ECONOMICAL AND SOCIAL EFECTS OF „SDMC" COMPUTER CONTROL SYSTEM IMPLEMENTATION IN THE URBAN ELECTRIC TRANSPORT

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Abstract **– Modernization of the urban electrical transport with computer systems on new technologies, in particular, IGBT-technology, is the way of solving of economical using of electrical power. In this paper is presented the three years positive experience of the trolleybus modernization from electrical transport department of Chisinau with computer control system type „SDMC", developed and produced by STE "Informbusiness".**

Keywords: computer control system, urban electrical transport, trolleybus modernization, economical-social effects.

1. INTRODUCTION

The urban electrical transport is more ecological mean of transport. Annually, about 3 trillion of passengers with urban transport are made, which about 50% are referred to the electrical transport [1-2], but in the some countries, such as Russia, Ukraine, Moldova, Romania and other, the most vehicles have an advanced moral and technical degradation state, the service is at the low level, functioned time is about 8-10 years, the traction motor control is usually traditional with serial starting rheostats in the rotor circuit, that leads to 25-35% damage of electrical energy. From the other hand, the traction motor protection is very primitive and the motor are defected by following causes: upload – 30%; corrosion – 19%; nominal parameters overflow – 13%; low ventilation – 10%; rotor defects – 12 %; other – 5% [1-2].
In such situations the ways of economical efficiency increasing of electrical transport are development and implementation of new technologies for transport units and relevant electrical network, that will permitted to minimize the electrical energy consumption. These technologies are directed to efficient using of traction and braking capacities of transport units, also its large utilization in the electrical networks for urban transport.
The problems of the urban electrical transport are already known [1,2,4], having the same characteristics for the most departments of the urban electrical transport with a some nonessential exceptions. It have a reason to mention some facts, that reflects the situation of the electrical transport department form Chisinau before the period of trolleybus modernization: the annual cost of electrical energy over consumption was about 20-30 mil. Lei. The similar situation is in the most big cities of the East Europe and other regions [1,2,4].

2. Economical and social effects analysis

It is known so named trolleybus energetic diagram, that reflects the level of expending and inefficiency of traditional control means based on the serial rheostats, especially in the transient regimes of operation.
To exclude these essential expending of electrical energy, it is used the computer control systems, that can to minimize the electrical power consumption in the stationary, also in the transient regimes of operation, and in some cases have the possibility of recuperation of energy in the braking regime.
The all world experience of electrical transport utilization and the simplest calculations shows, that implementation of the thyristor electronic control systems on the transport units gives the possibility to economize about 30-35% of the electrical energy, and in the some cases and especial conditions, that depends on climate and topographical factors tends to 50%. This will produce an essential economic and social effect. For example, in the Novosibirsc city (Russia, West Siberia) the annual consumption of electrical energy constituted 57.523.000 kWh, but the using of electronic control system can to economize about 20.133.000 kWh. Having the cost of electrical energy 1,17 Rub./kWh, this permits to obtain the economy 27.582. 300 Rub. (about 1.021.567 USD), respectively for a transport unit - 105 341 Rub. [4].
It need to be mentioned the important moment, that thyristor electronic control systems have some disadvantages:

- low frequency of control (f = 400 Hz);
- a large volume of the control units (causing by big condenser and inductances);
- limited of the control modes;

- a fixed logical scheme for one trolleybus model, that made impossible to extend on the other models.

Actually, there are exist an another way to solve these problems: electronic control system on base of microcontrollers with IGBT-type transistors, that practically permits to exclude all the mentioned disadvantages [1,3,4].

The Scientific and Technical Enterprise (STE) „Informbusiness" from Chisinau city was proposed already in the 2000 year to develop and produce high performance computer control systems for electrical transport units with IGBT-type transistors, which have the following distinguish sides:

- possibility of implementation on the more models of trolleybuses with a simplest soft reconfiguration;
- to have a low cost accessible for the most of the trolleybus parks;
- to have a reduced volume to be mounted in the driver cabin.

Recently STE "Informbusiness" have obtained practically these performances: it was developed and it produces a family of such systems, named SDMC-103, that can be mounted on the new models of trolleybus of a diverse manufactories, also on the old type of trolleybuses after capital reparations [3]. This way is used in the some trolleybus parks of the Chisinau from 2004 year and other cities. Now in the trolleybus parks of the Chisinau there are 36 trolleybuses type ZIU-9 (Russia) modernized after capital reparations and 20 trolleybuses type ЮМЗ – Т2 (Ukraine), with mounted from start computer control system SDMC-103.

Considering the saved up experience, in the current paper is proposed one method of calculation of economical effect obtained in the results of implementation of the computer control system type SDMC-103 on a new trolleybuses and after modernization of trolleybuses after capital reparations. The goal of the proposed method is the detailing of the all sides to will come nearer the calculated results to the real values and to have some possibilities for adaptation for particular cases for diverse cities.

