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Comparative analysis of traditional methods of towing aircraft at airports

This article is an attempt to conduct an objective comparative analysis of traditional methods of aircraft towing, which are implemented in modern civil aviation airports, with the aim of determining the most effective method according to certain operational criteria.

Introduction. Towing an aircraft is its movement on the airfield surface under the influence of an external source (usually special vehicles).

The expediency of using the aircraft towing process is explained by many factors, in particular, the need to ensure the safety of airport personnel movement on the apron, the saving of motor resources and fuel of aircraft engines, as well as the protection of the environment from noise and pollution.

To date, two main methods of towing aircraft are implemented in airports, which are based on the use of appropriate special equipment and airport tractors (AT) of various designs.

The first method of towing an aircraft requires the presence of an aircraft carrier with towing equipment, the second method is associated with the use of an aircraft carrier capable of lifting the aircraft by the front (main) chassis rack and fixing it on the appropriate platform (using the weight of the aircraft).

Currently, the most common are simple and reliable methods of towing an aircraft with the help of AT, which transfer the traction force to the aircraft with the help of towing carriers - when the aircraft is moving "nose forward" and using two slings of the same length when the aircraft is moving "tail forward" [1].

The second method of towing an aircraft is based on the operation of tractors, which use the mass of the aircraft to increase the traction force of the wheels with the airfield surface.

In fact, this type of AT is a powerful mobile hydraulic lift, and before towing, the technological process of capturing the pneumatics of the main strut of the aircraft landing gear and installing them on a special low platform of the tractor is implemented.

Such unmanned aerial vehicles have a relatively small weight and overall dimensions and are used not only for moving aircraft around the airfield, but also for towing aircraft to hangars.

The method of towing aircraft with lifting of the nose part and rigid fixation of the front landing gear due to structural complexity was not widely implemented until recently. However, today there are sufficiently reliable tractors from leading foreign companies that have a high resource and are actively involved in towing technologies in many airports of Ukraine [2, 3].

So, let's try to analyze both methods of towing aircraft in order to determine the most effective one according to certain operational parameters, which requires further development and improvement.

Main text. Despite the constant updating of the modern fleet of aircraft, the devices for their towing remain unchanged. The existing airfield tractors of aircraft in a number of cases do not perform their tasks due to the fact that they cannot always provide the necessary traction force to move the aircraft from its place, which is associated with the power of the tractors' power plants, with the insufficient towing weight of the towing tractor aircraft, as well as with a significant decrease in the values of the coefficient of adhesion depending on the weather conditions.

To increase the traction force of the tractor, it is used to load additional ballast on its chassis, which leads to increased wear and tear of the tractor units and units and a sharp increase in fuel consumption during idling (the fuel consumption rate increases for each ton of ballast weight up to 1.3 l/100 km for tractors with diesel and up to 2.0 l/100 km with gasoline engines).

The main shortcomings of modern means of towing aircraft, which cause the need for their further improvement, include, first of all, the lack of modern constructive, technological and schematic solutions. The ideas for the design, development and creation of the vast majority of driving airfield tractors date back to the middle of the last century (mainly in the 70s) using outdated technologies, using non-aviation materials and a relatively low level of safety (approach to the aircraft, coupling/uncoupling with by plane, control of the process of transporting the aircraft is provided by a team of 2-3 people).

Unfortunately, to date, the issue of increasing the efficiency of aircraft towing has not been properly reflected in the scientific and technical literature, namely conducting scientific research on the study of the interaction of elements in the "tractor - aircraft" system and the development of promising towing devices.

The goal of the development of an effective system of operation of aircraft ground maintenance facilities (including their towing on the platform) is to create a single balanced complex of various aviation ground equipment, which will allow the technological processes of airfield maintenance for most types of aircraft, in particular, it is about the possibility creation of universal airfield tractors.

Currently, the development of additional loading devices is underway, which will allow the driver-operator of the tractor to adjust the coupling weight, but the influence of the human factor on this process cannot fully implement it effectively. In this regard, there is a need to improve towing systems in order to ensure automatic adjustment of the towing weight of the tractor, which will significantly improve its traction-towing and economic parameters.

A number of technical and economic indicators can be used to evaluate the efficiency of the tractor, for example, towing speed, towing cycle time, technical productivity of the tractor, including tractor fuel consumption, etc.

Increasing the efficiency of the towing process is achieved by reducing the time of the towing cycle, fuel consumption, reducing the number of service personnel and increasing the productivity of the tractor, which in the complex makes it possible to increase the efficiency of air transportation.

At the same time, the methodological apparatus existing today does not allow to fully conduct an adequate assessment of the effectiveness of the design, development, and use of ground transportation means of aircraft, which indicates the need for its modification. In other words, there is an urgent need to further improve the operational

characteristics of wheeled airport tractors and, at the same time, to develop a methodological apparatus for the development of innovative designs of aircraft towing devices.

To date, a number of leading manufacturers of aviation ground equipment have successfully solved the urgent practical task of developing universal means of towing and evacuating aircraft, which ensure an increase in the traction qualities of the towing system "tractor - aircraft", which allows the weight of the aircraft to be used during the towing period to create required traction force.

According to European and American information sources, the tendency to replace traditional tractors with a driver, driverless ones (using the mass of the aircraft) is stable for certain reasons [4, 5].

Among the main ones:

- better maneuverability;
- quick coupling performed by one driver-operator;
- a significantly higher speed of towing the aircraft on the platform, due to which there is an opportunity to carry out 30-40% more aircraft towings than their driving competitors in the same time.

Not the last advantage is the significantly lower metal consumption of driverless tractors, because their weight is half as much for the same values of the mass of the towed aircraft.

According to a number of signs, at first glance, the advantage of driverless tractors becomes obvious. Indeed, tractors without a driver are simpler from the point of view of operation, the type of aircraft is selected by the driver on the control panel, the operation of connection with the aircraft occurs in automatic mode. All this, of course, significantly simplifies the work of the driver-operator. At the same time, the problem of the need to use carriers of different designs for each type of aircraft disappears, maneuverability increases due to the close location to the aircraft.

The capture of the pneumatic wheels of the front strut of the aircraft chassis is controlled by sensors, but at negative temperatures they may not work correctly, as a result of which the aircraft chassis may be damaged.

The tire of the chassis wheel is fixed, both from the front side and from the rear, with the corresponding clamps. However, there are cases of hydraulic system failures, it may happen that one of the rear clamps fails, so the tractor will be semi-fixed in relation to the aircraft and unable to tow it and away from the aircraft. Of course, this is provided for and auxiliary pumps are installed, but it will affect the maintenance time of the aircraft.

Otherwise, when using a towing tractor, in the event of its failure, it will be unhooked from the towing vehicle and transported to the place of repair. In such situations, the time to eliminate the problem of a possible delay in the process of towing the aircraft will be less than in a similar situation for the option of using a driverless tractor. In addition, in normal weather conditions, the driverless tractor performs its functions well, however, if there is ice on the apron, the plane will also move from its place will be a problem.

Due to the presence of a driving clutch, a classic tractor can serve a wide range of aircraft types - from business jets to B777, A350. Regarding the initial cost, the tractors are much cheaper than their opponents [6].

Conclusion. So, according to the results of the comparative analysis, it can be stated that with many positive points and certain disadvantages of airfield tractors and tractors without tractors (using the weight of the aircraft), none of the two types of this type of special vehicles has obvious advantages, and under certain conditions of use, taking into account model series of aircraft, climatic conditions, flight intensity, technical and economic capabilities of specific airports, driver and driverless tractors are operated on an equal footing, complementing each other in the system of ensuring aircraft towing.

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