Elimination of Microorganisms from Airflow Out of Air Conditioner Using Ozone Generating System †

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Abstract: Under hot weather condition, air conditioner is an important household device which control temperature and humidity of a closed chamber. A filtration in the air conditioner has functions in reducing dust and microorganisms of inlet airflow. However, humidity in conditioner system may enhance microbial growth inside the device and re-distribution in flowing out air. Furthermore, airborne pathogens are being concern because of epidermic crisis. In this research work, we investigated the impact of ozone, an air cleaning system, on reducing microorganism quality and quantity of airflow out of the conditioner. The ozone generating system is constructed and cooperated over the airflow channel. This ozone system is opened for fifteen minutes before placing enrich media at five different positions of pre-conditioning room. The medium plates were opened for fifteen minutes at 0, 3, 6, 12 and 24 hours after generating ozone. Collecting plates were incubated at room temperature and counted the microorganism colony for four days. The result showed that ozone generator cooperated over airflow out of the conditioner evidently presented a smaller number of microorganisms (bacteria, yeast, and fungi) in compared to non-cooperated system did. Therefore, the cooperated ozone treatment is effectiveness in eliminating microorganisms in the air conditioning room.

Keywords: Microorganism, Ozone, Eliminate, Air-conditioner

1. Introduction

Global warming affected the climatic changes because they enhance the average temperature of Earth's surface. An air conditioning system is commonly used an electrical device for achieving a comfortable environmental condition for people working and living. However, an internal air circulation space which is controlled by air conditioning system may risk on outbreaking epidemic crisis if peoples with the symptoms of diseases are living in the spaces. The cooling and humidification systems of air conditioner is also containing filtration and disinfection units which are important in reducing air contaminations. The cooling coils of system generated moisture in the device chamber when the air conditioner is turned off. Moistures and dusts promote microbial

growth especially spore formation of molds and these spores can re-distribute in air conditioning space [1]. The evidence of breathing microbial spores bring about respiratory allergies in human [2].

Therefore, disinfection unit is become more importance especially in during air epidemic crisis for well-being and patient safety. The choice of the appropriate sanitizer depends on the limitations of each processing, in achieving sufficient disinfection. Chemical sanitizer such as chlorine is commonly used, however, this treatment results in chemical residues that effect on health hazard and unwanted small. It has been demonstrated that a gaseous sanitizer (ozone) has more powerful disinfectant ability than a chemical liquid sanitizer because ozone molecules are highly distributed in complex area [3].

Ozone generating system, a high voltage device, ionizes two oxygen molecules in the air and converts into three oxygen molecules. Ozone is a colorless or pale blue gas, which contains unstable negative charged ion. Therefore, it is high possibility in electrostatic attraction to the air contaminants such as microorganisms and odors in the air space and surface. Ozone treatment is success to use in car disinfection processes [4]. However, the concentration of ozone and disinfectant process in air conditioning room should be established owing to effectiveness of ozone treatment without toxic to human health living in space.

In this research, application of an external unit of ozone generator over the airflow out of the air-conditioners are performed and are analyzed the microbial elimination efficiency in air conditioning room at different time intervals in compared to normal air conditioning room.

2. Experimental Procedure

Experimental room and condition. Twenty-five cubic meters in size of unfurnished room was used in experimental study. This room was installed air conditioner (9000 BTU) at the center of wall and 2.6 meters upper than floor. The air conditioner cooperated with standard dust filter. The air conditioning system was operated at 25±2 ^{o}C for 30 minutes before starting an experiment for stable temperature. Additional fan was placed on floor for an aeration of conditioning room.

Ozone generating system. Ozone generating unit was constructed in 19x86x12 cm. (WxLxH) opened box and placed over airflow out of air conditioner. This unit system generated 20 gh^{-1} ozone. Ozone was generated in experimental room for fifteen minutes before plating media at each time.

Microorganism collection and analysis. Luria-Bertani medium [5] are prepared in sterile agar plate. After generating ozone, sterile plates were placed at five positions on room floor and opened the cover for 15 minutes at 0, 3, 6, 12 and 24 hours. Collecting plates were incubating at room temperature for 5 days. Microorganism colonies grew on each plate were daily identified and counted. Collecting data were statistically analysis in compared to data of normal air conditioning room.

3. Result

Microorganism colonies grown on medium plating in experimental room are clearly appeared within two days and some colonies are appeared later. The plates incubated over 4 days, we found that some microbial colonies were overgrowth and fused each other. Therefore, the table result of microbial colony numbers are presented at 2, 3 and 4 days of culture times. Smooth or rough colonies with defined margins, looked wet and shiny are classified as groups of bacteria and yeast. Hypha colony are classified as fungal colony.

Under normal air conditioning room, both averages of bacteria plus yeast and fungi colony numbers are not statistically difference among the collecting time within two-day incubation (Table 1 and Table 2). After further incubation, the average of yeast colony from each time interval was approximately increasing 20-50% comparing to data that of two-day incubation. The maximum number of bacteria and yeast colony was found at the four-day culturing, which is before occurring the uncountable colony time.

