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Prospects for conversion to electric drive of agricultural machinery in Uzbekistan

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ABSTRACT: The article analyzes the state and problems of operation of the fleet of existing mobile technical means in agriculture of the Republic. Of the 52 thousand tractors, 57% are inter-row, 41% are transport. 31% of tractors have passed their service life. The relatively low efficiency of providing fuel and lubricants to remote areas affects the quality of agricultural activities. The process of updating equipment requires a huge amount of foreign currency due to the low level of localization of production of agricultural equipment by local manufacturers. The reason for this is the inability to produce in accordance with international requirements such basic components of tractors as diesel engines, gearboxes, rear and front axles, etc.due to a lack of qualified specialists and appropriate technologies. Information is given about the experience of developed countries in the development of electric tractors and charging stations. Based on the experience of developed countries in transferring mobile technical means to an electric drive and taking into account the scientific and technical base of the Republic, a model of strategy for transferring agricultural machinery to an electric drive in Uzbekistan is proposed.

I. INTRODUCTION

The problem of efficient and rational use of water, land, energy and other resources makes it necessary to constantly improve the system of machinery in agriculture. In connection with new scientific achievements, electrified technologies are becoming more and more widespread in the implementation of various agricultural activities. Agricultural and reclamation equipment is also gradually being converted from small tractors to electric traction. And in the future, it is expected to transfer more powerful tractors.

In recent years, the indicators of energy availability in the agricultural sector of the Republic have significantly increased. Previously, producers were mainly engaged only in growing agricultural products, but now they are gradually developing new technologies for processing, storing and transporting grown products. There are new types of services in rural areas. All this together leads to an increase in the requirements of consumers of transmitted electric energy in quantitative and qualitative terms. [1]

Analysis of the current state shows that the entire composition of mobile agricultural machinery runs on organic fuel. Often, due to organizational or financial reasons, agricultural machinery is idle in many farms in remote regions due to a lack of fuel and lubricants. As a result, sowing operations are carried out late or manually, and plants are not processed enough. If we add here a high share of oil products imported to the Republic, the relevance of diversifying the energy base of agricultural machinery through the transfer to electric drive is not in doubt. [2]

If the transition to electric drive of agricultural machinery in the world is at an early stage, the automotive industry has already entered an active phase in these indicators, and according to Moody's forecasts, by the end of the 2020s, 35% of cars sold will run on alternative energy sources, so the demand for gasoline will significantly decrease. The international energy Agency notes that by 2020, the number of "battery-powered" cars will be 9-20 million units, and by 2025 – 40-70 million.

In turn, Goldman Sachs predicts an increase in the share of electric vehicle sales to 8% by 2030 and 32% by 2040. The Bank's analysts estimate that the battery market for such vehicles will increase from $ 450 million in 2015 to $ 180 billion by 2040.

The main drivers of growth in this direction, experts call the reduction in the cost of lithium-ion batteries, which is faster than expected, as well as favorable conditions offered by companies and even entire States. Following France and the United Kingdom, which decided to ban the sale of cars with gasoline and diesel engines from 2040, China

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announced its intention to determine the optimal time frame for the introduction of a ban on the production and sale of such cars.

At the same time, more than two million electric vehicles are already in operation in the world and there is a corresponding network of electric gas stations. In developed countries, the construction of new electric filling stations is rapidly developing, their mobile versions are being operated, and work is underway to develop mobile power plants based on renewable energy sources.

II. PURPOSE OF RESEARCH.

Development of a strategy for converting agricultural machinery to electric drive in Uzbekistan based on the analysis of world experience and scientific, technical, and production capabilities. Development of a system that provides for a full cycle of activities (research, training and retraining of personnel, creation of production facilities with maximum localization and a wide service network) production and operation of electric tractors.

III. MATERIALS AND METHODS

There are 241 thousand units of agricultural machinery in the Republic, including 52 thousand tractors. The level of tractor availability is 54% in vegetable growing, 48% in horticulture and viticulture, and 55% in animal husbandry. Of these, 57% are tractors for inter-row processing, 41% are transport tractors, and 31% of tractors have passed their service life.

To compare tractors with a diesel engine and an electric drive, the method of determining the energy indicators of tractors under operating conditions in the transition mode is applied. This method allows you to obtain a traction characteristic in operating conditions.

