EFFECT OF AN RF DISCHARGE PLASMA ON THE TELEMETRIC ANTENNA RADIATION OF A SOUNDING ROCKET

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A considerable increase in the intensity of the telemetric signal radiated from the MR 12 sounding rocket surrounded by an artificial RF discharge plasma envelope was detected in the "Aktivny Shnur" ionospheric experiment in February 1991. The experimental data are presented and their interpretation is given.

The interest in the antennas operating in the absence of artificial plasma irregularities (envelopes) created by RF discharges in a rarefied gas arose long ago [1]. This interest is primarily due to the necessity of obtaining given characteristics for emitting and receiving systems in rockets and space vehicles. To date, the experimental studies of such antennas were mostly of a model character and were carried out, as a rule, under laboratory conditions. The theoretical consideration and laboratory experiments show that the envelope plasma has a considerable effect on the input and emissive characteristics of the antennas. In particular, it is noted that the plasma envelope can change the input impedance, radiation resistance, and radiation pattern of the antenna.

At the same time, many unclear questions associated with actual ionospheric conditions still remain since rather often it is not possible to exclude the influence of the limited plasma volume on the results of the experiment, simulate the antenna moving through the medium, etc. Moreover, the theory of antennas operating in inhomogeneous plasma envelopes is far from complete and must be developed in parallel with experiments.

In the present paper we describe the results of the ionospheric experiment and propose their interpretation.

The experiment was implemented during the flight of the MR 12 rocket launched from the Kapustin Yar test area in February 6, 1991 at 20:30 Moscow Time. The rocket moved at an angle 85° to the horizontal in the east direction. The scheme of the experiment is presented in Fig. 1. The diagram of the dependence of the flight height on the time elapsed from the start instant is given in Fig. 2.

The discharge at the rocket body was created using an electric dipole source consisting of two semicylinders made of a metallic grid with cell dimensions 20 \( \times \) 20 cm. The cylinder was 2 m in diameter and 1.2 m in height, and the distance between the edges of the semicylinders was 30 cm.

A generator with operating frequency 400 kHz was used to excite the electrodipole source. The generator signal was modulated at frequencies \( f_1 = 240 \text{ Hz} \) (generation time 10 s) and \( f_2 = 120 \text{ Hz} \) (generation time 10 s) according to a special cyclogram, then a 5 s pause followed and the cycle was repeated (Fig. 2). The maximum amplitude of voltage between the semicylinders amounted to \( \sim 1.5 \text{ kV} \).

The telemetric signal represented a sequence of radio pulses with carrier frequency 200 MHz and was recorded at the Earth surface near the place where the rocket was launched. The signal was emitted by two symmetrical loop antennas on the rocket sides, and the loop plane was parallel to the cylinder generatrix of the rocket body.

* Obviously, the ionospheric field experiments are limited to the studies described in [2,4].

Fig. 1. Scheme of the experiment: 1 rocket body, 2 electrodipole source grid, 3 insulator, 4 insulating rod, 5 telemetric antenna, 6 plasma sheath.

Fig. 2. Dependence of the rocket altitude on the flight time. The cyclogram of the discharge generator is shown under the diagram.

For the diagnostics of plasma formation parameters we used a Langmuir probe and an analyzer of geomagnetic field variations due to diamagnetism of the discharge plasma in the formation and relaxation of plasma inhomogeneities. Unfortunately, the discharge plasma densities were beyond or at the upper boundary of the calibrated scale of the devices in that stage of the experiment; hence, the data on plasma densities are not quite reliable. Interesting features in the received telemetric signal were observed during