AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 04 Issue: 04 April 2023 Article No: 18

Preservation of Agro-based Material by Ozone Treatment: An Industrial Approach

Sawant Sanket R[1], Bibek Bahadur Shresth[1] and MD.Faiyaz Ahmed[2]

[1]Assistant Professor, Department of Applied Engineering, Vignan University, Vadlamudi- Guntur, (A.P.)
[2]Assistant Professor, Department of Mechanical Engineering, Vignan University, Vadlamudi- Guntur, (A.P.)

SUMMARY

Ozone (O3) is formed by a high energy input that splits the oxygen (O2) molecule in the air into free radical oxygen. Single oxygen (O) molecules rapidly combine with available O2 to form ozone (O3+heat and light). For food processing plants, oxygen-enriched air (>90% O2) is provided simply and conveniently by means of oxygen concentrators. Ozone application has given promising results for important problems of food industry, such as mycotoxin and pesticide residues. Through emerging new techniques, as well as improvements and innovations in ozone generating and application systems, the subject will be evaluated more effectively in future.

INTRODUCTION

As a primary food concern and safety of agricultural products, reducing the load of microorganisms, spoilage and pathogens is taken into consideration. Presently thermal processing technologies (sterilization, blanching, roasting, evaporation, etc) are used to prevent the spoilage load but these techniques are responsible for the loss of important nutritional quality factors also. The thermal processing technology is having some limitations and drawbacks (overheating, cost of operation, time-dependent etc). To overcome these problems food scientist and researchers have developed non-thermal technology such as, Irradiation, cold plasma, arch discharge, dense carbon dioxide, ultrasound and, pulsed light which are able to prevent the food quality losses suchas loss of original flavor, taste, appearance, colour and nutritional quality etc. Promising results have been revealed in solving the problems of the food industry like microbes, pests, and mycotoxin and pesticide residues by ozone application. Spontaneous decomposition without forming hazardous residues in the treatment medium makes ozone safe in food applications. If improperly used, ozone can cause some deleterious effects on products, such as losses in sensory quality. Ozone is a strong oxidant and potent disinfecting agent. Disinfecting agents have widespread applications to assure safety and quality in the food industry. However, some of these agents, such as chlorine, are inefficient against some organisms, particularly at high pH or against spore-forming microbes. Furthermore, chlorine can react to form trihalomethanes, which are of concern for both human dietary safety and as environmental pollutants. Therefore, the food industry is in exploration of applications that are:

- Effective in inactivation of common and emerging pathogens, and removing toxic contaminants.
- Leading to less loss in product quality and ensure 'freshness'.
- Adaptable to food processes and economically feasible.
- Environmental friendly

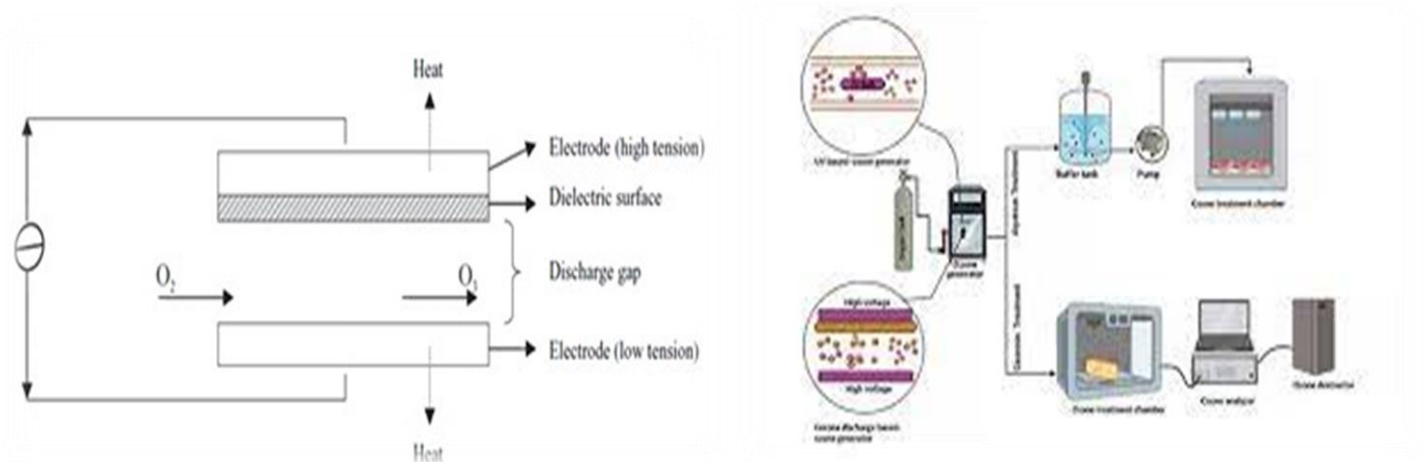


Fig. Schematic and Process diagram of ozone generation by corona discharge method

Generation of Ozone

Ozone (O_3) is formed by a high energy input that splits the oxygen (O_2) molecule in the air into free radical oxygen. Single oxygen (O) molecules rapidly combine with available O_2 to form ozone (O_3+heat and light). In nature, the source of this high energy is the ultraviolet irradiation from the sun and also lightning discharge. Since ozone is unstable, it splits back into oxygen molecule. Ozone can be generated on-site as required by several techniques, three of which are available commercially at the present time – corona discharge, UV radiation and electrolysis.