In the middle of the twentieth century, electric tractors were created in the former USSR, preparatory work was carried out and corresponding economic tests were carried out, including in Uzbekistan. Power supply to such tractors was provided from a cable clamp. These studies were suspended due to the lack of appropriate batteries.

Since the beginning of the twenty-FIRST century, all multinational companies specializing in the production of batteries have invested heavily in the development of high-performance batteries for mobile equipment. For example, the Israeli strartapStoreDot has developed a battery that can be fully charged in just five minutes, and the amount of energy received during this time will provide an electric car with a mileage of 300 miles (480 km). To show its technology in action, StoreDot demonstrated the prototype's capabilities on stage at the CUBE Tech Fair in Berlin.

Samsung SDI also introduced cells and modules based on the new "21700"cylindrical battery standard. The "21700" battery has a diameter of 21 mm and a height of 70 mm. Its capacity is 50 % larger than the existing "18650" battery (18 mm in diameter and 65 mm in height). Its size is optimal for maximizing capacity and service life. The "21700" battery has attracted the attention of major global automakers as the standard for the next generation of electric vehicles.

Given the above achievements, along with well-known automakers, well-known manufacturers of agricultural machinery began to invest heavily in the development of electric tractors.

An electric tractor based on the HTZ-3512 tractor was created at the Kharkiv tractor plant together with Avtoenterprise. This class 0.6 electric tractor is equipped with 24 kW electric motors from the Japanese company Nissan Motors and lithium-ion batteries. The total battery charging time is 2-4 hours. In the transport version, it can work up to 8 hours, in the aisle processing time is up to 4 hours without interruption. The electric tractor can transport loads weighing up to 2 tons at a speed of 40 km / h using trailers.

At the agricultural exhibition in Hanover, Fendt presented its e100vario-duty electric tractor with a capacity of 50 kW, which can work up to 5 hours on a full charge. It has an additional regenerative braking system, which makes it possible to get additional backup energy. Equipped with a lithium-ion battery. Using the European standard IEC 62196 Type 2konnektor, the battery can be charged up to 40% within 80 minutes. There is also the possibility of charging from a three-phase 400V system.

John Deere presented a prototype electric tractor equipped with batteries for 130 kWh model SESAM (Sustainable Energy Supply for Agricultural Machinery) using only an electric drive. Instead of a diesel engine, 130 kWh battery packs and two 150 kW electric motors are installed. The power of the SESAM is 402 horsepower.

The sharp reduction of parts increases reliability and reduces the cost of repairs . A full battery charge provides operation for about 4 hours under normal operating conditions or a power reserve of about 55 km. It takes approximately 3 hours to charge. The battery life is about 3100 cycles. [3]

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If we compare the designs of tractors that run on organic fuel and electric energy, the main factor that shows the efficiency of electric tractors is the absence of such components as the diesel engine, gearbox, fuel equipment, cooling system, rear and front axles that increase the weight, reducing the reliability of the tractor. Figure -1.

