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Ground Technical Means of Influence to Clouds and Fogs

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Abstract:

This article broadly covers the problems of weather control of artificial influence on clouds and fogs in order to increase or decrease precipitation, dissipation of clouds and fogs. Technical means of active influence on hydro meteorological processes, allowing solving a number of problems.

Keywords: atmosphere, clouds, plane, fog, aerosol, meteorology, hail, generator, project, liquid.

To implement methods of artificial influence on super cooled clouds, a number of technical means have been developed for the delivery and dispersion of the reagent into the cloud, both from the aircraft and from the ground.

Airborne means of influence include generators permanently installed on board the aircraft, and generators fired from the aircraft directly into the cloud.

Ground-based means include generators of ice-forming aerosols, which disperse reagents using installations located on the ground.

These can be rocket launchers that deliver reagents directly to the cloud, and ground-based generators that disperse the reagent in the surface layer.

Technical means of active influence on hydro meteorological processes allow solving a number of problems, in particular:

- increase the amount of precipitation from clouds in areas with insufficient moisture;
- increase the amount of precipitation in fire hazardous areas in order to prevent and localize fires over large areas;
- provide anti-hail protection of agricultural crops in areas prone to hail damage;
- reduce the negative consequences of man-made emergencies associated with harmful emissions into the atmosphere by depositing them on controlled territories by precipitation artificially caused from clouds;
- ensure favorable weather conditions during mass festive, socio-political, cultural and sports events;
- to disperse fogs at airports, on highways, in the waters of sea and river ports, in order to reduce the number of delays in aircraft flights, improve flight safety, the movement of ships and vehicles.

Ground generators are mainly used to influence clouds in the foothills and mountainous areas in order to increase precipitation and in hail control work.

Generators are installed on the windward side, where the strongest updrafts are.

The rise of air along the mountain slopes and convection ensure the rise of the ice-forming aerosol to a level where the reagent is active.

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An important advantage of the use of ground-based aerosol generators for active actions on clouds is their simplicity and relative cheapness in comparison with aircraft and rocket-artillery methods of cloud seeding.

These projects mainly use ground-based acetone generators from the French company ANELFA (Association Nationale d'Etude et de Lutte contre les Fleaux Atmospheriques), pyrotechnic and acetone generators from the American companies North American Weather Consultants and Ice Crystal Engineering, and pyrotechnic generators Bulgarian company Stroyproject Trade Ltd.

Figure 1 shows photographs of some of them.

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Rice. 1. Ground-based acetone generator of the French company "ANELFA" (a), automated ground-based pyrotechnic generator "AHOGS" of the American company Ice Crystal Engineering (b)

In the Soviet Union, up to now, not enough attention has been paid to the development of methods and means for influencing clouds with the help of ground-based aerosol generators of ice-forming aerosols.

It should be noted here a complex of ground-based generators with a remote control system "Bouquet", developed in the period of 1980-90s of the XX century and designed to artificially increase precipitation in mountainous areas. The complex "Bouquet" consisted of remote control equipment and a set of ground generators.

The set of ground generators included a propane-acetone generator, a pyrotechnic generator of silver iodide and a nitrogen generator.

Serious interest in this method arose in the 2000s, when, due to insufficient funding for anti-hail services, alternative methods began to be considered in the work on protecting crops from hail damage.

In 2005, the Agency for Atmospheric Technologies began research on existing projects for the artificial destruction of clouds and protection against hail damage using ground-based generators, the processes of aerosol propagation in the free atmosphere (sub-cloud layer) were studied, numerical and experimental studies were aerosol generators.

Below are the main types of ground-based aerosol generators developed by the Agency of Atmospheric Technologies, designed to influence low clouds and fogs, both independently and in conjunction with other technical means.

- Below is a list of ground means of influence, the development and improvement of which was carried out with the direct participation of the Agency for Atmospheric Technologies:

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- pyrotechnic ground aerosol generator NAG-07 and NAG-07M;
- fireworks type ice-forming aerosol generator GLA-105;
- liquid ground aerosol generator NAG-07A;
- anti-hail rocket "Alazan-9" and launchers for its launch.

