About methods and means of extinguishing landscape fires with atmospheric nitrogen

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Abstract. This article discusses the problems of extinguishing forest, steppe and peat fires, as well as ways to prevent them and reduce losses. The existing ground-based methods of extinguishing and preventing the fire of peat bogs are analyzed. It is proposed to use a nitrogen membrane station to perform the task. The methods of extinguishing forest and steppe fires with the help of aircraft are considered. Based on the analysis of the disadvantages of all the described methods, it is proposed to use a nitrogen membrane station based on a helicopter or airship. The results are a reduction in the cost of extinguishing farmland fires, steppe, forest and peat fires and damage from them, and the implementation of regular monitoring of steppe and forest areas.

Keywords: fire protection, thermomagnetic air separation, membrane separators, fire helicopters, fire airship, peat nitriding.

Introduction

Currently, monitoring of farmland, forests and steppe massifs is carried out with the help of helicopters, airplanes, satellites and even a simple bypass of fields with measuring devices.

At the same time, the" human factor " and climatic anomalies are the main causes of fires on farmland and in forests. The real scale of forest fires both abroad and in Russia, as well as the extent of the damage caused by fire, have not been reliably established to date, since regular monitoring of forest fires is carried out only in the zone of active forest protection, due to limited material and human resources [1].

The post-war statistics of forest fires in the USSR (Fig.1, 2) shows that every year in the country there were from 20 to 30 thousand forest fires on an area of 0.5 to 2.5 million hectares, and today only in the forests of Siberia there are up to 27 thousand fires that cover an area of 3.5 to 18 million hectares [1, 2].

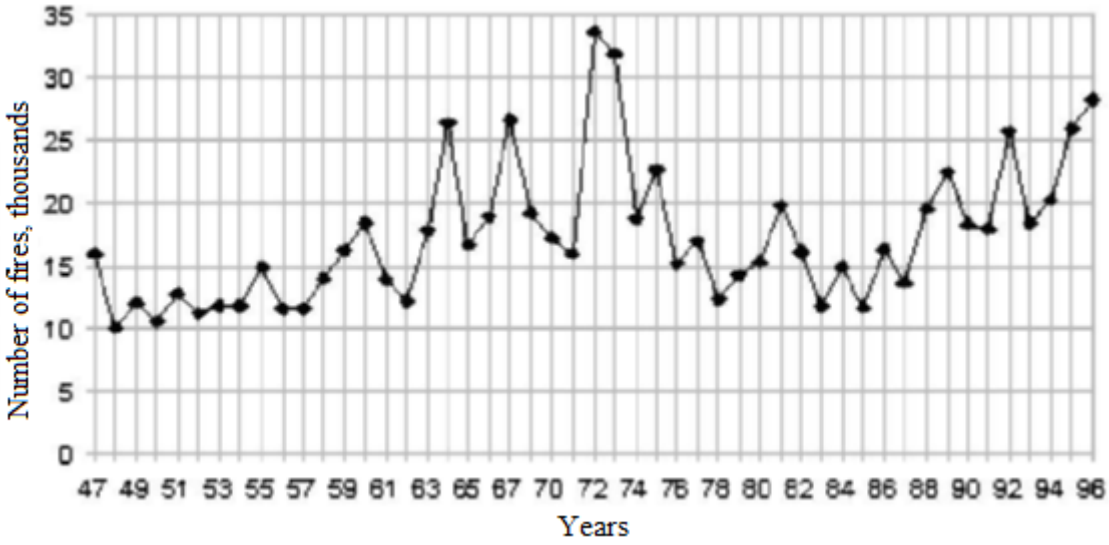

Figure 1 - Dynamics of the number of forest fires on the territory of the USSR in 1947-1996

