The synergetic disinfectioneffect analysis on different microorganisms using underwater plasma discharge

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Underwaterplasma can generate UV, shock wave and reactive species. These factors are ableto kill microorganisms by protein denaturation, breaking the cell wall,membrane lipid peroxidation and so on. But, inactivation speed and factors variesfrom each other and it is due to the residual time of reactive species andstructure of microorganisms.

E. coli and *M. testaceum* are selected asa representative gram negative and positive bacteria respectively. Typicallygram positive bacteria have a thick cell wall and are hard to be killed. Plasmaproduces various reactive species, including hydroxyl radicals, ozone, hydrogenperoxide, residual chlorine in salt water. Some species remain long time butsome disappear quickly. OH radical is short-lived species, and hydrogenperoxide, ozone, residual chlorine are long-lived species. Bacteria were inactivated quickly by thephysical effect (UV irradiation, shock wave) and chemical effect (OH radical). Thesewere killed slowly by the residual chemical species (hydrogen peroxide, ozone,residual chlorine). But there were also synergetic inactivation effect whenmicrobial experienced direct and indirect treatment continuously. This study analyzeddirect (by the UV, shock wave and short-lived species), indirect (by thelong-lived species) and synergetic inactivation effects of *Escherichia coli* and *Microbacteriumtestaceum* using an underwater plasma discharge in salt water. We confirmedthat there were synergetic inactivation effect and that of *E. coli* was 5.6 times greater than the indirect effect, and 1.5times greater than the indirect effect in M. testaceum case. This outcomeindicates that gram-negative bacteria with thinner peptidoglycans are weakenedby the direct effect of the plasma and are easily killed by the long-livedspecies. A gram-positive species such as *M.testaceum* has thick peptidoglycans, and the power of the synergetic effectis not significantly greater than in the gram-negative bacteria case.

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