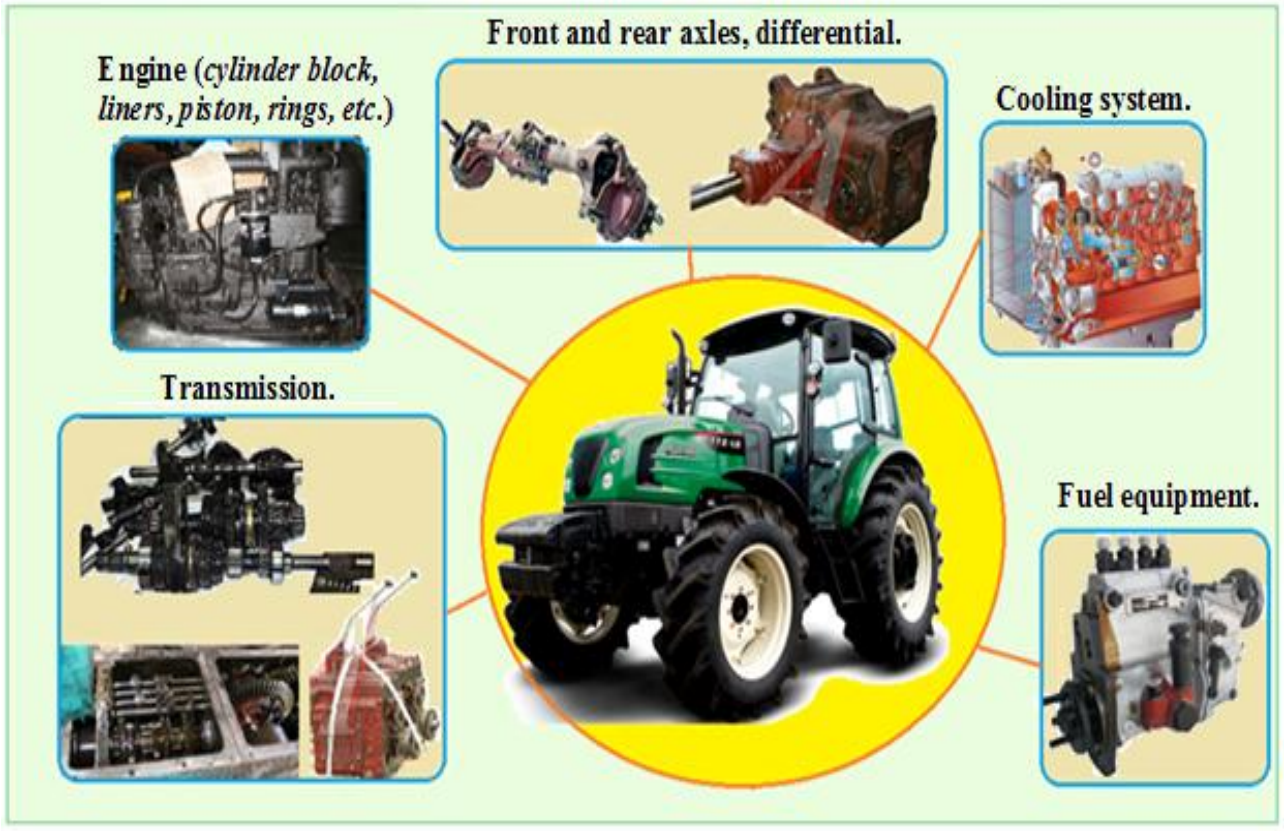

Fig. 1. Parts that have a great influence on the reliability and quality of the tractor when operating a diesel engine.

And in tractors with electric drive, either there are no such components, or it has a simple structure, energy consumption indicators, per unit of production are much less. A number of campaigns by global agricultural machinery manufacturers have also launched their own research on converting tractors to electric drive. Table 1 shows the components of diesel engines that are not present in electric tractors. The above data shows that electric tractors have better performance than diesel tractors in terms of energy efficiency and reliability. Only here the problem is related to high-capacity batteries, and in the following years, a number of positive research results in this area create opportunities for effective solutions to the problem.

As you know, with the increase in the number of electric vehicles, the infrastructure for charging them should develop no less dynamically. Combined with the continuous improvement of battery life in electric cars, a tipping point in the mass opening of EV stations should soon come. As with other such innovative technologies, the transition to electric vehicles will gradually increase. [3]

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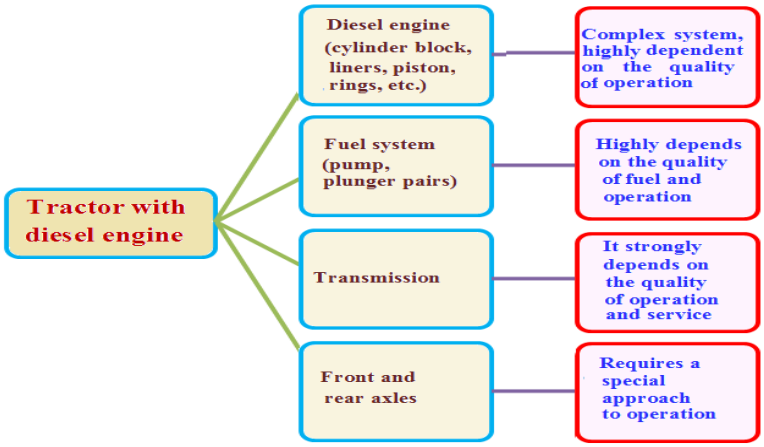
Table 1

Components of diesel engines that are not present in electric tractors.