Components of Ozone System

A complete ozonation system (gaseous ozone) for use in food processing plants consists of the following subunits

- **Oxygen concentrator**

For food processing plants, oxygen-enriched air (>90% O_2) is provided simply and conveniently by means of oxygen concentrators. These devices take in ambient air, automatically filter (remove dust particles), then separate and remove nitrogen (thereby leaving air considerably enriched with oxygen). These oxygen concentrators operate on the principle of pressure swing adsorption (PSA) drying. An air compressor pressurizes the airflow and sends it through a molecular sieve (microscopic porous bead) bed that adsorbs or traps nitrogen and moisture, while providing oxygen-enriched air to the supply output of the concentrator. As the molecular sieve bed becomes loaded with nitrogen and moisture, they desorb to waste in vapor form to the environment, recovering the adsorption capacity of the sieve bed.

- **Ozone generators**

Ozone generators may be UV generators or Corona discharge generators. The quality of gas fed to an ozone generator can be a critical factor, particularly if ozone is produced by corona discharge (CD) or plasma techniques. UV generators of ozone do not require any special air preparation. If an air dryer is selected to feed a CD ozone system, make sure that the air preparation equipment is matched and sized to the ozone.

- **Flow meters**

Mass flow meter provides accurate measurement of total oxygen gas flow from the oxygen concentrator to ozone generator. Ozone flow meter use small gas stream (< 2 lpm) to measure ozone concentration and for regulation of gas flow through ozone analyzer.

- **Treatment chamber**

It is the collector where ozone enters from the top and returns though the bottom outlet after completing the exposure time. The chamber is air tight and avoids leakages. The dimension and type will be based on the mode of application of ozone and type of product being processed. The outlet is connected to ozone analyzer and then to ozone destructor.

- **Ozone analyzer**

This device will be used for measuring the ozone concentration in per cent by weight, or g/m^3 that enters and leaves the treatment chamber.

- **Ozone destructor**

The outlet of the destructor, excess ozone is destroyed, and the cleaned and decontaminated air is re-circulated to its intended enclosure or discharged to the ambient atmosphere. Excess ozone can be broken down into oxygen and send to the atmosphere in order to prevent any harm for the worker. Ozone at high concentration is corrosive and toxic even at lower ppm. In this device, the excess ozone is allowed to release into the air such that the contact of both is controlled.

Advantages and Limitations

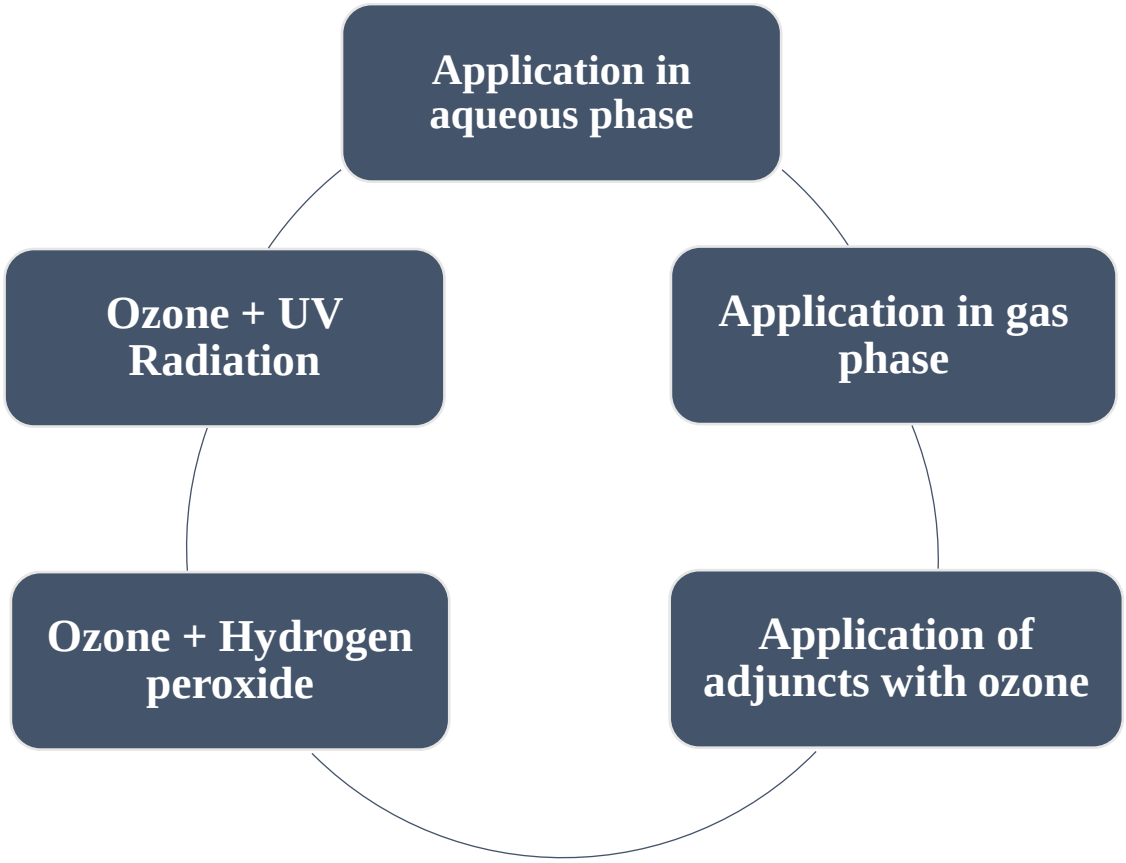
- ✓ No residue problem as it is completely utilized and get reduced
- ✓ Non-hazardous at low ppm (<4 ppm) and effective in bactericidal uses
- ✓ No need to store hazardous substances compared to other methods
- ✓ No heat requirement and no heat generation in treatment
- ✓ Saves transport of disinfectant chemicals& storing of gas cost
- ✓ Eco-friendly and economically feasible technology

