Department of Physical and Mathematical Sciences.
Tartu State University, Estonian S.S.R.

Generators of Air Ions and Electroaerosols

H. Tammet*, L. Visnapuu, J. Reinet*****

Radioisotope and corona air ionizers are most common. The advantages of these two methods are so obvious that, with few exceptions, other types of air ionizers are only experimental attempts to find new solutions. This does not refer to generators of electroaerosols, which serve another purpose.

The first radioisotope air ionizers have been described in the article by Verigo and Poderni (1934). In the air ionizers designed by A.B. Verigo an α-preparation Ra^{226} is used. Air ions are removed by an electric field, which makes it possible to achieve 100 per cent unipolarity, or they are blown out by the application of electric separation, which ensures a regulated unipolarity. To achieve the concentration $n = 1000$ mm^{-3} at a distance of 0.5 m from the device, it is necessary to apply a preparation containing up to 0.2 mg of Ra. Properties of air ionizers designed by Verigo are described in detail in the report of Baranova and Trambitskaya (1959).

Many investigators consider the use of the emanative preparation Ra^{226} to be inadmissible. In the paper mentioned, Pb^{210} (Ra D with a half-life of 23 yrs) and Po^{210} (Ra F) are recommended. However, Pb^{210} also emanates to some extent radioactive daughter isotopes and is not a clean α-source. Po^{210}, which is likewise used in air ionizers (Hicks 1953, 1956), is free or such byproducts, but has a very short half-life of 138 days.

At the present time α-preparations of Pu^{239} with a half-life of about 24 000 yrs are easily obtainable. Its daughter isotope U^{235} possesses only a negligible radioactivity.

Alpha-ray air ionizers were produced by Wesix in the U.S.A.

In 1962 Shteinbok recommended application of soft β-rays of Pm^{147} (half-life $\tau = 2.6$ yrs, maximum energy $E = 0.22$ MeV, path length of β-particles in the air up to $l = 350$ mm); C^{14} ($\tau = 5400$ yrs, $E = 0.16$ MeV, $l = 200$ mm) and H^3 ($\tau = 12$yrs, $E = 0.02$ MeV, $l = 5$ mm). In the above — mentioned paper the author describes also methods of generation of air ions and designs of β-ray air ionizers. Air ionizers utilizing Pm^{147} are made in the U.S.S.R.

The results of the investigation of air ions produced by α-rays of Po^{210} and β-rays of H^3 are set forth in the papers by Norinder and Siksna (1958) and Siksna and Lindsay (1965).

The keeping of devices containing some radioactive preparations demands certain

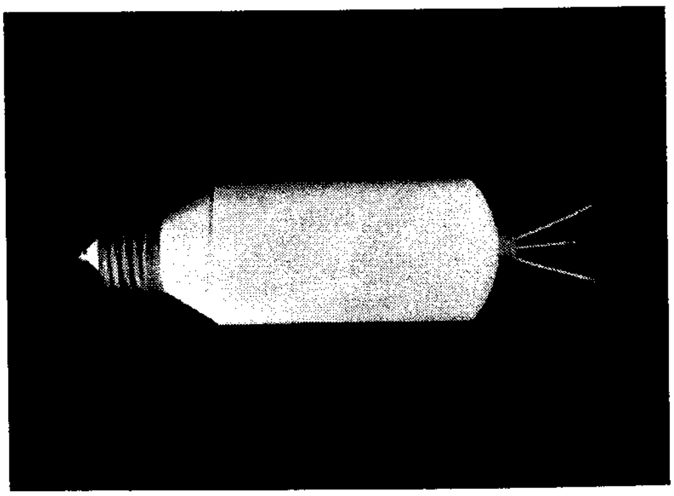

Fig. 1 - Corona air ionizer.

(*) Candidate of Physical and Mathematical Sciences, acting Assistant Professor.

(**) Post-graduate.

(***) Candidate of Physical and Mathematical Sciences, Assistant Professor.

precautions. For this reason corona air ionizers free of that defect are increasingly preferred. Franklinization devices are the oldest type of corona air ionizers (Putilin, 1959). A franklinization machine is a powerful source of unipolar air ions.

