# Naskah Prosiding-CI2-TB-Revisi

*anonymous marking enabled*

# Model of Chlor Gas Electrolyzer from Salt Water Electrolysis as A Disinfectant for Room Air Microorganisms for TB Patients

**Sri Puji Ganefati[1], Narto Narto[2], Yamtana Yamtana[3], Choirul Amri[4*]**

[1234]Department of Environmental Health of Poltekkes Kemenkes Yogyakarta, Jl. Tata bumi no 3 Banyuraden Gamping Sleman Yogyakarta Indonesia-55293

* Corresponden Email: choirul.amri@poltekkesjogja.ac.id

**Abstract.** Based on the laboratory test in book two, the results obtained: there is an effect of disinfecting the room air using Chlor gas from the electrolysis of saltwater on the decrease in the number of germs in the room air. The results of laboratory tests for room air disinfection using Chlor gas from the electrolysis of salt water or NaCl on exposure within 10 minutes, the content of Chlor gas is 0.0216 ppm and meets the quality standard. The number of airborne germs measured does not exceed 700 colonies/m3 of air. Until now, the electrolysis model with its variations has not been found to reduce airborne bacteria in TB patients with TB. The purpose of this study was to determine the effect of various electrolysis models on the reduction of indoor air bacteria in TB patients. This study uses an experimental type with pre-test and post-test designs. The independent variables in this study were various models of electrolysis and the dependent variable was the decrease in airborne bacteria in the TB patient room. All TB patients in the working area of Puskesmas throughout Yogyakarta as many as 83 Puskesmas became a population in this study. Meanwhile, all TB patients in the working area of Gamping II Public Health Center, Sleman, were the samples in this study.

This study shows that there is an effect of room disinfection with the Electrolysis method on the reduction of room bacteria (P = 0.000), and the Electrolysis model one is the tool that reduces bacteria the most, which is 51.0 x 10-5 CFU/m3 (60.5%) . The results of the study are recommended to be tested for acceptance of the Electrolysis I, II, and III models by the public.

## 1. Introduction

Chlor gas as a room air disinfectant can be produced from the electrolysis of saltwater (NaCl). Based on the preliminary test of room disinfection with Chlor gas from the electrolysis of saltwater with a concentration of 100, 500, and 1000 g/L of water, it can reduce the number of germs sequentially by 15 CFU/$m^3$, 32 CFU/$m^3$, and 56 CFU/$m^3$. Room disinfection using Chlor gas from the electrolysis of NaCl saltwater, exposure time of 10 minutes, Chlor gas content of 0.0216 ppm, and not exceeding the standard.

Air disinfection in TB patient rooms uses electrolysis of salty air, as one of the family's or community's efforts to prevent TB disease transmission and encourage the government's Stop TB program. The results of reducing the number of germs in room air with Chlor gas disinfection for a concentration of 10% were 56 CFU/m3 (84.5%) reaching 9.33 colonies/m3. This has met the quality standards contained in the Minister of Health of the Republic of Indonesia Number 1077/Menkes/Per/V/2011 concerning Guidelines for Indoor Air Sanitation that the number of germs should not exceed 700 colonies/m3 of air.

The manufacture of tools used for Chlor gas disinfection requires Appropriate Technology (AT) so that people can be independent in preventing the transmission of TB disease. The application of AT in room air disinfection has 2 (two) benefits, namely the provision of room air disinfection equipment and business opportunities to improve the family economy. The purpose of this study was to find the electrolyzer model that most reduces the bacteria in the room air of TB patients and which is widely accepted by the public.

Disinfectant is a material to carry out disinfection activities. The main ingredients of disinfectants generally come from chemicals. The use of disinfectants can cause impacts on water such as changes in color, odor, and taste. Disinfectants can also be carcinogenic at high concentrations but are not corrosive to metals, these properties can cause irritation of the skin, eyes, and respiratory tract or can produce residues [1] [2].

Disposal of disinfectant waste into the soil can kill bacteria in the soil that are beneficial for the environment so that the soil becomes barren. Disposal of disinfectant waste into waters can cause water pollution, which results in damage to aquatic ecosystems and the death of several aquatic biotas. The use of disinfectants in humans, if excessive, can cause the skin to become dry, even disinfectants can be carcinogenic [3]. Control of Mycobacterium tuberculosis can infect several organs of the body, the lungs which are often infected. There are two types of Mycobacterium tuberculosis bacteria found in the patient's body, namely bacteria through inhalation contained in droplets into the patient's respiratory tract (per inhalation) and transmission through direct contact (per continuity) [4]. Spots are an infection that appears white spots due to *Mycobacterium tuberculosis* bacteria entering the patient's lungs and damaging lung tissue through the air and then multiplying into colonies. Damage to lung tissue in TB patients can increase if they do not get treatment properly. Sputum sprinkling in TB patients can be carried through the flow of a house or room that has good air circulation, this has the potential to be an effective transmission medium in the spread of TB disease [5]. Intact skin tissue, which is the best part of the body in the external defense system, is often the target of infection with the *Mycobacterium tuberculosis* bacteria. If this tissue is slightly damaged, it is susceptible to infection with tuberculosis or the like. Tissue on the skin that is often infected, such as the hands, facial skin, and feet [6].

