Analysis of Ozone Technology in Commercial Kitchen Ventilation

TB16-1003

February 1, 2016

A recent addition to the commercial kitchen ventilation industry has been the introduction of ozone to the kitchen exhaust process. This new exhaust method utilizes an ozone creation device that feeds ozonated air into the exhaust airstream following the greasy air's departure from the hood and coinciding with its entrance into the duct. Manufacturers of ozone technology hold that a two-stage filtration method of utilizing traditional hood filters (Stage 1) coupled with ozonated air (Stage 2) outperforms standard mechanical-only filtration for grease and odor reduction. This technical bulletin investigates this claim in order to determine whether or not ozone technology is an effective and reliable means of grease and odor reduction.

Background

The basis of the ozone exhaust theory rests on the creation of ozone, produced by Corona Discharge (CD) ozone generators in most cases (e.g., one manufacturer uses proprietary Corona Class Cells [CGCs] for this process). As power is supplied to the CGCs, a strong electric field is created over a dielectric and between an air gap. The dielectric allows the charge to be spread over a large area as opposed to remaining at a single point, as in the case of a spark. As oxygen molecules (O_2) flow through the gap, they are exposed to the electrical discharge and split into two monatomic oxygen atoms (O^-). These freed oxygen atoms then combine with other oxygen molecules to form ozone molecules (O_3) [1].

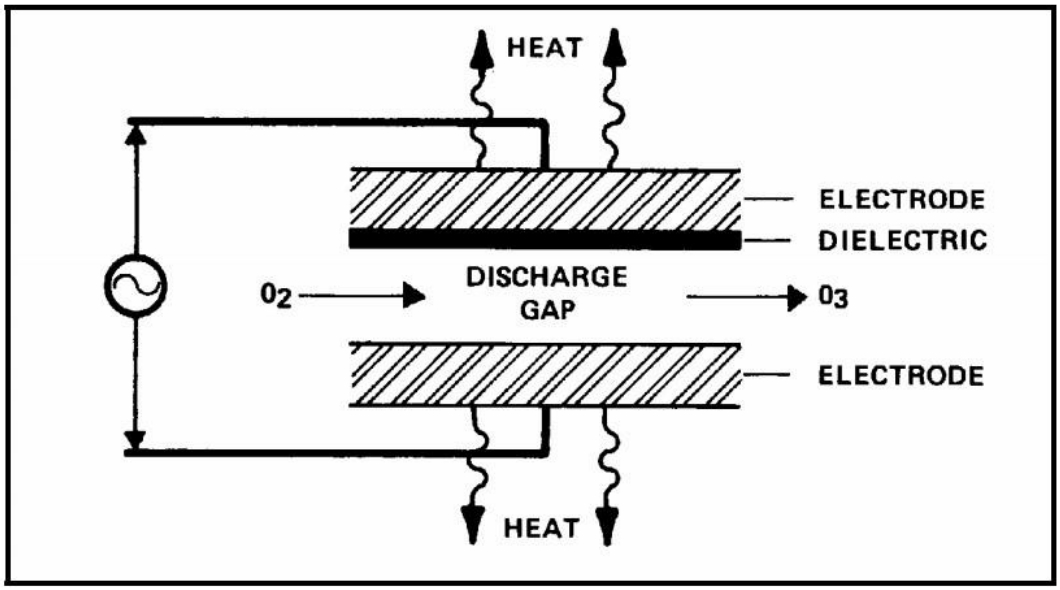

Fig 1: Corona Discharge Cell Configuration
Source: Principles of Ozone Generation, Wayne Smith, Watertec Engineering Pty Ltd

It is important to note that the type of feed gas, the power input/frequency, the unit construction and the temperature and humidity level of the air all greatly affect the amount of ozone generated. For example, if the air being fed into the CD ozone generator contains high humidity levels, ozone production will drop rapidly, similar to the way humidity reduces static electricity in the air.

Additionally, it should be noted that ambient air CD systems require occasional cleaning due to the formation of nitric acid produced as a result of moisture in the air, which is highly corrosive to the internal parts of a CD ozone generator [1, 2]. Cleaning can be avoided with the use of pure oxygen feed air or a heated desiccant air dryer, but the economic feasibility of these solutions is unlikely in most commercial kitchen ventilation applications [2].

Manufacturer Claims

The most well-known maker of CD ozone generators makes the following claims regarding the benefits and effectiveness of ozone technology:

Grease Reduction: "[The unit] considerably reduces the grease buildup in exhaust ducts by breaking down the grease into water vapor and dry minerals which are mostly expelled with the air flow."

Odor Reduction: "With [the unit] odors can be reduced to up to 95%."

Bacteria Control: "[The unit] effectively eliminates all types of bacteria…within ventilation ducts."

