



## Infraq Sterilization Box with UV and Ozone (BIUZ)

*Zaenal Arifin, Aries Jehan Tamamy, Hery Pamungkas, Dita Ayu Mayasari, M Ary Heryanto*

*Universitas Dian Nuswantoro, Jl. Nakula I No. 5-11, Semarang, 50131, Indonesia*

### ARTICLE INFORMATION

Received: August 06, 2022  
Revised: February 17, 2022  
Available online: March 29, 2022

### KEYWORDS

COVID-19, Ultraviolet (UV), Ozone (O<sup>3</sup>)  
Money.

### CORRESPONDENCE

Phone: +6281574114321  
E-mail: xzaenal@dsn.dinus.ac.id

### A B S T R A C T

The COVID-19 pandemic that has occurred to date has resulted in the loss of many lives. This is due to the ease with which the COVID-19 virus spreads. According to the latest research published by the WHO, the virus can spread through the medium of objects, one of the easiest object to spread virus is money. The spread of the COVID-19 virus can be done through money transactions that have previously been used by people infected by the virus. This is because COVID-19 virus can survive for more than 72 hours. To prevent this, it is necessary to sterilize so that the virus in the money can be neutralized. The technology that can be used for disinfection in this tool is Ultra Violet (UV) light and Ozone Generator. Many studies have shown that UV rays and ozone gas (O<sub>3</sub>) are able to kill viruses that are on the surface of objects. The ability of UV rays and ozone gas (O<sub>3</sub>) can kill viruses in money because UV rays and ozone gas (O<sub>3</sub>) have radiation that is quite harsh, so that if exposed to human skin continuously it can cause damage to skin tissue. In this study, to overcome this problem, a device that is automatically able to carry out the disinfection process in the room is made by utilizing UV light. Infraq Sterilization Box with UV and Ozone (BIUZ) can kill viruses in money, it is also easy to operate and safe. The size of the tool made is adjusted to the object or partner of the research activity, namely the Central Java Great Mosque Manager (PP MAJT). The need for partners is that the tool is able to carry out the sterilization process of infraq money provided by the congregation, both in the form of paper and coins effectively.

## INTRODUCTION

### COVID-19 case in Indonesia

The rate of transmission of the COVID-19 virus continues to increase over time. The number of people infected with the number of people recovering from the disease has a wide disparity. In Indonesia, it was reported that until January 2021, the virus had infected a total of 1,937,652 people. This disease can basically be cured by self-isolation because it is a Self-Healing Disease group, but low immunity makes this virus stay in the patient's body and even cause death[1]. In fact, until the same date, the number of deaths from COVID-19 reached 53,476 people.



Figure 1. Data Update Covid-19 from World Health Organization (WHO)

In a recent study conducted by researchers from the University of Nebraska Medical Center, providing new evidence regarding the

risk of spreading COVID-19 through the intermediary of objects that are touched in turn[2]. The researchers collected samples of objects in the treatment room for COVID-19 patients. This is one of the reasons why the COVID-19 virus is very easily transmitted to everyone. Banknotes and coins, are one of the things that are commonly transferred from one hand to another, so they can be said to be objects or media that can spread virus exposure[3], [4]. One of the preventions that can be done so that the virus is not easily spread is to diligently wash your hands after touching objects outside. But sometimes it is often forgotten to do.

### UV and Ozone (O<sup>3</sup>) as a Disinfectant

According to research conducted by Alinea D E., and friends from the Jember State Polytechnic and the Airlangga University Stem Cell Research Center, it shows that UV light is able to kill viruses on the surface of money, including the COVID-19 virus [5]. The process of irradiating UV rays for 10 seconds, is able to kill bacteria on the surface of the money more than 60%. UV rays are electromagnetic radiation waves that can be sourced from sunlight or lamps with certain specifications. The effects of exposure to human skin with UV continuously, can cause damage to skin tissue[6]. This was stated by Sheila P, from Padjadjaran University in the FARMKA journal. This is also confirmed by research conducted by Siti H I, from the Islamic University of

Indonesia who wrote research on the importance of protecting the skin from direct UV rays[7].

