Applied Cold Plasma for Environment Treatment, Horticulture and Medicine

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The applicative researches on plasma science and technology have been conducted at the Center for Plasma Research at Diponegoro University, Indonesia. Corona plasma technology and Dielectric Barrier Discharge (DBD) applications, for Public Health and Agri-Food have been commercialized. Through the development of Double Dielectric Barrier Discharge (DDBD), medical ozone is produced. The applicative researches on plasma science and technology have been conducted at the Center for Plasma Research at Diponegoro University, Indonesia. Corona plasma technology and Dielectric Barrier Discharge (DBD) applications, for Public Health and Agri-Food have been commercialized. Through the development of Double Dielectric Barrier Discharge (DDBD), medical ozone is produced. Application has been used with the bagging method for wound healing in humans. Apart from that, medical ozone has also been used for primary autohemotherapy as a preclinical test. In this annual conference, we focus on discussing DDBD and DBD Plasma to produce highly efficient ozone. Especially for application on Enviroment Treatment, Horticulture, plasma technology was combining with micro-nano bubble technology. This combination is used to neutralize industrial wastewater. For waste water treatment plasma technology micro-nano bubble technology has been used for degradation of Ciprofloxacin (CIP). CIP has been listed in the last version of the surface water due to its ability to kill human cells by inhibiting the activity of DNA topoisomerase IV. Thus, CIP, along with other antibiotic pollution has become a serious threat to the environment and public health. Ozonation has been used as an advanced technique that is applied in wastewater treatment to remove CIP, but the primary limitation of this method is the low solubility of ozone in water. This study is the first report of CIP removal in a scale-up of its aqueous solution using a self-developed aerator pump-enhanced ozonation (APO) system, which only employs a propeller and a zigzag arrangement of meshes. This aerator pump decreased the size of ozone bubbles by 90% and increased the effective ozone solubility to 0.47 ppm. The mechanism of degradation of CIP is attributed to an oxidation reaction of the antibiotic with reactive oxygen species, such as hydroxyl, oxygen, and hydroperoxyl radicals, generated on the surface of the ozone microbubbles. It was found that the rate and efficiency of degradation of CIP using the APO system were 3.64×10^{-3}/min and 83.5%, respectively, which is higher compared with those of conventional flow ozonation (FO) systems (1.47×10^{-3}/min and 60.9%). The higher degradation efficiency of CIP by the APO system was also revealed by its higher electrical energy efficiency (0.146 g/kWh), compared to that of the FO system (0.106 g/kWh). The degradation of CIP was also monitored by the resulting antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*.

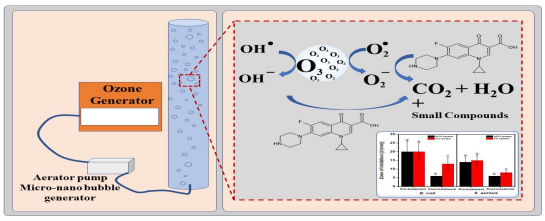

Figure: Grafical abstract of micro-nano bubble technology for degradation of Ciprofloxacin (CIP)

Applying this combination method is very effective in maintaining the freshness of vegetables and fruit. This method can also remove pesticides from vegetables so as to maintain food safety. Ozone produced from DBD is dissolved in water and the water is used to wash the product before being stored or processed as raw material. The basic principle of ozone in preserving is the ability of ozone to kill microorganisms such as bacteria, fungi, molds, viruses. Bacteria that are lost from the product lead to reduced formation of spoilage enzymes. Furthermore, the mechanism of ozone in preserving horticultural products is due to the stimulation of cuticle formation, reducing membrane damage, reducing skin rupture, reducing evaporation of water and fatty acids (oleic acid), activating lipoxygenas for utin formation (cuticle monomers). The freshness of horticultural commodities can last longer. Research conducted on ozonation of horticultural products has resulted in the Indonesian National Standard (INS). The research group from CPR who became the drafter for INS 8759:2019: Postharvest horticultural product storage equipment using ozone technology-Quality requirements and test methods. In 2018, ozonation technology has also been selected to accompany the ASEAN Cooperation Project for Reduction of Post-Harvest Losses (PHL) for Agricultural Produces and Products. This technology has been used in 10 provinces in Indonesia,and is expected to reduce inflation due to volatile foods.

References

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