Ozone concentration generated in each round of experimental room at 25 ^{o}C was 100 ppm. This concentration of ozone clearly reduced the average number of microorganism colony, especially in bacteria and yeast numbers (Table 1 and 2). Approximately fifty percentage of bacteria and yeast number on plate was reduced at first time (0 hour) of ozone application in air conditioning room

compared to that of normal air conditioning room. At the second times of ozonation treatment (3 hour), average bacteria and yeast number on plate was further reduction. An increasing number of ozonation after 3 hours had no effects on reducing bacteria, yeast, and fungus colony on plate. Long time interval of ozonation treatment was slightly enhance average numbers of bacteria yeast and fungi colonies, especially at 24 hours, however, not statistically difference among data is presented.

Table 1. Average number of bacterial and yeast colonies grown on plate collecting from control room and ozonation room at different times. Culturing plates are counted the colony at 2, 3 and 4 days.

Treatments	Days	Number of Bacteria and Yeast				
		Hours				
		0	3	6	12	24
Control	2	11.75±0.96	11.25±0.96	11.00±0.96	12.00±1.22	12.75±0.96
	3	14.25±0.96	16.25±0.50	16.50±0.58	17.50±1.29	18.25±0.96
	4	16.75±1.26	17.75±0.96	17.00±0.82	19.00±2.16	19.00±0.82
Ozone	2	04.80±3.77	01.00±1.73	01.60±1.14	00.20±0.84	02.80±1.30
	3	05.80±3.70	01.20±1.30	01.80±1.30	01.20±0.84	03.60±3.05
	4	08.40±5.50	01.60±1.52	02.40±1.67	01.40±0.55	03.40±2.61

Table 2. Average number of fungus colony grown on plate collecting from control room and ozonation room at different times. Culturing plates are counted the colony at 2, 3 and 4 days.

Treatments	Days	Number of Fungi				
		Hours				
		0	3	6	12	24
Control	2	1.00±0.00	0.25±0.50	0.25±0.50	0.25±0.50	0.00±0.00
	3	1.00±0.00	0.25±0.50	0.50±0.58	0.25±0.50	0.50±0.58
	4	1.00±0.00	0.25±0.50	0.50±0.58	0.25±0.50	0.50±0.58
Ozone	2	0.00±0.00	0.00±0.00	0.00±0.00	0.20±0.45	0.20±0.45
	3	0.00±0.00	0.00±0.00	0.00±0.00	0.20±0.45	0.20±0.45
	4	0.00±0.00	0.00±0.00	0.00±0.00	0.20±0.45	0.20±0.45

4. Discussion

Microbial growth rate on culture medium is variable depending on type of microorganism. The microbial cells slowly developed into visible colonies, therefore the numbers of microbial colonies, increased after two days in normal air conditioning room. Our result showed that filter of air conditioning system under normal condition is not affected on reducing numbers of microbial colony on culture plate although long time operation of air conditioning room is performed. The standard dust filter in home's air conditioning has potential to trap particles that are 5-10 microns in size or larger if these particles are flow directly into the air filter. Large particles may be not directly flow in an air filter of wall air conditioner. Owing to their limitation, dust filter is not effectiveness to remove particles of a certain size which is including microorganism.

External part of ozone generator produced polar trioxygen molecules. This unstable of oxygen in ozone molecules are easily to attach and to catalyze organic and inorganic matters. Ozone is a strong oxidizing agent which has patentability to catalyze surface microorganisms such as bacteria, yeast, and fungi. The injury levels of microbial cell depend on lipid peroxidation level of cell membrane. A concentration of 100 ppm ozone in air conditioning room was strongly injuring and also killing microorganisms. This condition was reducing number of microorganisms on place compared to non-treated ozone room was.

Ozone gases have potential to penetrate into cell wall of broad spectrum of microorganisms [3]. It can attach bacteria, mold spores, and organic matter and destroy them. [6-8]. Ozone has strong oxidizing effect which reacts with cellular biomolecules containing carbon-carbon double bonds, aromatic ring, and amine group such as lipid membrane protein and genetic materials. [9-10]. Ozone gases inactive corona virus has been reported [11]. However, the effectiveness of microbial cellular damage is depending on relative humidity level, type of microorganism, ozone concentration, treatment time [12-13], temperature and turbidity. Moreover, smoke and odor pollutants are easily attached and removed by ozonation [6, 14]. Although ozone is toxicity and reactivity, but it will be generated on-site and have short haft-lift. Therefore, ozonation process should be managed and used for microbial disinfection in safety level for human.

5. Conclusion

Normal air conditioning system is suitable for cooling and humidification usages. Under epidemic crisis, disinfectant units are becoming importance. In this research result presented that external ozone generating system placed over airflow out of air conditioner are high potential in eliminating microorganisms approximately half time of normal condition are. Ozonation should be powerful method for air disinfectant in a short time, but the appropriate operation method should be performed, owing to avoid toxicity.

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