Investigation of heavy ekranoplanes construction concepts

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Abstract

The article critically analyzes three concepts of building large ekranoplanes – two American and one Russian. Their advantages and disadvantages are compared according to the criteria of fuel efficiency, speed, regularity of flights, seaworthiness indicators and infrastructure requirements. Variants of a wheeled chassis and airfield are being considered that reduce the power required. A list of new missions that a heavy ekranoplane can perform better than other transport vehicles is proposed and justified. The innovative attractiveness of ekranoplanes is investigated. The need to install an intelligent automatic motion control system on a heavy ekranoplane, the prototype of which was created 40 years ago, will be justified. According to the experience of past years, it is argued that in order to create a perfect automatic control system, funding should be at least 1/10 of the total funding for creation of ekranoplane. Each of these projects was announced and passed the initial design stage, but was eventually stopped. The possible reasons for making such a decision are analyzed. The main reason is the excess of actual expenses over the originally adopted, which became obvious at a certain stage of work. This is often found at the development of new transport vehicles with a complex structure and many uncertainty factors. With low ice hummocks, the ground effect will be preserved, which will ensure that the fuel consumption of large ekranoplanes is reasonable due to the presence of an additional quality criterion with significant nonlinearity - the necessary seaworthiness of the device, i.e. the ability to fly at low altitude in the area of the ground effect at strong sea waves. Calculations are usually carried out for sea waves of 6-7 points, when the height of the waves with a security of 3% is 6 m. The article shows that seaworthiness a very large ekranoplane with a size (length) of about 50-100 m can have. This requirement often conflicts with the requirement of a limited cost, since the cost depends on the size of the vehicle almost linearly. The conclusion from the analysis of these complex dependencies is that it is possible to build a large ekranoplane with virtually unlimited seaworthiness only if there is funding of about $ 200M (two hundred million US dollars).
It is clear that such large costs can be recouped only with the multipurpose use of ekranoplane, which excludes its long downtime. Several directions of the effective use of heavy ekranoplanes are analyzed in addition to all known military applications as an amphibious vehicle and in the version of a carrier of anti-vessel missiles. The latter option has somewhat lost its relevance in recent years due to an increase in the accuracy of missile guidance and an increase in their range. The ground deployment of anti-vessel missiles now often exceeds the effectiveness of ekranoplanes use. But the rapid landing of contingents is relevant. It is important to serve the settlements in the Arctic without the construction of airfields. Part of the cargo flows of the Northern Sea Route can be transferred to ekranoplane.
Among the options for the civilian use of heavy ekranoplanes, the rescue mission looks effective, which consists in quickly arriving at the accident area, searching for victims, taking them on board, providing primary medical care and fast delivery to the base. The number of rescued can be measured in hundreds and thousands, depending on ththe e size of the ekranoplane. Unfortunately, in the described variant, most of the time the ekranoplane will be idle waiting for an emergency message. Moreover, the option with several "rescuers" based in different waters of the world ocean will be more stable. However, this option is also able to minimize the waiting time for help.
In recent years, there has been a need to assist the sea landing of spaceships, more precisely, to find and quickly evacuate a landing capsule with a crew. To carry out this mission, the ekranoplane must be equipped with a special radar, since the radar response of the landing module floating in water and possibly covered with a wet parachute is very small. There is another option for space landing: by docking aerospace plane with ekranoplane at the low altitude of ekranoplane flight. This option requires particularly advanced automatic control systems for both aircraft.
Finally, the purely transport use of the ekranoplane of unlimited seaworthiness can easily find its niche in the market of transport services. However, for this, it is important to find a transport line with a constant high cargo flow so that the large ekranoplane is fully loaded on each flight. It is impossible to reduce the size of the ekranoplane and, accordingly, its carrying capacity, since its seaworthiness will decrease and flights in stormy seas will become impossible. The regularity of flights is the most important indicator of the competitiveness of a transport vehicle.
A quantitative analysis of all the quality indicators of a large ekranoplane is given in the article. The requirements for automatic flight control systems (ACS) capable of expanding and improving the functionality of the ekranoplane are

described. The models of impacts and elements of the unchangeable part of the ACS necessary for the synthesis of such systems are proposed.