B-17.2 Analysis of the causes to prevent for spread electric vehicles widely

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Abstract

The causes to prevent for spread electric vehicles (EV) are analyzed by hearings, inquiries and driving tests. In a lightweight transportation in a city, the maximum range per charge and the weight of load should be 150km and 2 tons, respectively. And in taxies the maximum range should be 350km and 300km, for small sized and midium sized taxi, respectively. Driving test were made by using a lightweight electric truck, an electric mini-car and a prototype electric passenger car. Acceleration and maximum velocities were enough in each car. The energy consumption rate of the electric mini-car was about the half of the same size ICE (internal combustion engine) car. To compare the characteristics of an EV with an ICE car, the items of evaluation are selected. An electric car has advantages on environment and energy, and disadvantages on the driving performances, economics, functions and enjoyment.

Key Words Wide Spread, Practical Use, Driving Test, Evaluation of EV

1.Background

About 16% of CO_2 is emitted from automobiles in Japan. An electric vehicle (EV) is one of the effective measures to decrease the emission of CO_2 in the transportation field, because the primary energy consumption rate is much better than that of an ICE car.

The performances of the present EV are much lower than that of ICE internal confusion engine car. The price of an EV is also much higher because it is hand made. To decrease such disadvantages is very important to spread electric vehicles widely.

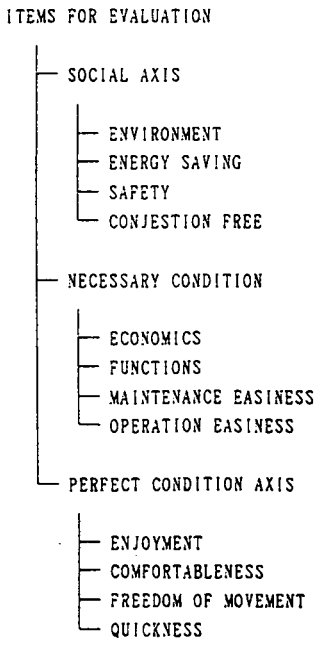

Fig.1 ITEMS FOR EVALUATION OF ELECTRIC VEHICLES

2.Objective

The purpose of the research is to analyze the courses to prevent

for spread electric vehicles, and find the way to decrease the disadvantages.

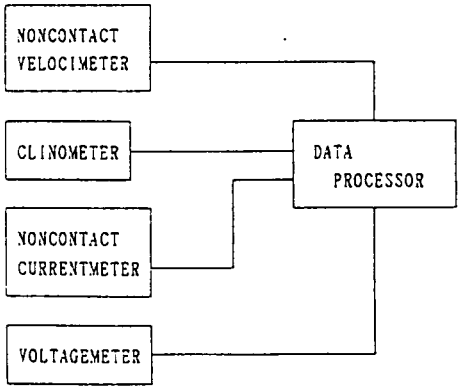

Fig. 2 TESTING INSTRUMENT

3.Research Method

To spread an EV widely, the disadvantages should be decreased and the advantages must be increased compared with conventional ICE cars.

To analyze the courses to prevent for spread EVs, the items to evaluate the characteristics of vehicles were selected. Fig.1 shows these items. These items are composed of three categories. The first is the social axis which include environment, energy, safety and conjestion free. The second is the necessary condition axis. Economics, functions, maintenance easiness, operation easiness belong to the category. The third axis is the perfect condition. Enjoyment, comfortableness, freedom of movement and quickness are in the axis.

Table 1 SUPECIFICATIONS OF EV'S WHICH WERE TESTED

	LIGHT TRUCK	MINI-CAR	PROTOTYPE PASSENGERCAR
SIZE			
LENGTH(m)	4.975	3.295	4.87
WIDTH(m)	1.795	1.285	1.77
HEIGHT(m)	2.800	1.330	1.26
WEIGHT			
CURBWEIGHT(kg)	4.860	850	1.573
PASENGERS	2	2	4
LOAD(kg)	1.250		
TOTAL WEIGHT(kg)	6.220		1.793
DRIVING SYSTEM			
MOTOR	SHANT WIND	BLUSHLESS DC	BLUSHLESS DC
RATED POWER, VOLTAGE, TIME (kW, V, HOUR)	33·108·1	4·96·CONTINUOUS	6.8·288·CONTINUOUS
MAX, POWER, VOLTAGE, TIME (kW, V, sec)	100·108·30	8·96·-	25·288·20
CONTROL METHOD	CHOPPER	PWM	PWM
CONTROL DEVICE	TRANSISTOR	IGBT	IGBT
BATTERY			
TYPE	LEAD ACID	LEAD ACID	Ni-Cd
CAPACITY, VOLTAGE (Ah, V).	150·12	150·12	100·12
NUMBER	27	8	24
WEIGHT(kg)	1215	360	531
PERFORMANCES			
MAX VELOCITY (km/h)	110	90	176
ACCELERATION (sec)			18.01(0→400m)
RANGE (km) (40km/h CONSTANT)	100	240	548

Hearings and inquiries were made for user of EVs and automobiles, respectivity, to evaluate each items. In the driving test, an instrument for testing was developed as is shown in Fig.2, and it was used in the actual driving test.