In developed countries, the construction of new electric filling stations is rapidly developing, and according to forecasts, by 2020 the number of electric charging stations may well exceed the number of conventional gas stations. Moreover, some countries already use mobile versions of them. This shows that efficient operation of mobile agricultural equipment requires mobile chargers to recharge them in the field.

Types of chargers.

1) Normal charge from the 220 V network [3.5 KW / 16A] - inexpensive power supply (<$100), slow charge (6-7 hours when fully discharged);
2) Average charge from the 220 V network [15 KW / 70A] - average S / Y (< 1000$), average charge time (less than 100 minutes);
3) Fast charge from the 380 V network [22 KW / 80A] - fast S / Y (< 2000$), fast charge time (about an hour);
4) ultra-Fast charging from the 380 V network [50 KW / 140 A] - rapid charger (<$20,000), fast charging time (20-30 minutes);
5) Tesla SuperCharger 380 V [150 KW / 400 A] - !!! High Voltage !!! (<100 000$), fast charging time for Tesla (20-30 minutes).

Taking into account the above data, the analysis of world experience and the scientific base in our Republic, the sequence of necessary studies has been clarified. Having studied the experience of developed countries, and taking into account the scientific and technical base of the Republic, a project was developed aimed at the gradual introduction of electric-driven tractors in agriculture, providing for stationary and mobile electric charging stations based on renewable energy sources. Figure -2.

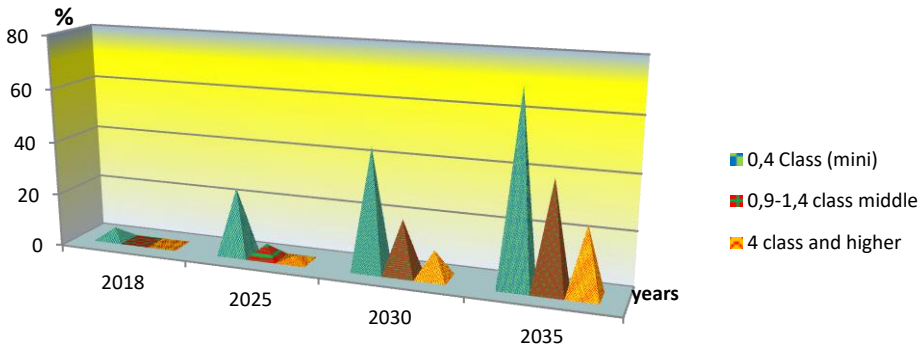


Fig. 2. Dynamics of conversion to electric drive of agricultural tractors until 2035 in the conditions of the Republic of Uzbekistan

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As you know, batteries are used in Autonomous energy sources in a variety of areas. The requirements for these devices also differ significantly. In the conditions of the Republic of Uzbekistan, when choosing a specific type of battery from a consumer point of view, the following characteristics are taken into account

- operating voltage;
- maximum discharge current;
- temperature range during discharge;
- acceptable charging mode (standard, accelerated, fast, or continuous charging mode, also called buffer mode);
- weight and dimensions;
- life.

As a result of the developed technical innovations, the cost of batteries in the world is becoming cheaper and safer. So far, the problem is the capacity and price of the batteries. If the price is cheaper than the current one, and the duration of work with the maximum load is 8-10 hours, and the fast charging mode is from 30 minutes to 1 hour, or fast battery replacement (which is more important in the field, for example, during the shift of machine operators), such equipment will be competitive in the future. [4]

IV. CONCLUSION

Based on the results of static, comparative studies of the achievements of developed countries and the results of research by leading scientists in the field of introduction of mobile equipment with electric drive, the following conclusions can be drawn:

- it is Necessary to conduct a systematic analysis of the state of operation of agricultural machinery in order to transfer them to electric drive;
- A comprehensive approach involving all stakeholders is required (UNIVERSITY-research Institute-KB-Production-NTD-Service)
- Determine the possibilities of organizing the production and service of components of electrical equipment and storage batteries in the Republic of Uzbekistan;

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