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МОДИФИКАЦИЯ СЕЛЬСКОХОЗЯЙСТВЕННОГО САМОЛЕТА АН-2 НА ОСНОВЕ МОДЕРНИЗАЦИИ ЕГО СИСТЕМ И ЗАМЕНЫ ПОРШНЕВОГО ДВИГАТЕЛЯ НА ТУРБОВИНТОВОЙ

Аннотация: В статье рассмотрена решение задачи модернизации одномоторного сельскохозяйственного самолета Ан-2 в модификацию Ан-2-100 на основе замены поршневого двигателя на более мощный турбовинтовой двигатель, который повлек за собой перерасчет массы всех его компонентов, расчета пустой массы и дальности полета, перерасчета центровки с точки зрения изменения конструкции, а также аэродинамического и прочностьного расчета. На основе выполненных исследовательских проектно-конструкторских работы и полученных результатов представлены основные выводы и заключения.

Ключевыеслова: поршневой двигатель, турбовинтовой двигатель, модификация, масса самолёта.

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DEVELOPMENT OF THE AGRICULTURAL AIRCRAFT AN-2 ON BASIS OF THE MODERNIZATIONS OF ITS SYSTEMS AND CHANGE PISTON ENGINE TO TURBOPROP

Annotation:The article shows that the solution of the problems of modernization of the single-engine An-2 agricultural aircraft to the An-2-100 modification based on replacing the piston engine with a more powerful turboprop engine, including calculating the mass of all its components, the empty mass and the flight range, the alignment, the aerodynamic quality, and the strength. On the basis of the performed research design and construction work carried out and received results show the main summary and conclusions.

Keywords:piston engine, turboprop engine, modification, aircraft mass.

The Antonov An-2 is a Soviet single-engine biplane agricultural aircraft and

its high notable durabilityhigh lifting power, and capability of taking off and landing from poorrunways have been allowing it a long service life.

AN-2 airplanes are used in agriculture for aviation chemical services for additional fertilizing of the grain crops, cotton defoliation and against pests. Every year 150 thousand hectares are covered from air. It is expected that given aircraft will be still used on its purpose at least during10-15 years in Uzbekistan. Thoughaircraft was designed and made a slightly more than half century ago, a good tactician, technical features and possibly allow to use with condition of its deep modernization.

The AN−2 upgrading into AN 2-100 consists of alternating the АШ−62ИР piston engine (1000 h. p.) with more powerful turboprop engine TPE331-12H New Zealand company Honeywell (1100 h. p) fitted with a five−blade reversible pitch propeller, the new arrangement of the flight compartment with the heating and ventilation systems. Besides, there is going to change the electrotechnical and flight navigation systems, navigational equipment. New integrated warning and fire protection systems are being installed. There is also improved a broadcast external agricultural equipment (broadcast boom).

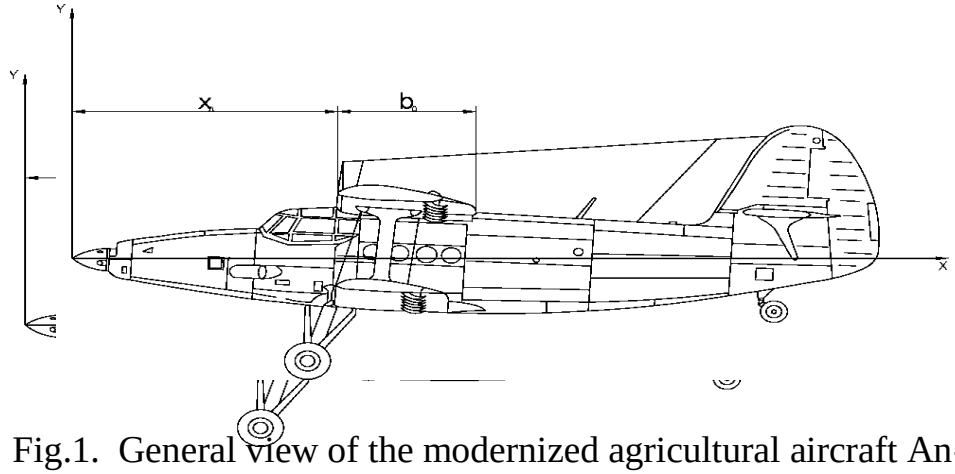


Fig.1. General view of the modernized agricultural aircraft An-2.

Problem data of modification aircraft An-2 solves consecutively on existing methods, beginning is a calculation geometric and aerodynamic parameter of airframe. Where first problem is a calculation of the mass and geometric parameter of the aircraft.

All components of the aircraft are determined, including: weight of the wing, weight of the fuselage, weight of the empennage, weight of the tail part, weight of the equipment and weight of the powerplant.

Then empty mass of the aircraft is calculated, which is defined as:

$$m_{emp} = m_w + m_f + m_{emp} + m_{und} + m_{eqp} + m_{p.p.}$$

substituted values will be received:

$$m_{emp} = m_w + m_f + m_{emp} + m_{und} + m_{eqp} + m_{p.p.} = 1309 + 424.5 + 141.8 + 269.5 + 371.4 + 417 = 2933.3k$$

Fuel weight can be determined by the takeoff weight formula:

$$m_0 = m_{emp} + m_{chem} + m_{fuel} + m_{ser.load.}$$

substituted values will be received:

$$m_{fuel} = m_0 - (m_{emp} + m_{chem} + m_{ser.load.}) = 5500 - (2933.3 + 1500 + 160) = 906.7kg$$

Flying range (Lp) is determined by the following formula for aircraft with turboprop engine:

$$\bar{m}_{fuel} = \frac{1.3 L_p c_e}{270 \eta_g K}$$

substituted values will be received:

$$L_p = \frac{270 \eta_g K \bar{m}_{fuel}}{1.3 c_e} = \frac{270 * 0.87 * 8 * 0.165}{1.3 * 0.243} = 980.9km$$

Specified calculations were also carried outon the basis of above:

- a calculation of the alignment of the aircraft;
- an aerodynamic calculation;
- a calculation of strength and etc.