The EVs used for the driving test were a light truck, an electric mini-car and a prototype passenger car. The specifications of each EVs are shown in Table 1.

4.Result and discussion

1)The results of the hearing.

The results of the hearing to a user of EVs are as next.

(1)Although it is considered that the range per charge is the biggest problem, it is not always the problem because the drivers understand this problem and they don't drive long range.

(2)The acceleration and the maximum velocity used to be a big problem also. In the new developed ones these performances increased so much.

(3)The request of a precise battery capacity meter is strong.

(4)The energy consumption rate varies greatly by each drivers. This occurs the difference of acceleration pattern.

(5)Defroster and heater sometimes consumes electricity greatly and they decrease the range.

(6)Water supply to batteries is bothering the user.

(7)The cabin and luggage space are decreased by batteries.

(8)The cost of the battery change is felt more expensive than the initial cost of the EV.

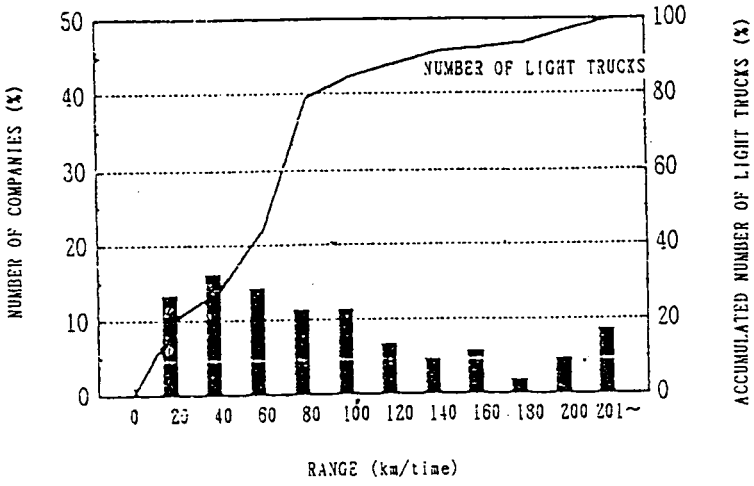

Fig. 3 THE NUMBER OF COMPANIES AND THE ACCUMULATED NUMBER OF LIGHT TRUCKS AS A FUNCTION OF RANGE

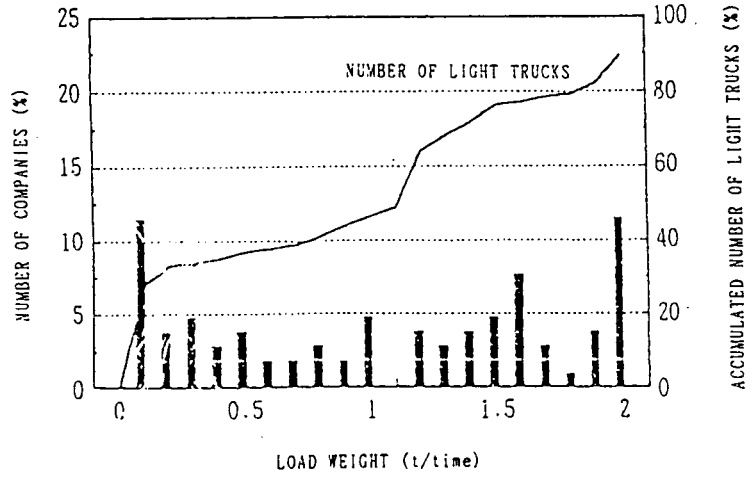

Fig. 4 THE NUMBER OF COMPANIES AND THE ACCUMULATED NUMBER OF LIGHT TRUCKS AS A FUNCTION OF LOAD

2)Results of the inquiry to the automobile users.

Transportation companies, taxi companies, newspaper transportation companies and post offices are selected as users. Figure 3 shows the relation between range per transportation and the percentages of the number of company and accumulated

number of trucks in 31 transportation companies. From the figure, the range per transportation of less than 60km is 45%, less than 100km is 85% and less than 150km is 92% trucks.

Figure 4 shows the relation between the weight of load per transportation and the number of the company and the accumulated number of trucks. From the figure, the weight of load of less than 1 tone is 47%, less than 1.5 tone is 73% and less than 2 tone is 90%. These results shows that if the range per charge is 150km and load is 2 tone in an transportation light truck, it is almost enough for practical uses.