*Mycobacterium tuberculosis* can be controlled by : (1) Air filter system; Air that enters the room has flowed through an air filter system. Facilities can be in the form of central air conditioning, split air conditioning, or a special building for air filtering, (2) Self closing door; This system does not have a natural installation and is provided with a mat that is pre-soaked in a disinfectant solution and placed in front of the door in the room, (3) Tool irradiation system; This system uses a movable and angle-adjustable irradiation device. Ultraviolet works when the red light is on, this light is mounted on the walls and ceiling of the room and above the entrance and (4) Disinfectant spraying system; The tool used can be a sprayer, mister or fogger. The spraying method produces low-pressure airbursts along with a disinfectant solution with large enough granules, physically the surface becomes wet [7].

Chlorine compounds have a mechanism as a disinfectant to inhibit enzymes involved in carbohydrate metabolism. Besides being easy to use, the many types of microorganisms that can be killed by this chlorine disinfectant are the advantages of this disinfectant [8]. Chlorine gas can be made with salt water by the electrolysis method to produce 2Na in solid form and a gas that is toxic when in high concentrations when used as a disinfectant to kill microorganisms [9]. The maximum concentration of chlorine gas in space is 1 ppm [10]. Bubbles of H2 gas and OH- ions at the cathode and chlorine gas at the anode are produced from the electrolysis reaction of NaCl salt solution. This can be proven by changing the color of the solution to become cloudy. Chlorine gas coming out of the anode which is released into the air functions as a disinfectant in the TB patient room so that there is no transmission to healthy families. [11].

The electrolyzer model can be used for bacterial disinfection in the air of the TB patient room, used as a basis for acceptance testing in the community.

## 2. Methodology

This study uses an experimental type with a pre-test and post-test design. The independent variables in this study were different electrolysis models (I, II, III). The dependent variable in this study was the decrease in the number of airborne germs in the TB patient room. Electrolysis Model I is a salt water electrolysis device with a box-shaped vessel 17.5 cm high. Electrolysis Model II is a salt water electrolysis device with a box-shaped vessel 23.5 cm high. Electrolysis Model III is a brine electrolysis device with a vessel 20.5 cm high. The decrease in the number of germs in the room air is the number of germs that results from the difference between the pre-test and post-test results of CV laboratory tests. Cemix Pratama Yogyakarta Indonesia.

The population in this study were TB patients in county and city health centers in D.I. Yogyakarta. The sample of TB patients at Gamping II Public Health Center, Sleman Yogyakarta was drawn using a stratified random sampling technique with the following steps: Number of public health centers in DI. Up to 83 draws were made in Yogyakarta, then shuffled and given out 1 fruit with the results of Gamping II Health Center Sleman Yogyakarta. From Health Center Gamping II there are 23 TB patients plus 10 residents' houses adjoining TB sufferers (by lottery). A total of 33 samples were divided into 3 groups (11 houses) each for electrolysis models I, II and III.

## 3. Result and Discussion

The research had to be conducted in the rooms of TB patients and surrounding houses in the work area of Gamping II Health Center, Sleman Yogyakarta. Each model sampled airborne germs from 10 homes. Disinfection by placing the electrolyser on the floor (middle room). The germ sampling took place at 5 places, in each corner and in the middle of the room. The germ count was examined in the laboratory of PT Cemix Pratama. The concentration of NaCl salt solution is 10% or 100 grams of salt in 1 liter of water.

This study shows that different electrolysis models (I, II and III) have an effect on reducing indoor airborne bacteria (p=0.000). Electrolysis Model I is the largest electrolysis for reducing indoor air bacteria. The use of electrolysis model I with the working principle of dispersing chlorine gas in the air through channels/pipes in the electrolysis circuit. One of the preventions of transmission of TB disease is to spray a disinfectant spray system into the room air by spraying low-pressure air together with a disinfectant solution with sufficiently large grains, thereby physically wetting the surface [12].