In addition to UV rays, ozone gas (O<sub>3</sub>) is also proven to be able to kill bacteria and viruses in the air in certain levels[8]. Ozone is used in the fields of water treatment, disinfection, decolorization, deodorization, organic synthesis, materials testing, etching and dry cleaning processes in the semiconductor industry and other industrial areas. The advantages of using ozone over other chemicals are: strong oxidizing power, its clean nature leaving only oxygen after treatment, and on-site power generation. Monitoring of ozone dose and residual levels is required in all these processes[9].

As with UV, ozone is also very harmful to humans if the gas is inhaled directly and continuously. Ozone can worsen asthma and increase susceptibility to respiratory diseases such as pneumonia and bronchitis. TCLO is 50 ppm. Pulmonary symptoms at low levels (60-200 ppm) include substernal pain, cough, dry throat, wheezing, and dyspnea. The American Conference of Governmental Industrial Hygienists (ACGIH) lists ozone as A4 (not classified as a human carcinogen).

### Problem on fields MAJT (PP MAJT)

One source of operational funds from MAJT is infaq funds from the congregation. The calculation of money is done every Tuesday and Friday every week. This caused anxiety on the part of the manager because money is one of the media for the spread of the COVID-19 virus. In the manufacture of money sterilizers in charity boxes at the Great Mosque of Central Java (MAJT), utilizing UV combined with an ozone generator. Based on the research that has been done, the two compounds are able to kill bacteria and viruses that are on the surface of money effectively. This can affect the Central Java Grand Mosque Manager (PP MAJT) so that they can work comfortably, especially in the process of calculating the infaq money received from the congregation. The tools designed in this study must be easy to use so as not to cause new problems in the future. That's because the users of this tool are the general public who certainly have a low level of understanding of control systems and electronics. From these problems, the researchers tried to design a tool that is easy to operate just by pressing 1 button, and is equipped with indicators that make it easier for operators to operate the tool.

### DESIGN OF BIUZ

The design of the Infaq Sterilization Box tool with UV and Ozone (BIUZ) begins with making 3D sketches with AutoCAD software. The size of the tool is adjusted to the needs of PP MAJT with a capacity of 36 liters.

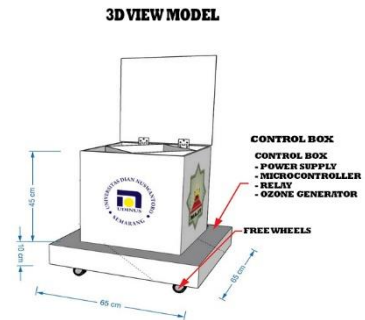


Figure 2. front view design

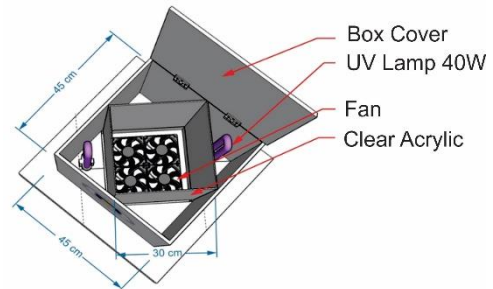


Figure 3. Top view design

### Schematic Diagram

The electronic circuit in BIUZ mainly consists of a controller circuit using Arduino Uno R3 and a relay connected to a UV lamp, an ozone generator and a fan. The following is a schematic diagram in figure 4.