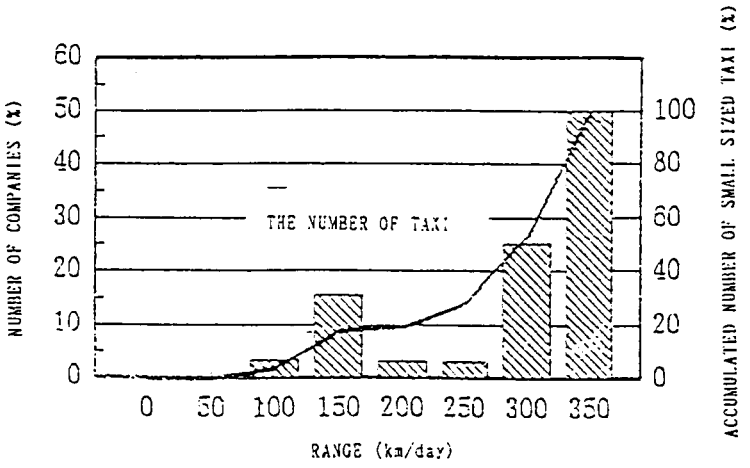

Fig. 5 THE NUMBER OF COMPANIES AND THE ACCUMULATED NUMBER OF SMALL SIZED TAXI AS A FUNCTION OF RANGE PER DAY

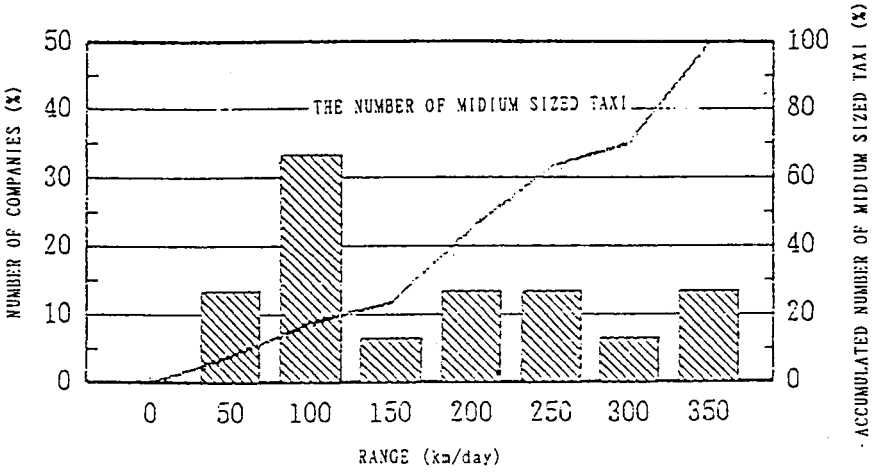

Fig. 6 THE NUMBER OF COMPANIES AND THE ACCUMULATED NUMBER OF MIDIUM SIZED TAXI AS A FUNCTION OF RANGE PER DAY

Figure 5 shows the relation between the range per day and the percentage of the number of companies and the accumulated percentages of the number of cars in the category of small sized taxi. Figure 6 shows the result for medium sized taxies.

From these figures the required ranges per day are 350km and 300km for small sized and medium sized taxies, respectively.

3)The results of driving test

At first, the free deceleration test, acceleration test and crusing drive test were made for the light truck.

The drag of a car is composed of rolling drag and air drag. Rolling drag is almost independent of velocity and air drag is proportional to the square of velocity. These values can be obtained separately by the free deceleration test. The result of the measurement is shown in Fig. 7.

Figure 7 shows the relation between velocity and the drag. From the experimental line of the drag, Cd=1.03 and μ =0.011. The acceleration was measured also and the result was 7.4sec when 0 to 50km/h full acceleration. As the acceleration time of ICE light truck was 8.5sec, the

acceleration of the electric truck was better than that of ICE light truck. From the cruising test, the efficiency of drive train was obtained by the use of the value of air drag and rolling drag, and the measured value of the efficiency was 88%.

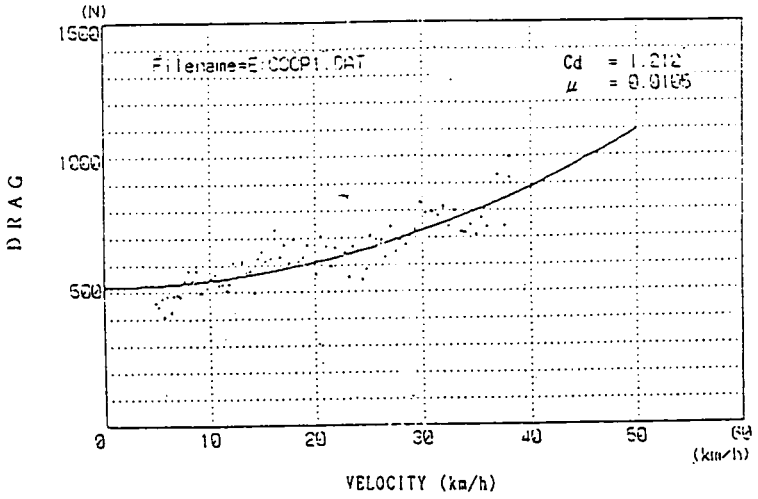

Fig. 7 THE RESULT OF THE FREE DECELERATION TEST

The result of the driving test in a city is shown in Table 2. From the table, the range per charge for the practical use in a city is 35.2km. When the time of deliveries increase, the times of stopping increase, then the range per charge decreases. Even the range is the level as is shown in table 2, it is concluded that the light truck is useful if it is used within a clouded city.

