



Chamber for Growing and Observing Fungi

Lyndon B. Johnson Space Center, Houston, Texas

A chamber has been designed to enable growth and observation of microcolonies of fungi in isolation from the external environment. Unlike prior fungus-growing apparatuses, this chamber makes it possible to examine a fungus culture without disrupting it. Partly resembling a small picture frame, the chamber includes a metal plate having a rectangular through-the-thickness opening with recesses for a top and a bottom cover glass, an inlet for air,

and an inlet for water. The bottom cover glass is put in place and held there by clips, then a block of nutrient medium and a moisture pad are placed in the opening. The block is inoculated, then the top cover glass is put in place and held there by clips. Once growth is evident, the chamber can be sealed with tape. Little (if any) water evaporates past the edges of the cover glasses, and, hence there is little (if any) need to add water. A microscope can

be used to observe the culture through either cover glass. Because the culture is sealed in the chamber, it is safe to examine the culture without risking contamination. The chamber can be sterilized and reused.

This work was done by Duane L. Pierson of Johnson Space Center and Thomas C. Molina of KRUG Life Sciences. For further information, contact the Johnson Innovative Partnerships Office at (281) 483-3809. MSC-22904

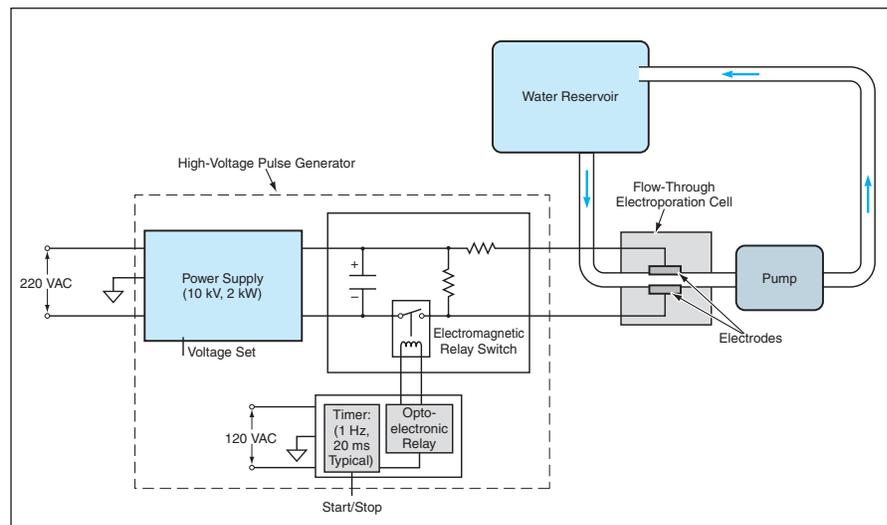
Electroporation System for Sterilizing Water

Amounts of chemicals needed for sterilization are reduced.

Lyndon B. Johnson Space Center, Houston, Texas

A prototype of an electroporation system for sterilizing wastewater or drinking water has been developed. In electroporation, applied electric fields cause transient and/or permanent changes in the porosities of living cells. Electroporation at lower field strengths can be exploited to increase the efficiency of chemical disinfection (as in chlorination). Electroporation at higher field strengths is capable of inactivating and even killing bacteria and other pathogens, without use of chemicals. Hence, electroporation is at least a partial alternative to chlorination.

The transient changes that occur in micro-organisms at lower electric-field strengths include significantly increased uptake of ions and molecules. Such increased uptake makes it possible to achieve disinfection at lower doses of chemicals (e.g., chlorine or ozone) than would otherwise be needed. Lower doses translate to lower costs and reduced concentrations of such carcinogenic chemical byproducts as trichloromethane. Higher electric fields cause cell membranes to lose semipermeability and thereby become unable to function as selective osmotic barriers between the cells and the environment. This loss of function is the cause of the cell death at higher electric-field intensities. Experimental evidence does not indicate cell lysis but, rather, combined leaking of cell proteins out of the cells as



High-Voltage Pulses Are Applied to a pair of electrodes as water flows between them. Depending on the pulse amplitude, the resulting electric field between the electrodes either makes pathogens in the water more vulnerable to a disinfecting chemical or else inactivates them even in the absence of such a chemical.

well as invasion of foreign chemical compounds into the cells.

The concept of electroporation is not new: it has been applied in molecular biology and genetic engineering for decades. However, the laboratory-scale electroporators used heretofore have been built around small (400-microliter) cuvettes, partly because the smallness facilitates the generation of electric fields of sufficient magnitude to cause electroporation. Moreover, most laboratory-scale electroporators have been de-

signed for testing static water. In contrast, the treatment cell in the present system is much larger and features a flow-through geometry, such that electric fields strong enough to effect 99.9-percent disinfection can be applied to water flowing in a pipe.

The figure schematically depicts one version of the prototype system, wherein the output of a high-voltage pulse generator is applied to two electrodes on opposite sides of a flow-through electroporation cell. The pulse amplitude, duration,

and repetition period are chosen to obtain the desired degree of disinfection. Most critical is the amplitude, which is chosen in consideration of the interelectrode gap (1 cm in the prototype) to obtain the needed electric-field intensity. The threshold electric-field intensity for transient changes in permeability and reduced-dosage infection is about 0.2 kV/cm; the threshold for inactivation is about 5 kV/cm. In a practical system, the electroporation cell would be equipped with multiple pairs of electrodes along the flow path and the high-voltage pulses ap-

plied to the pairs would be synchronized so that any given small volume of water would be subjected to multiple high-voltage pulses on its way through the electroporation cell.

Electroporation sterilization technology is best employed in small point-of-entry (POE) and point-of-use (POU) applications as in homes or other small facilities. In smaller pipe diameters, it can be very cost effective, but the power usage becomes excessive in larger water or wastewater treatment facilities. Bioelectromagnetics, however, has developed an alternative

electromagnetic field technology that is very cost effective in large water/wastewater treatment installations.

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