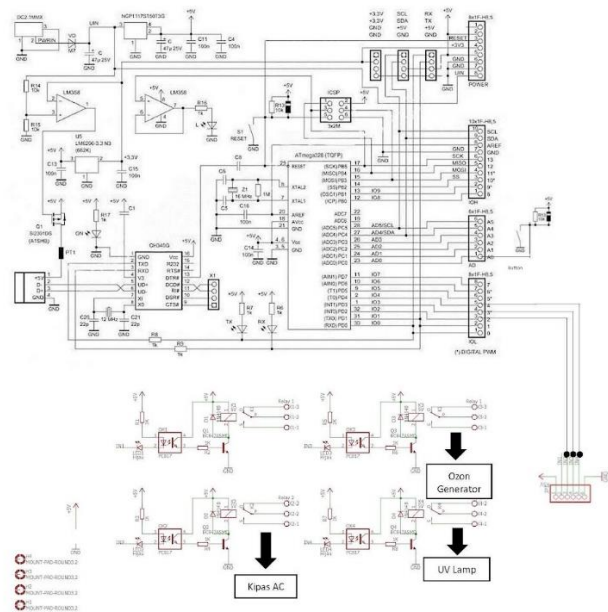


Figure 4. Schematic Diagram of BIUZ

### Ultraviolet (UV)

The UV mounted on the BIUZ, has a lamp height specification of 40 cm, capable of emitting UV-C rays with a power of 36 watts which can cover an area of 40 m<sup>2</sup>. There are 2 UVs installed in the box.

## Ozone Generator and Fan

The Ozone Generator used in BIUZ has a power of 90 watts, capable of producing 10 grams of ozone ( $O_3$ ) per hour. The ozone gas produced is channeled into a chamber that has a ventilation hole so that it can carry out the process of disinfecting the air in the chamber. To be able to push the gas up, at the bottom of the ventilation there are 4 DC fans. The fan also functions to form air circulation so that banknotes can fly so that all sides can be exposed to UV rays.

## Working process of BIUZ

Infaq Sterilization Box with UV and Ozone (BIUZ) has the following way of working:

The power cable is connected to a 220V AC power source and the power switch is in the on position, then BIUZ is in standby with a yellow LED indicator.



Figure 5. BIUZ on Standby and Process Notification

If the chamber has been filled with money for the sterilization process, the operator can press the process button so that BIUZ works to carry out the sterilization process with a green LED indicator.



Figure 6. BIUZ on sterilization process

The sterilization process works for 3 minutes. In the first minute the UV lamp and fan are on at the same time. Then entering the 2nd minute, ozone begins to work to fill the sterilization acrylic box to help UV kill viruses and bacteria. At the 3rd minute, the ozone starts to stop working but the UV and fan are still on to remove the ozone that is in the acrylic case. After the 3rd minute, the sterilization process is complete and the standby indicator light turns yellow again.

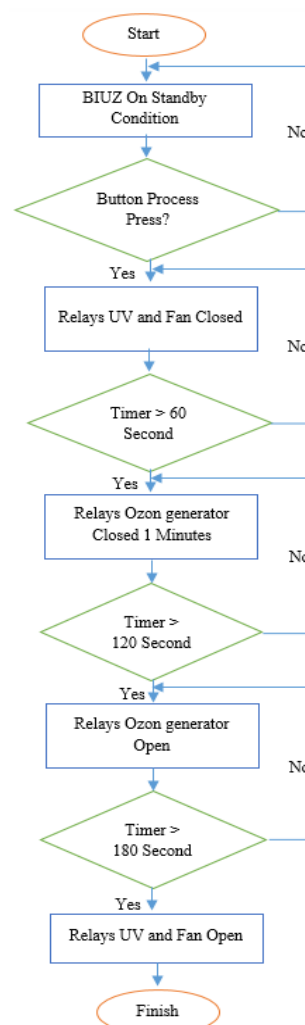


Figure 7. Flowchart BIUZ

## RESULTS AND DISCUSSION

In the following is the design implementation result of BIUZ



Figure 8. Device Realization

From the test results, it was found that the intensity of UV-C produced by 1 UV lamp with a power of 36 watts was able to illuminate an area of up to 40 m<sup>2</sup>. Inside the sterilization box measuring 30 cm x 45 cm there are 2 UV lamps and an ozone generator capable of producing 10 grams of ozone gas within 1 hour, so it is very effective in the sterilization process.