A long range running test was made in the mini-car. The round trip driving was done between Tokyo and Osaka. The total round trip distance was 1164km. On the test, the same sized gasoline ICE car was driven at the same time. The result is shown in table 3. In the table, the electric power consumption rate was measured at the input of the charger.

From the table, both the energy price and the primary energy consumption rate of the EV is about the half of the ICE car.

The prototype passenger car is 4 persons sporty type one. The car is developed under the concepts as nest; ① select highest technologies from automobile, electric and material technology, ② select a low loss driving system and ③ make a body and frame as an electric vehicle. As is shown in table.1 this EV has very high performances.

Table 2 THE RESULT OF DRIVING TEST OF A LIGHT TRUCK

CASE	CITY NORMAL DRIVE	LONG RANGE LITTLE DERIVERY	SHORT RANGE MANY DELIVERY
DRIVEN DISTANCE(km)	15.2	13.8	7
ENERGY CONSUMPTION (kWh)	21	21	15
ENERGY CONSUMPTION RATE (kWh/km)	1.38	1.52	2.14
RANGE PER CHARGE(km)	35.2	32	22.7
DRIVING TIME (km)	45	110	140
AVERAGE VELOCITY (km/h)	20	7.45	3.0
DRIVING TIME PER CHARGE (hour)	1.73	4.2	7.5

The purpose of the driving test of the prototype EV was to check the characteristics other than that the driving performance. The positive results were that the acceleration

Table 3 ENERGY CONSUMPTION IN A LONG RANGE DRIVING TEST

	ELECTRIC MINI-CAR	ICE MINI-CAR
ENERGY CONSUMPTION	164 kWh	-----
GASOLINE CONSUMPTION	----	68 ℓ
ENERGY COST	¥ 4,100	¥ 8,160
ENERGY CONSUMPTION RATE (HEAVY OIL BASE)	41 ℓ	90 ℓ

feeling is better than that of an ICE car especially at the highter speed, and the handrining of the staring is smooth. Negative results are that the yor moment is larger compared with conventional ICE car because of the setting of batteries, and the matching of regenerative and mechanical breaking is not smooth.

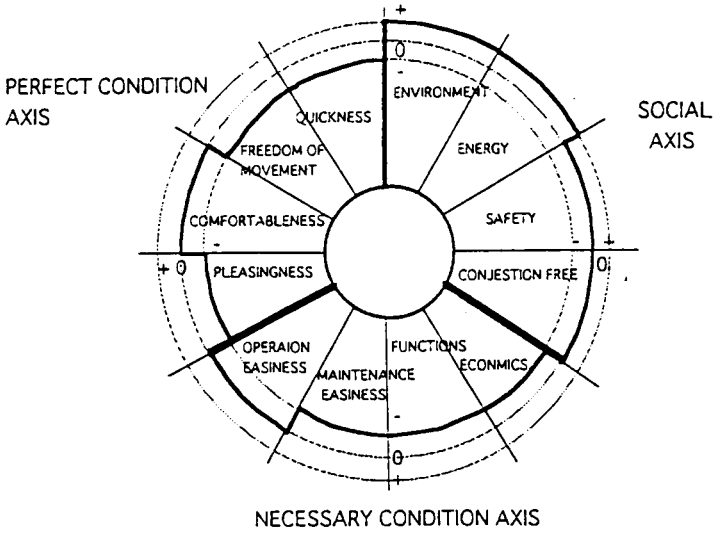

Fig.8 EVALUTION OF AN EV COMPARED WITH AN ICE CAR

5.General discussion of an EVs.

The general discussion of the characteristics of an EV will be made. Over all results are shown in Fig.8. In Fig.8, +1 is assigned in the items where an EV has advantages obviously, -1 is for disadvantages, and is neutral. From the figure, an EV is fine in environment and energy saving. And it is fail in economics, functions, maintenance, pleasantness, freedom of movement and quickness.

6.Conclusion

In this report, the course to prevent for spread electric vehicle were analyzed, by hearings, inquires and driving tests. As a results, several disadvantages were pointed out. The possibility to decrease these disadvantages with be discussed in (5).