Limitations of ozone treatment

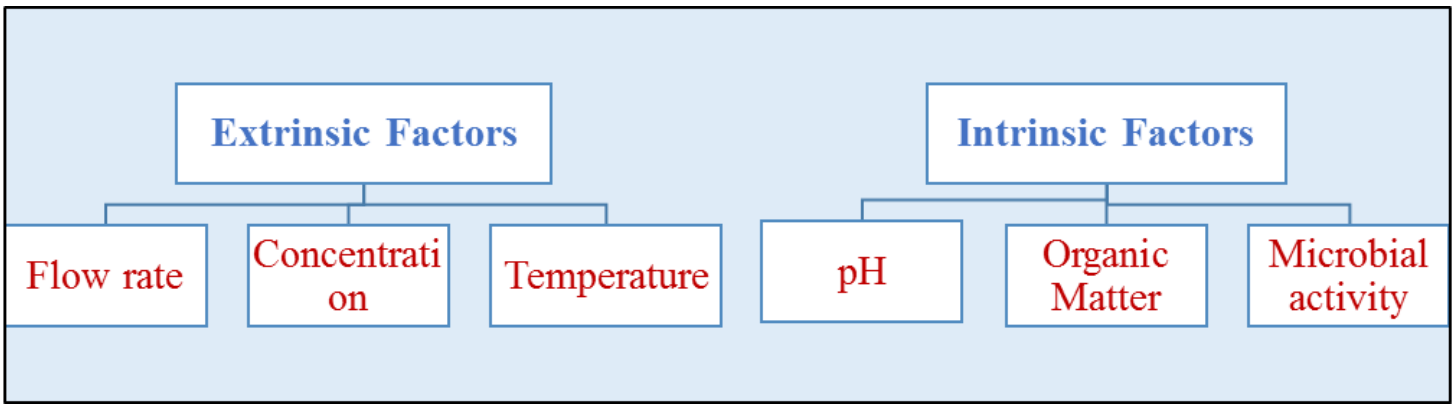
- ✓ Ozone is toxic; when inhaled it cause throat and nasal problems, even lead to asthma
- ✓ It requires regular monitoring in indoor applications for any leakages
- ✓ Higher initial investment for the generation equipment
- ✓ Onsite generation is required as it is unstable

Modes of Application

Modes of application may be selected based on the type of food and the need for ozone treatment.



Factors Affecting Efficacy of Ozone Processing



CONCLUSIONS

Ozone is an effective sanitizer with great potential applications in the food industry. Ozone application has given promising results for important problems of food industry, such as mycotoxin and pesticide residues. Due to its high oxidation capacity and microbial inactivation potential, ozone has prevented various kinds of microbial spoilages usually encountered in fruits and vegetables. Through emerging new techniques, as well as improvements and innovations in ozone generating and application systems, the subject will be evaluated more effectively in future.

REFERENCES

Aguayo, E., Escalona, V.H. and Artes, F. 2006. Effect of cyclic exposure to ozone gas on physicochemical, sensorial and microbial quality of whole and sliced tomatoes, *Postharvest Biology and Technology*, 39: 169– 77.

Melendez-Martinez, A.J., Vicario, I.M., Heredia, F.J., 2007. Review: analysis of carotenoidsin orange juice. *J. Food Compos. Anal*. 20 (7), 638649

Rakness, K.L., 2015. Applications in drinking water treatment. Ozone in Drinking Water Treatment: Process Design, Operation and Optimization. *American Water Works Association*, Denver, CO, pp. 1774

Wu, J., T. Luan, C. Lan, W.H. Lo, and G.Y.S. Chan 2017. ‘‘Removal of Residual Pesticides on Vegetable Using Ozonated Water’’, *Food Control*, 18:466–472.