The proposed method include the following compartments of economical effect calculations subsequently:

- substitution of the high cost equipment;
- simplification of the reparation and service procedures and increasing the resources of the trolleybus components;
- reducing the electrical power consumption during the operation.

The first compartment includes the expenses having connection with costs of rheostats type control equipment installed on the traditional trolleybuses, but is lack on the new types and after capital reparations:

$$C_1 = C_{utl} + C_{cab} + C_{man}$$

where: C_{utl} - costs of the substituted base equipment (rheostats, contactors, voltage converters, etc);

C_{cab} – costs of the substituted cable;

C_{man} – costs of the assembling/disassembling works.

The second compartment covers more sides, that are referred to operation and reparation of the trolleybuses. It need to be mentioned, besides the main effect – reducing of the electrical power consumption, there are a lot of additional effects, that must not be ignored:

- the traditional base equipment: rheostats, contactors, voltage converters requires expensive costs for the service and maintenance, after modernization these expensive costs are excluded;
- the substituted base equipment decrease the weight of the trolleybus;
- computer control system SDMC-103 provides the most the best operation regime and protection for the traction motor: overloads, overheating, short-circuits, that increase the operation time about 45-50%;
- computer control system SDMC-103 contains control algorithms, that provides a lent accelerating/braking regimes, therefore the resources of the transmission are increasing about on 50%;
- an another important side is decreasing the number of idle-time trolleybuses from the park, owing to decreasing of reparation time.

Thus, the cost of the second compartment is formed by:

$$C_2 = C_{ser} + C_{resm} + C_{resm} + C_{rep}$$

where: C_{ser} - the cost of reparations and service for the substituted base equipment;

C_{resm} – economy of means, because of life time increasing of the traction motor about 45 – 50%;

C_{rest} – economy of means, because of life time increasing of the transmission about 50%;

C_{rep} – economy of means, because of idle time decreasing during the trolleybuses reparations.

It is proposed to using the following calculation mode for the third economy of means C_{rep}:

$$C_{rep} = T_1/(T_2 \cdot N_{zile}) \cdot C_{trol}/T_3,$$

where: T_1 - idle time decreasing in trolleybus reparation;

T_2 – the one day operation time of the trolleybus ;

N_{zile} – the annual average number of operation days of the trolleybus ;

C_{trol}- trolleybus cost ;

T_3 – the total average number of operation days of the trolleybus .

The third compartment reflects the economic effect based on the electrical power reducing, owing to implementation of the computer control system SDMC-103. This effect is proposed to calculate by following way:

Nr. park	C_1, MDL	C_2, MDL	C_3, MDL	T_3, years	C_0, MDL
1	68.250	44.500	73.063	10	1.243.875
2	62.500	43.750	73.063	10	1.230.625
3	69.500	40.750	73.063	10	1.207.625
Average:	**66.750**	**43.000**	**73.063**	**10**	**1.227.375**

Tabl. 1. Economical effect of trolleybus modernization.

$$C_3 = \eta \cdot (E_r \cdot N_{zile}) \cdot C_e$$

where: E_r – one day electrical energy consumption of the trolleybus with rheostat control unit;

N_{zile} – annual average days of trolleybus operation;

C_e – the cost of electrical energy ;

η – the grade of electrical power reducing of the trolleybus with computer control system under the attitude traditional trolleybus :

$$\eta = (E_c / E_r) \cdot 100\%$$

where: E_c – one day electrical energy consumption of the trolleybus with computer control system.

The total economic effect obtained for un modernized trolleybus on the hole operation time is calculated by using the following formula:

$$C_0 = C_1 + (C_2 + C_3) \cdot T_3$$

where: C_1 - the expenses having connection with costs of rheostats type control equipment;

C_2 – economy of means, because of increasing of operation time of traction motor, transmission and of idle time reducing during the trolleybus reparation;

C_3 – economical effects based on reducing of electrical energy consumption;

T_3 – the total average number of operation days of the trolleybus .

The proposed method was used for economical effect calculations in the parks of electrical transport department from the Chisinau city. It was obtained the following results:

4. CONCLUSIONS

The successful experience of modernized trolleybus service and operation was presented at the conference on problems of electrical transport from the CSI countries in may 2005. This experience show that it is very favourably from technical, economical and social point of view to modernize the trolleybus parks from Chisinau city, also from other cities.

Now the computer control systems SDMC-103 are used in some cities from, Santk-Petersburg, for example, because of combination of possibilities flexible functionality, low dimensions and weight, also a very attractive cost. The SDMC-103 systems are large used on new models diverse trolleybus of some manufactories, such as S.A. “Trans-Alfa” (Vologda, Russia), “IUJ-MAS” (Dnepropetrovsk , Ukraina).

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