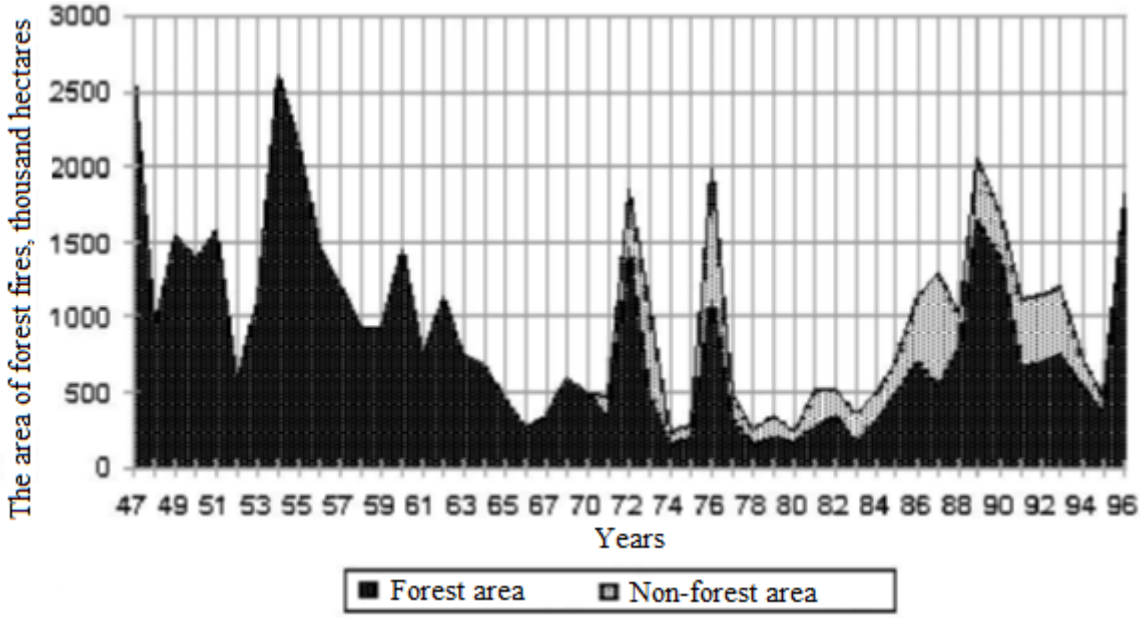

Figure 2 - Dynamics of the area of forest fires on the territory of the USSR in 1947-1996

Statistics also show that the scale of forest fires is increasing every year, causing significant harm to the health of the population due to the release of a dangerous carcinogen - benzopyrene.

Purpose of the study.

The purpose of the study is to ensure fire and environmental safety of the biosphere and resource conservation of farmlands, peatlands and forests, which are renewable natural resources.

Materials and methods

Many countries, such as the USA, Canada, Australia, France, for which the problem of forest fires is relevant, have special aviation fire formations, and Russia is no exception, since fire equipment based on aircraft has been used in Russia for almost 90 years [3].

Each type of equipment has its own advantages and disadvantages. For example, unlike airplanes, MI-8, Ka-32 and MI-26 helicopters with spillway devices, the speed of transporting water containers is significantly lower and in case of fires in small territories or in mountainous areas, this is a fundamental advantage, since when draining at high speeds, at altitudes exceeding 40-50 m from the ground surface, the discharged liquid as a result of the incoming air flow breaks up to the state of aerosols and most of it evaporates before reaching the fire [4]. A common disadvantage of existing methods and devices is the high cost of both the equipment itself and its operation. As a result, it can only be used centrally on a national scale or in large regions of Russia. At the same time, extinguishing forest and steppe fires with water with the help of aviation is not only unprofitable, but also not effective, since planes and helicopters constantly have to refuel with water, fly up to the fire site, pour out the water and fly to the refueling station, during which the fire flares up with a new force [5].

Protection of peat from spontaneous combustion and prevention of peat fires is of extremely important social and economic importance both in our country and abroad [6, 7].

However, it is during the drainage of peat that there is a danger of its spontaneous combustion due to the products of the vital activity of microorganisms that warm up its mass to 70 degrees Celsius. The resulting destruction processes cause a further increase in temperature, which turns the peat into a semi-coke, which, in the presence of oxygen, self-ignites. Such self-heating and self-ignition also occur during the storage of extracted peat [7, 8].