From the tests that were carried out repeatedly, it was proven that the tool was able to work well. Before being used directly to carry out the infaq money sterilization process at MAJT, BIUZ was tested in the lab for 7 days by operating repeatedly. It didn't take

long for operators to learn how to operate BIUZ. This is because to carry out the sterilization process only by pressing 1 button.

### **Correlation and proves UV and Ozone are able to kill bacteria**

Structurally, viruses have a simpler structure when compared to the structure of bacteria. Viruses generally only have genetic material protected by a capsid[10]. Coronavirus is a virus with single-stranded RNA (ssRNA) genetic material. This virus also has several structural proteins, namely spike protein (S), envelope protein (E), membrane protein (M) and nucleocapsid (C)[11], [12]. S protein is found on the outer surface of the envelope, plays a role in binding to receptors on the surface of the host cell to mediate the entry of viral genetic material into the host[13]. E & M proteins found on the envelope. This E & M protein which will facilitate the coronavirus can enter and replicate genetic material in human cells[14].

Based on research by Bernardino Clavo showed that the use of ozone with a concentration of 2000ppm for 5 minutes can inactivate the coronavirus found in PPE clothes & masks[15]. Coronavirus inactivation with ozone can occur due to oxidative stress in the virus. Oxidative stress occurs due to damage to polyunsaturated fatty acids found in the viral envelope, proteins (especially S-protein), and lipoids found in the capsid & viral envelope.

Damage to the structure of the viral envelope & capsid that occurs causes the genetic material to lose protection. This causes the genetic material to be susceptible to damage. ssRNA as coronavirus genetic material has low stability when exposed to the external environment. Viruses with ssRNA genetic material were more susceptible to UV inactivation than dsRNA & dsDNA. The use of UVGI at a dose of 339-423uW.sec/cm<sup>2</sup> was able to inactivate 90% of ssRNA viruses[16].

### **Important steps in the sterilization process**

To operate the Infaq Sterilization Box with UV and Ozone (BIOZ), it is necessary to pay attention to the following:

#### **Manual Operational Technical**

1. Operate the device in an open space with good air circulation
2. Before operating, make sure the UV lamp on the box is off and the yellow LED is turned on
3. For filling banknotes or objects to be sterilized, a maximum of 3/4 of the volume of the box is recommended
4. When pressing the start sterilization button, make sure the box is completely closed
5. Maintain a minimum distance of 5 meters from the device while the sterilization process is running
6. Withdrawal of money is done after the process stops and the box is in standby position

Direct testing was carried out in April 2021 on Friday witnessed by the deputy governor of Central Java and received a positive response from PP MAJT.

## **CONCLUSIONS**

In the design of the BIUZ sterilizer, it is equipped with an ozone and UV generator that is able to kill viruses attached to infaq money from the congregation. The tool is able to work well during the testing period of more than 1 month. The sterilization process takes 3 minutes for each session. In the first minute, UV and continued in the second minute the ozone generator works for 1 minute. After working for 1 minute, the ozone generator turns off because it produces enough ozone gas according to the area of the sterilization box. To neutralize the box from ozone gas, the fan and UV remain on until a time duration of 3 minutes is reached. In the future, it is necessary to carry out laboratory testing so that it can be seen how efficiently BIUZ is able to sterilize money so that its ability can be known.

## **ACKNOWLEDGMENT**

The author would like to thank all parties who helped in the research process of BIUZ sterilization box design. First to LPPM Universitas Dian Nuswantoro as the party funding research activities, secondly PP MAJT as a partner of research, and the laboratory of the Faculty of Engineering, Universitas Dian Nuswantoro which facilitates the research process. The activity documentation video can be seen via the link

[https://www.youtube.com/watch?v=Zy9l\\_KQRA9M](https://www.youtube.com/watch?v=Zy9l_KQRA9M)

