ACTION OF CORONA DISCHARGES ON BACTERIA AND SPORES*)

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We have measured the E.coli bactericidal efficiency of DC and AC point-to-plane coronas in air and in argon in the corona modes positive glow, positive streamer, negative Trichel pulse and negative glow. Negative Trichel pulse and positive streamer coronas are the most efficient for production of bactericidal agents in air. Less than 5 minute exposure to the products from 30 μA of these coronas will sterilize the E.coli covered agar surfaces in a 31 volume to a survival ratio of $10^{-5}$. Positive glow coronas are two orders of magnitude less efficient. 50 Hz AC coronas seem to mainly work during the negative half cycles. The bactericidal agent(s) produced by the coronas have not all been identified, but ozone O$_3$ with concentration 35–40 ppm is probably the most important one. We show that charged particles and photons can play only a minor role, so the agent(s) must be neutral particles. The main part of them must have a lifetime in the vessel of more than 3 minutes. The much smaller, and volume/distance dependent, efficiency of coronas in humid argon indicates that metastable neutrals or radicals from H$_2$O can play only a minor role. A preliminary test showed negligible effects of the corona treatment on the spores of Bacillus subtilis.

1 Introduction

Corona discharges are well known and exploited as generators of quasi-stable bactericidal chemicals, as testified by many plants for generation of ozone for water purification. For efficiency, such generators must be fed with dried air or oxygen, which adds considerably to the generator cost. Corona discharges in air, however, will generate a broad spectrum of stable and unstable neutral particles in addition to ozone, see the reviews [1,2]. It is thus hoped that an air corona directed at a close bacterial target can have higher efficiency than corresponding to its ozone production.

This idea is not new, see [3-7]. Common to these works is, however, that the type of corona is not well known or specified. Also the authors of [3] and [5] assume that the bactericidal action observed is due to corona ions or current, which according to [4] and our own experience is not true. It is not clear whether the aerosol-carried bacteria in [6] and [7] are killed or simply removed with the aerosols.

In the present project we wanted to exploit our long experience with corona discharges and their diagnostics to determine the bactericidal efficiencies of various

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well-defined corona types and geometries. On the other hand, our inexperience with bacteria forced us to choose one of the simplest cases, E.coli on agar medium. The spores we chose were from Bacillus subtilis.

From our experiments it is clear that the main bactericidal agent emanating from our coronas is ozone. In the future we hope to identify the complete spectrum of bactericidal agents and to optimize their production and transport to the target. Ultimately this might lead to apparatus for reducing the microorganism contamination in food processing, and to sterilization of objects without the use of heat or radioactivity. However, we may have a problem: preliminary tests indicate that our coronas have little effect on bacterial spores (the referee kindly suggests that this might be due to too high initial spore concentration, leading to shielding effects).

2 Experimental

2.1 General

We have exclusively worked with point-to-plane coronas, a “point” being a sharply rounded high-field electrode. The point polarity, shape and material were chosen to produce the desired types of coronas: positive glow (PG), positive streamer