Bulky corona air ionizers of the type « electroeffluvial chandeliers » as described by Tchizhevsky (1933), (1960) are inferior to modern models of franklinization machines and are only of historical interest. The common defect of both devices is a considerable discharge of nitrogen oxides and ozone. The portable instrument described by Israel and Schulz (1934) is somewhat superior.

Perfection of air ionizers with the voltage of a few kilovolts (Tammet, 1959) made corona air ionizers capable of competing successfully with the radioisotope units. The corona air ionizer (Fig. 1) described by Tammet (1962) has dimensions $50 \times 50 \times 190$ mm generates ions in the concentration of $n = 1000$ mm^{-3} at a distance of 0.5 m. The production of nitrogen oxides and ozone has been practically entirely eliminated. Highly effective are miniature corona air ionizers for local action. The designer succeeded in introducing the corona point through a syringe needle into the internal cavities of guinea-pigs (Tammet, 1959). Some corona air ionizers, including the device AIP-2 put out serially in the U.S.S.R., are described by Portnov (1960).

Corona air ionizers produce 100% unipolarity by removing air ions with the help of an electric field as well as by the less frequent application of the air-flow method (Whitby and McFarland, 1961). Bipolar ionization is achieved only by using the air-flow method and by feeding alternating voltage to the corona electrode.

To carry out air ionization of spacious rooms, it is expedient to use corona antennae made of fine wire (Tammet, 1962). Such antennae may be fed from a franklinization device. Properties of this system were analyzed by Tammet and Salm (1966).

Hot-wire and photoelectric air ionizers are characterized by the need of considerable power and a relatively low ion output. Air ionizers employing a heated wire as described by Hicks (1952) and Reinet *et. al.* (1963) are of some interest. An essential defect of photoelectric air ionizers is a considerable production of biologically active gases. Some properties of air ionizers based on different principles have been considered in the report of Skilling and Becket (1953) and by Gratchov and Trambitskaya (1962).

Generators of electroaerosols must produce fine microscopic aerosols suitable for the inhalation of medicines and be able to impart a unipolar charge to particles. It is necessary to point out that any sprayer of a liquid is — due to the Lenard or balloelectric effect — a generator of electroaerosols with a weak charge. Balloelectric generators of aerosols, also called hydro-aeroionizers, are formed by evaporation of small air ions formed by evaporation of drops (Tchernyavsky, 1955). Superior devices of the latest type are provided with a centrifugal disc sprayer. Characteristics of the device « Serpukhov - 1 », produced in the U.S.S.R., were presented by Salm and Tamm (1963).

The charging of particles by corona discharge found in the past application in electroaerosol generators for industrial, agricultural and sanitary purposes. In medical devices induction electrification is more satisfactory. Several well-known units have been modeled after a powerful electroaerosol generator (Burkhardt, 1935), originally designed for the conduction of physical experiments. In induction charging the Bergson-Barkovsky sprayers of simple construction are preferred (Tammet and Reinet, 1958; Reinet and Siirde, 1967). An electroaerosol generator for the inhalation therapy of tracheotomized patients, breathing by means of artificial breathing apparatus, was described by Reinet *et al.* (1963) and Raudam and Reinet (1966). In similar devices spraying is performed by air and by oxygen at pressures of up to 2 atm. at the voltage of the induction electrode ranging from 300 to 800 V, the liquid to be sprayed is earthed. Good parameters of the aerosols to be generated are achieved if the rate of spraying reaches a few mm^3 s^{-1} (Visnapuu and Jents, 1964). In the U.S.S.R. the generator of electroaerosols « Elektrozol - 1 » designed by Kitayev and Pomel'tsov (1962) is manufactured. The principal characteristics of this instrument are: rate of spraying aqueous solutions — 3 mgs^{-1}, charging power — 0.8 nCc^{-1}, particle diameter not above 20 µm.

Generators of aerosols with a high polarizing voltage (Nückel 1957) possess good parameters; they are, however, less convenient for experimentation.

The method of spraying liquids by electric forces has been little studied. In this respect the report by Drozin (1955), on the method ensuring a 100 % unipolarity and a maximum degree of charging is of interest.