## **REFERENCES**

- [1] M. B. Karo, "Perilaku hidup bersih dan sehat (PHBS) strategi pencegahan penyebaran Virus Covid-19," in *Prosiding Seminar Nasional Hardiknas*, 2020, vol. 1, pp. 1–4.
- [2] WHO, "Coronavirus disease (COVID-19) outbreak situation." <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>.
- [3] T. Rashed, J. Ghanaat, K. Ghazvini, and E. Rashed, "Bacterial contamination of current banknotes and coins," 2006.
- [4] S. Ghobadirad *et al.*, "A Study on Bacterial Contamination of Banknotes and Coins in Circulation in Iran during 2013-14," 2014.
- [5] A. D. Elisanti, E. T. Ardianto, N. C. Ida, and E. Hendriatno, "Efektifitas Paparan Sinar Uv Dan Alkohol 70% Terhadap Total Bakteri Pada Uang Kertas Yang Beredar Di Masa Pandemi Covid-19," *J. Ris. Kefarmasian Indones.*, vol. 2, no. 2, pp. 113–121, 2020.
- [6] S. PRATIWI and P. Husni, "Potensi penggunaan fitokonstituen tanaman Indonesia sebagai bahan aktif tabir surya," *Farmaka*, vol. 15, no. 4, pp. 18–25, 2017.
- [7] S. H. Isfardiyana, "PENTINGNYA MELINDUNGI KULIT DARI SINAR ULTRAVIOLET DANCARA MELINDUNGKULIT DENGAN SUNBLOCK BUATAN SENDIRI," *Asian J. Innov. Entrep.*, vol. 3, no. 2, pp. 126–133, 2014.
- [8] C. Tizaoui, "Ozone: a potential oxidant for COVID-19 virus (SARS-CoV-2)," *Ozone Sci. Eng.*, vol. 42, no. 5, pp. 378–385, 2020.
- [9] US EPA, "Wastewater Technology Fact Sheet Ozone Disinfection," *United States Environ. Prot. Agency*, pp. 1–7, 1999.
- [10] A. P. Golin, D. Choi, and A. Ghahary, "Hand sanitizers: A review of ingredients, mechanisms of action, modes

- of delivery, and efficacy against coronaviruses,” *Am. J. Infect. Control*, vol. 48, no. 9, pp. 1062–1067, 2020, doi: 10.1016/j.ajic.2020.06.182.
- [11] P. V'kovski, A. Kratzel, S. Steiner, H. Stalder, and V. Thiel, “Coronavirus biology and replication: implications for SARS-CoV-2,” *Nat. Rev. Microbiol.*, vol. 19, no. 3, pp. 155–170, 2021, doi: 10.1038/s41579-020-00468-6.
- [12] C. P. E. R. E. Novel, “The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China,” *Zhonghua liu xing bing xue za zhi= Zhonghua liuxingbingxue zazhi*, vol. 41, no. 2, p. 145, 2020.
- [13] V. S. Mandala, M. J. McKay, A. A. Shcherbakov, A. J. Dregni, A. Kolocouris, and M. Hong, “Structure and drug binding of the SARS-CoV-2 envelope protein transmembrane domain in lipid bilayers,” *Nat. Struct. Mol. Biol.*, vol. 27, no. 12, pp. 1202–1208, 2020, doi: 10.1038/s41594-020-00536-8.
- [14] M. Bianchi, D. Benvenuto, M. Giovanetti, S. Angeletti, M. Ciccozzi, and S. Pascarella, “Sars-CoV-2 Envelope and Membrane Proteins: Structural Differences Linked to Virus Characteristics?,” *Biomed Res. Int.*, vol. 2020, 2020, doi: 10.1155/2020/4389089.
- [15] B. Clavo and C. Elizabeth, “Effects of Ozone Treatment on Personal Protective Equipment Contaminated with SARS-CoV-2,” pp. 4–12, 2020.
- [16] C. C. Tseng and C. S. Li, “Inactivation of virus-containing aerosols by ultraviolet germicidal irradiation,” *Aerosol Sci. Technol.*, vol. 39, no. 12, pp. 1136–1142, 2005, doi: 10.1080/02786820500428575.