Disinfection of chlorine gas with electrolysis with the active principle of releasing disinfectant (chlorine gas) into the room air [13]. The nature of chlorine gas can kill germs in indoor air. TB germs and other dead space germs are caused by the presence of chlorine gas, so there is no transmission of TB disease in healthy families [11]. Tuberculosis is caused by Mycobacterium tuberculosis [14].

This is a group of bacteria that reproduces in a slow time, which is around 15-20 hours, and can infect people even after several days outdoors, especially in humid places. These bacteria are not resistant to disinfectants. The spread of Mycobacterium tuberculosis bacteria occurs in two ways, namely by breathing the bacteria contained in the droplets into the patient's airways (by inhalation) and by transmission by direct contact (by continuity). Bacteria enter the patient's lungs via the air, multiply into colonies and further damage the lung tissue [15]

One of the characteristics of TB bacteria is that they are not resistant to disinfectants. The presence of chlorine gas in the air kills the bacteria. Death is caused by the nature of chlorine gas which is toxic and can kill bacteria and fungus. Based on the results of the laboratory tests in book two, it was determined that room disinfection with chlorine gas at a salt water concentration of 100 g/L can reduce the average number of germs by 84.5%. This situation proves that chlorine gas can be used as an air disinfectant in the room of TB patients to prevent the transmission of TB disease to healthy family members to prevent new TB cases [16].

In-room air disinfection for TB patients must also be performed to prevent transmission of other diseases caused by the presence of other germs in the room [17]. Infection with other germs will worsen the condition of people with TB and make them very vulnerable. Other diseases that can be transmitted through indoor air are ARI and influenza.

In relation to the usual airborne germ count in living spaces, it should not exceed 700 CFU/m3 [18]. About guidelines for indoor air hygiene). The result of the laboratory test in Book 2, air disinfection of CO2 gas chambers from electrolysis of salt water with a concentration of 10% with the result of a germ count of 56 CFU/m3 room air, meets the requirements for the germ counting room air.

The results of the calculation of the weight of chlorine gas show the number 0.0649 ppm, while the maximum standard for chlorine gas in space is 1 ppm maximum [19].

Community applications to use desiccants to infect indoor air must design an electrolysis model related to its ability to employ bacteria. Proof of the killing power of bacteria from different electrolysis models to determine the best model for disinfection with CO2 from salt water electrolysis [20]. The discovery of the next model of electrolysis needs to be released to the public to find out what the level of acceptance of the tool is.

## 4. Conclusion

The average decrease in the number of bacteria after room disinfection using the saltwater electrolysis method with the Electrolysis model (sequentially $51.0 \times 10^{-5}$, $32.8 \times 10^{-5}$, and $33.7 \times 10^{-5}$ $CFU/m^3$). There is a difference in the meaning of the difference or decrease in the number of bacteria between the use of the Electrolysis model with P = 0.000. Electrolysis model one is the tool that reduces the number of bacteria the most by $51.0 \times 10^{-5}$ $CFU/m^3$ (60.5%).

## References


[1] D. Indriana, I. Syakari, A. N. Amalia, and R. Wulandari, "POTENSI KOMODITI HASIL PERKEBUNAN SEBAGAI BAHAN BAKU PRODUK DISINFEKTAN ALAMI ( ULASAN ) Potential of Plantation Commodities Products as Raw Materials of Natural Disinfectant Products ( Review ) PENDAHULUAN Pandemi virus corona ( Covid- 19 ) yang saat ini," vol. Vol 16, No, pp. 18–31, 2020, [Online]. Available: http://202.47.80.55/bbihp/article/view/6848.

[2] G. Tugas and C.-K. Binjai, "Jurnal Menara Medika https://jurnal.umsb.ac.id/index.php/menaramedika/index JMM 2020 p-ISSN 2622-657X, e-ISSN 2723-6862," vol. 3, no. 1, 2020, [Online]. Available: https://media.neliti.com/media/publications/326199-dampak-cairan-disinfektan-terhadap-kulit-37323c1b.pdf.

[3] D. Ghafoor, Z. Khan, A. Khan, D. Ualiyeva, and N. Zaman, "Current Research in Toxicology Excessive use of disinfectants against COVID-19 posing a potential threat to living beings," *Curr. Res. Toxicol.*, vol. 2, no. February, pp. 159–168, 2021, doi: 10.1016/j.crtox.2021.02.008.

[4] Y. Lan, L. Chen, and H. Zhang, "Case Report Pulmonary and testicular tuberculosis in one patient caused by Mycobacterium tuberculosis with different genotypes," pp. 2–5, doi: 10.3855/jidc.11063.