Despite the fact that the uselessness of extinguishing peat fires with water was proved at the end of the last century, many modern developments in the field of extinguishing peat fires use water methods. Special means are also being created for this, despite the fact that filling the peat bog with water makes it impossible to extract and use it [9-11].

There are also other methods of extinguishing fires on peat bogs, including waterless ones, one of which, for example, is to create a barrier along the contour of the most fire-hazardous areas before the occurrence of spontaneous combustion or during fires. When the fire spreads to the barrier, the special mineral material decomposes with the release of carbon dioxide, which reduces the oxygen content in the air. Magnesium and calcium oxides begin to interact with various additives to

form a porous barrier resistant to high temperatures, which prevents the spread of fire. The disadvantage of the method is, firstly, the destruction of peat by fire, secondly, high one-time and operational costs for its implementation, and thirdly, the inability to locate and prevent spontaneous combustion of peat [10].

There are gas methods of extinguishing forests and peatlands: "bombs" with liquid nitrogen, "briquettes" with carbon dioxide granules, etc., but they have "surface efficiency", and the spontaneous combustion of peat and the development of fire occurs in the depth of the peat, where they cannot get [11].

Results and discussion

The authors have developed a method of nitriding peat, which consists in the fact that with the help of an air separation unit (membrane or thermomagnetic), oxygen is separated from the surrounding atmosphere, and nitrogen is introduced into the peat self-heating zone with the help of gas-peat fire barrel with thermal probe (GPFBTP). This zone is determined by three GPFBTP, by thermal location of the "self-heating hearth", which allows to prevent spontaneous combustion and ensure safe extraction and storage of peat [10, 11].

A model of an automated complex was developed that eliminates the disadvantages of installing the nitriding method and expands its capabilities as follows [12]:

- the use of a highly passable serial mobile nitrogen station TGA 5/10 with a capacity of 300 hp with a capacity of 5 Nm^3/min. and a pressure of 10 atm., with a nitrogen purity of 98-99% with overall dimensions of 6.0×2.5×3.6 m. and a mass of 11.5 tons, which makes it possible to extinguish fires and prevent fires even on hard-to-reach peat bogs

- the use of gas-peat fire barrel with thermoelectric probes (GPFBTEP). using the method of electric sounding, which allows determining the profiles of the peat birthplace.

Thus, the use of the method and a mobile automated complex based on TGA-5/10 for detecting, preventing and extinguishing peat fires allows solving the problems of fire and environmental safety of peat bogs, as well as peat extraction and storage [13].

In the problem of extinguishing forest and steppe fires with the help of aviation, a promising direction is the replacement of the fire extinguishing composition (water) with atmospheric nitrogen produced using a nitrogen membrane station. At the same time, the most suitable aircraft for this method are airships and helicopters with high lifting capacity, for example, the MI-26.

Airships are mobile and reliable aircraft, with a sufficiently large autonomy, have a high load capacity and weight return, universal application and low total cost, including the cost of man-

ufacturing -10 times lower than helicopters, and operating costs - 100 times lower. Therefore, there is an idea to equip an airship with the necessary fire-technical means, which will be able to solve all the problems of fire protection of farmland, forest masses and peat bogs [14, 15].

Also, when equipped with additional means, the airship will be able to monitor fire parameters, amphibious and rescue operations in hard-to-reach places, and is also able to perform long-term tasks of patrolling remote regions where there is a risk of fires.

Conclusion

Thus, the technical results of the claimed method are the reduction of costs for extinguishing fires of farmland, steppe, forest and peat fires and damage from them, and the implementation of regular monitoring of steppe and forest areas not only in the zones of their active protection, including farmland, with the possibility of using agrotechnologies of precision agriculture on them, such as local mapping, analysis of the state of agricultural crops, soil and other parameters.

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