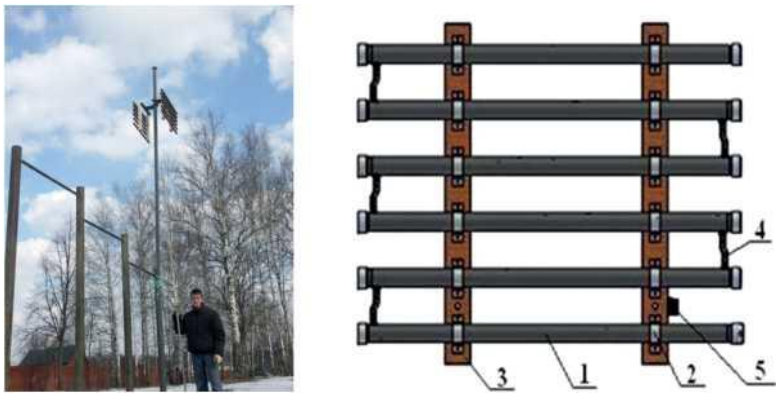
Ground aerosol generator NAG-07. The generator set includes two active elements (Fig. 2b), each of which consists of six metal tubes (1), in which pyrotechnic pieces with an ice-forming aerosol composition are placed.

The tubes are connected by clamps (2) to the frame (3), which has a fastening device to the mast (5). The pipes are interconnected by igniter cords (4) for the transmission of a fire impulse during the operation of the generator.

The first pyrotechnic block of the active element is equipped with an ignition unit, which is initiated from an electric battery with a voltage of 24 V.

The mast with attachment points allows you to install active elements at a height of up to 4 m.

A general view of the NAG-07 generator and the active element are shown in fig. 2 (a, b).



Rice. 2. Generator NAG-07 (a) and active element of the generator NAG-07 (b)

The efficiency of the NAG-07 generator was demonstrated during trial operation in the North Caucasus in 2009-2010, in the North Caucasian paramilitary service of Roshydromet.

Ground aerosol generator NAG-07M. In 2015, the development of the ground-based generator NAG-07M, which has improved performance characteristics, was completed.

The NAG-07M generator (Fig. 3) contains an improved launch control system and 80 active elements of the AG-1M type [101], providing a total generator continuous operation time of more than 8 hours.

When the generator is operating in automatic mode, active elements are switched on in series (from 1 to 3 pieces in a series) with intervals between series from 1 s to 360 s. The operating time of one active element is at least 6 minutes.

The NAG-07M launch control system allows you to control the operation of active elements in manual mode, by wire through the control panel, by radio and GSM channels. The communication range when the generator is controlled via a radio channel is up to 20-30 km, when controlled via a GSM cellular network - without restrictions.

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The NAG-07M generator differs from previous designs in its long battery life, increased height of ice-forming aerosol emission due to the creation of additional draft in the chimney.

Rice. 4. Active element AG-1M

The active element AG-1M is triggered when an electric current pulse is applied from the generator starter to the electric igniter, which in turn initiates the combustion of the pyrotechnic composition.

Full-scale tests of the prototype NAG-07M were successfully carried out at the test site of the Federal Scientific and Practical Center "Research Institute of Applied Chemistry" in the 2014-2015 season.

In 2018, the generator was upgraded and given the name NAG-7M2. In order to reduce the cost, it uses a new design solution - reusable barrels and a sleeveless version of the active element.

Ground aerosol generator GLA-105. Simultaneously with the beginning of the development of ground-based aerosol generators of the NAG-07 type, work was underway to create generators that make it possible to create an ice-forming aerosol cloud at a higher altitude.

As a result, on the basis of a 105 mm firework, an ice-forming aerosol generator GLA-105 was developed (Fig. 5), which is launched vertically from a special launcher (Fig. 6). height with a bursting charge, forming a cloud of ice-forming aerosol with a diameter of about 50 m.

Rice. 5. Generator GLA-105

Rice. 6. Launcher for GLA-105

Upon completion of the work of the pyrotechnic checkers, a cloud of ice-forming aerosol is formed with an upper limit of about 250 m.

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