via the control computer of the regeneration plant.

e purpose of the work presented in this paper was to evaluate road performance of the monstration electric vehicle powered by Zinc-Air battery under typical conditions of the aeli traffic.

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Prescription of the Demonstration Program

The electric vehicle used in the demonstration program is presented in Fig. 1. It is a converted electric version of Mercedes Benz 410 van. The car is driven by zinc-air battery. The demonstration program includes driving the vehicle at constant speed as well as driving it in urban conditions (typical of city center driving in Israel) at various hours during the day and with different driving styles. The experiments also include evaluation of the EV dynamic performance at various stages of battery DOD (depth of discharge) and have been described in detail in [6].

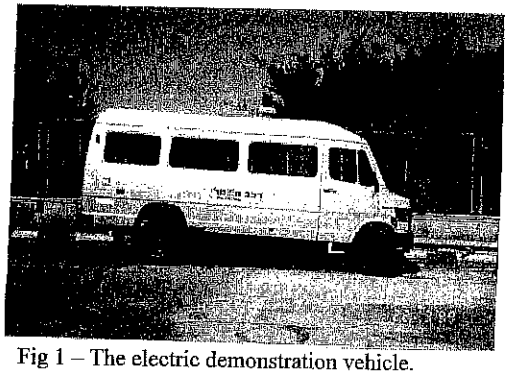
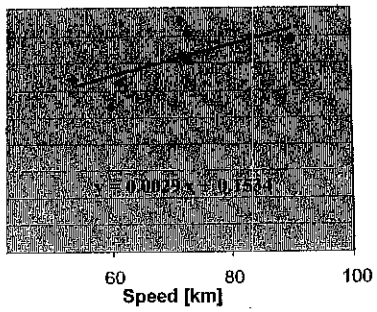


Fig 1 – The electric demonstration vehicle.

Results of the Demonstration Program

The test results of the constant speed phase are presented in Fig 2. As may be observed from the results, the energy consumption is a linear function of the driving velocity. An increase of the driving speed from 50 to 90 km/h result in an increase of the energy consumption from 0.28 to 0.42 kWh/km.

The results of the city center drives are presented in Fig. 3. The results show, as expected, that the energy consumption of the EV is increased as the average vehicle velocity is decreased. The main reason for this is that as the average velocity during the stop-and-go driving is lower, more energy-consuming accelerations are needed. The energy consumption of the EV was measured for three different driving styles: calm, normal and aggressive.
The energy consumption for the normal driving style ranges from 0.9 kWh/km at an average velocity of 20 km/h to 1.4 kWh/km at an average velocity of 8 km/h. It can be concluded that the energy consumption in a congested city center route, where the driving has a nature of stop and go, is drastically higher than at constant speed.



– Energy consumption – constant speed

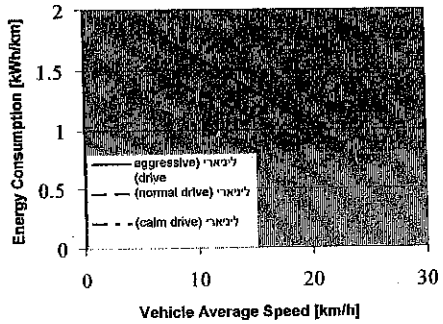


Fig. 3 – Energy consumption – city center driving.

cial series of experiments was performed in order to quantify the influence of the g style on the EV performance. The driving styles were defined according to the ire [7]. Sharp accelerations and sudden brakes characterize aggressive driving style. :ate accelerations and brakes characterize normal driving style. And considerably slow riority set forth driving characterizes calm driving style. It can be concluded that a ion of the energy consumption of 50% and even more can be reached when the EV is trained and drives the vehicle in the right manner.

summarizes the results of the dynamic performance of the EV. The acceleration time en 0 and 80 km/h was calculated as an average of several experiments. The acceleration of the EV when the battery was full was 35.5 sec as compared to 38.1 sec when the y's DOD was 50% charged – increase of only 7%. These results demonstrate that the idency of the power density on the charging state of the battery is relatively low.

est program included 20 demonstration The average range that was measured en battery recharges was approximately 300 r drive. It is important to mention that most e drives were urban ones. Therefore the y consumption was high and the istration vehicle was equipped with a ely out-of-date propulsion system that les transmission gear and a clutch that d unnecessary energy losses.

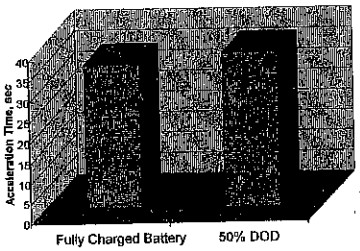


Fig. 4 – Acceleration time between 0 – 80 km/h.

Conclusions

It was observed that at constant speed driving within the range of 50 to 90 km/h, the EV's energy consumption varies from 0.28 to 0.42 kWh/km respectively. This means that the equivalent diesel fuel consumption of this large van (maximal allowed weight is 4.5 ton) ranges from 3 to 4.5 lit./100km, pointing out the high operational efficiency of the electric drive train.

The results of the urban driving experiments demonstrate the importance of the driving style in achieving minimal energy consumption and as a result – maximal vehicle range. A calm driving style without sharp accelerations and decelerations can save up to 50% energy when compared to an aggressive driving style.

The results of the dynamic performance test of the EV demonstrate that the dependency of the power density on the charging state of the Zinc-Air battery is relatively low.

The test program included 20 demonstration drives. The average range that was measured between battery recharges was approximately 300 km per drive. It is important to mention that most of the drives were urban ones therefore the energy consumption was high and the demonstration vehicle was equipped with a relatively out-of-date propulsion system that include transmission gear and a clutch which caused unnecessary energy losses.

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