Fire Safety and Duct Cleaning: "Since [the unit] lowers the grease and soot content in the exhaust duct, fire risk is also minimized and the service life of the ventilation system is lengthened. The frequency of expensive duct cleaning is thereby also reduced." [3]

Analysis of Manufacturer Claims

Taking each of these claims in turn, one can see that there are major oversights and oversimplifications at work in this literature.

Grease Reduction: Though it is true that ozone is a strong oxidizer, residence time of ozone in the system and the quantity of ozone generated determines whether or not grease buildup can actually be substantially reduced. As discussed above, the humidity of the incoming air drastically affects the amount of ozone generated by the CD process, which then leads to the logical question of what occurs on rainy days or in humid climates. Even when enough ozone is produced, there will simply be too many grease particles and too little residence time for appreciable reaction with the ozone to occur, thus rendering the majority of the grease particles unchanged [4].

Odor Reduction: No independent, third party entity has tested or verified this claim. Additionally, manufacturers state that, "To obtain good odor reduction results…it is important that the ozone have enough time to react with the odor particles in the duct air stream…We recommend a minimum dwell time of 2 seconds to obtain 'good' results for the reduction of cooking odors." (emphasis by third party manufacturer) [5]. After analyzing these numbers, and performing a quick calculation using an average duct velocity of 1500 FPM, the manufacturers are essentially admitting that if the exhaust duct run is less than 50 feet in length, results will be lower than expected or advertised.

Bacteria Control: Though this statement may be true, its actual benefits are overblown. There has been no evidence presented on the reduction of bacteria in the exhaust airstream at standard residence times. Additionally, since all exhaust air exits the building in an enclosed system, the direct benefit to the building occupants and operators is not evident.

Fire Safety and Duct Cleaning: As discussed above, the success of this system in the reduction of grease and soot in exhaust air is dubious at best, thus calling this fire protection claim into question. In addition, as Jack Grace points out in his analysis of UV hoods, the claim that less maintenance is required often leads operators to extend the time between duct cleaning, creating a greater potential for danger and an *increased* fire risk due to these claims by manufacturers [6].

Other Concerns

In addition to the concerns outlined in the previous section, there are a few other significant concerns associated with ozone generators in commercial kitchen ventilation applications.

Numerous possible adverse effects on human health may result from exposure to ozone. Acute exposure to ozone may cause irritation and burning of the skin, reduced vision or irritation in the eyes, and breathing problems [5]. The Environmental Protection Agency warns that ozone can aggravate lung diseases such as asthma, emphysema and chronic bronchitis while also increasing the frequency of asthma attacks, and can continue to damage the lungs even when symptoms have ceased [7]. Ozone-producing appliance manufacturers do not deny that ozone has a high reactivity and oxidation ability and they readily admit this fact on their websites.

Retrofitting an existing kitchen application with an ozone generator can prove problematic for the exhaust fan because additional air is being added to the system. The fan may need to be replaced with a larger model that can adequately handle the added air alongside the standard load of exhaust air.

In DCKV and VAV systems, the proper amount of static pressure must be maintained at the unit in order to ensure proper system performance. This engineered process is far from the "plug and play" illusion that ozone unit manufacturers like to claim.

Conclusion

After thorough investigation and consideration of the added system cost, possible adverse human health effects resulting from ozone exposure, increased fire risk due to decreased maintenance, engineering concerns due to adding new air to the ventilation system, and the overall abundance of dubious and misleading (if not outright fallacious) arguments surrounding ozone technology for kitchen exhaust systems, it is determined that ozone generation via CD or otherwise has little to no measureable benefit.

Sources

[1] Smith, Wayne. “Principles of Ozone Generation.” Watertec Engineering Pty Ltd Information Sheet. http://watertecengineering.com/TZ000002%20Principles%20of%20Ozone%20Generation.pdf

[2] Corona Discharge vs. UV Ozone. http://www.waterth.com/products/pdf_files/applier_ozone.pdf

[3] AirMaid V. http://www.interzon.com/products/airmaidv/

[4] Farrell, F.M. (Tim). (2010, Jan). “Cooking Emissions and the (Supposed) ‘Light Fantastic’.” The Consultant. https://www.captiveaire.com/Resources/Articles/ConsultantArticle.pdf.

[5] AirMaid Installation, Operation and Maintenance AirMaid V Series Ozone Cleaning System. http://www.interzon.com/wp-content/uploads/2015/12/AirMaid-V-OM-North-America.pdf

[6] Grace, Jack. (2008). “UV Technology – a light at the end of the duct*?” International Kitchen Exhaust Cleaning Association*. Vol. 23 http://www.ikeca.org/sites/default/files/IKECA%20Journal%20-%20Spring%202008.pdf

[7] “Ground-Level Ozone: Health Effects.” http://www3.epa.gov/ozonepollution/health.html