Performed constructive and aerodynamic calculation has allowed to get comparative technical-economic indicators and features modified aircraft An-2-100 with existing An-2, which is presented in table № 1.

Table № 1. Comparison of technical and economic indicators of Agricultural aircraft (AGA)

№	Name	designation	unit. meas	An-2 AGA	Projected. AGA
1	Take-offweight	m0	kg	5500	5500
2	MaximalMassofchemicals	mchem	kg	1500	1500
3	Massoffuel	mf	kg	650	907
4	Mass of the empty plane	memp	kg	3600	2933
5	Enginecapacity	N0	kVt	735	808,5
6	Massoftheengine	men	kg	579	175
7	Hourfuelconsumption	mfuel.h	kg	230	119
8	Planeprice	Ца	kg /h	1324800	1079344
9	Engineprice	Цен	$	252840	278296
10	Specific price of the plane	kc	$		--
11	Specific price of the engine	ken	$/kg		--
12	Expensesonfuels	Af	$/kVt	230,46	119
13	Expensesondepreciation	Adep	$/h	226,49	145,03
14	Expensesonoverhaul	Ao	$/h	22,95	18,952
15	Expensesonmaintenance	Am	$/h	67,94	43,5
16	Expenseson a salary	Asl	$/h	13,15	13,15
17	Expensesoninsurance	Ains	$/h	8,624	7,39
18	DirectcostsΣAi	Adoc	$/h	569,63	347,02
19	Airportexpenses	Aap	$/h	42,72	26,02
20	Expenses of the agriculture enterprise	Aag	$/h	7,67	7,67
21	Costflight hour	Afh	$/h	620,02	380,71
22	Cost of processing at: Qchem= 5 l/ha ПIfh= 70 ha/f*h Qchem= 25 l/ha ПIfh= 35 га/f*h Qchem= 50 l/ha ПIfh= 28 га/f*h	Cha	$/ha	 8,85 17,71 22,14	 5,43 10,87 13,6

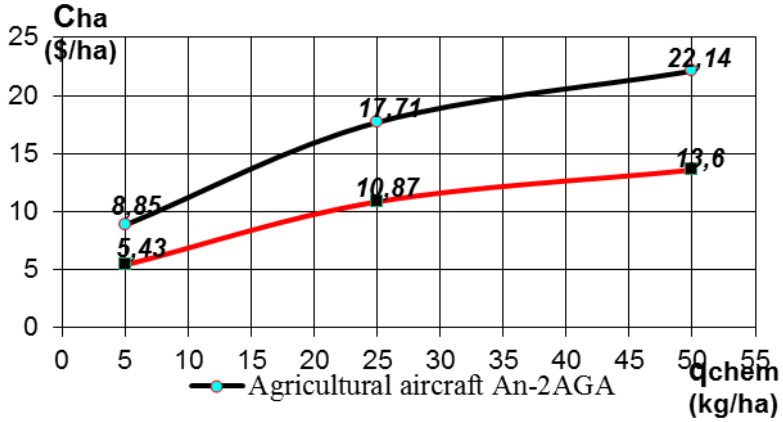
Prime cost of Aviation chemical work (ACHW) at various values of a

hectare consumption of chemicals will have the following values:

$q_{chem} = 5\ l/ha$ $C_{ha} = \frac{A_{fh}}{П_{fh}} = \frac{380,71}{70} = 5,43\ \$/ha$, $q_{chem} = 25\ l/ha$ $C_{ha} = \frac{A_{fh}}{П_{fh}} = \frac{380,71}{35} = 10,87\ \$/ha$,

$q_{chem} = 50\ l/ha$ $C_{ha} = \frac{A_{fh}}{П_{fh}} = \frac{380,71}{28} = 13,6\ \$/ha$

Figure 2. presents a graph of prime cost ACHW for these aircraft under different rate of the consumption of chemicals



It is possible to make the following conclusions on the basis of the received results:

1. Technical and economic indicators of the projected aircraft significantly surpasses, thanks to higher aerodynamic quality and bigger load ratio in a payload.
2. Prime cost of AChWfor one hectare on projected AGA is about 62% lower in comparison to An-2 AGA.
3. When using technology of ultralow-capacity (ULC) spraying with an expense of qchem of =5 l/hectare cost of processing decreases, more than 1,5 times.

However, it should be noted that the algorithm of cost calculation of processing demands improvement. More detailed analysis of technical and economic indicators of AGA can be carried out at a stage of implementation of the project in the course of flight tests.

The designed agriculture aircraft in comparison with the existing prototype has the following advantages:

- increase the aircraft productivity into 1.5 times;
- increase the aircraft payload into 1.2 times;
- increase the speed of flight into 1.2 times;
- increase the rate of climb into 1.85 times;
- ensure the comfortable conditions for the crew, to decrease the level of noise and vibration inside the cockpit and make a convenient entrance;
- increase the aircraft reliability and safety;
- the fuel weight of the aircraft is 35-40 % more than for prototypes;
- fuel consumption is 120…150 kg / h, which is also better than prototype (200…250);
- the aircraft has a maximum aerodynamic quality of 10.9, which is significantly greater than the aerodynamic qualities of prototype.

- prime cost of AChW of one hectare on projecting AGA is about 62% lower in comparison to An-2AGA
- another fundamental result of updating kerosene to oil that will be used for the rest of the airplanes (for example: The T−1, TC−1 types).

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