[5] A. K. Subramanian, "Mycobacterium tuberculosis infections in solid organ transplantation : Guidelines from the infectious diseases community of practice of the American Society of Transplantation," no. February, pp. 1–11, 2019, doi: 10.1111/ctr.13513.

[6] S. Gagneux, "Ecology and evolution of Mycobacterium tuberculosis," *Nat. Publ. Gr.*, no. April 2018, 2018, doi: 10.1038/nrmicro.2018.8.

[7] Y. Faturahman, A. Purwanto, I. Pendahuluan, and W. H. Organitation, "Jurnal Pengabdian Siliwangi ITGBM PEMBENTUKAN KADER PENGAWAS MINUM OBAT ( PMO ) PADA PENDERITA TUBERCULOSIS Jurnal Pengabdian Siliwangi Volume 4 , Nomor 1 , Tahun 2018 P-ISSN 2477-6629 E-ISSN 2615-4773," vol. 4, pp. 8–12, 2018, [Online]. Available: http://jurnal.unsil.ac.id/index.php/jps/article/view/491/412.

[8] K. Dhama, S. K. Patel, R. Kumar, R. Masand, J. Rana, and M. I. Yatoo, "The role of disinfectants and sanitizers during COVID-19 pandemic : advantages and deleterious effects on humans and the environment," 2021, doi: https://doi.org/10.1007/s11356-021-14429-w.

[9] Y. S. Rahayu, "PERBEDAAN VARIASI WAKTU KONTAK REAKTOR OZON TERHADAP PENURUNAN TOTAL COLIFORM PADA KRAN AIR BERSIH UNIT PRODUKSI WTM 8 PT. BAKRIE PIPE INDUSTRIES," pp. 1–10, 2017, [Online]. Available: http://repo.poltekkesbandung.ac.id/1482/.

[10] L. A. Yoshi and S. A. Wibawa, "Pengaruh pH dan Dosis NaOCl terhadap Penurunan Kadar COD dan Klor Bebas pada Pengolahan Limbah Cair The Effect of pH and NaOCl Dose on the Reduction of COD and Free Chlorine at Wastewater Treatment," vol. 13, no. 2, pp. 120–126, 2018, doi: https://doi.org/10.23955/rkl.v12i1.2018.

[11] E. Kenedyanti and L. Sulistyorini, "Analisis Mycobacterium Tuberkulosis dan Kondisi Fisik Rumah dengan Kejadian Tuberkulosis Paru," *J. Berk. Epidemiol.*, vol. 5, no. 2, pp. 152–162, 2017, doi: 10.20473/jbe.v5i2.2017.152-162.

[12] WHO, *consolidated guidelines on tuberculosis*. 2020.

[13] K. A. Mourad and S. Hobro, "Pulmonary and testicular tuberculosis in one patient caused by Mycobacterium tuberculosis with different genotypes," *Sci. Total Environ.*, p. 136108, 2019, doi: 10.1016/j.scitotenv.2019.136108.

[14] D. Das, S. Das, M. Pandey, and D. Bhattacharyay, "In silico Analysis of Phytochemicals from Mucuna pruriens (L.) DC against Mycobacterium tuberculosis Causing Tuberculosis", *EJMP*, vol. 31, no. 4, pp. 19-24, Feb. 2020.

[15] E. Kenedyanti and L. Sulistyorini, "Analisis Mycobacterium Tuberkulosis dan Kondisi Fisik Rumah dengan Kejadian Tuberkulosis Paru," *J. Berk. Epidemiol.*, vol. 5, no. 2, pp. 152–162, 2017, doi: 10.20473/jbe.v5i2.2017.152-162.

[16] S. P. Ganefati, A. H. Sutomo, and P. Setyono, "EFFECT OF CHLORINE GAS DERIVED FROM SALT WATER ELECTROLYSIS ON THE DECREASE OF AIR MICROBE NUMBER OF HOSPITAL CARE-ROOMS ( NOSOCOMIAL INFECTIONS PREVENTION THROUGH THE CONTROL OF AIR MICROBE POLLUTION )," vol. 24, no. 04, pp. 1568–1578, 2020, [Online]. Available: http://eprints.poltekkesjogja.ac.id/5444/1/2021 04 22 144.pdf.

[17] R. A. Hobday, "The open-air factor and infection control," *J. Hosp. Infect.*, vol. 103, no. 1, pp. e23–e24, 2019, doi: 10.1016/j.jhin.2019.04.003.

[18] F. SWANDI, "ANALISIS KANDUNGAN JUMLAH BAKTERI DI UDARA DALAM RUANG KERJA INSTITUSI PENDIDIKAN X DI KOTA PADANG," 2021, [Online]. Available: http://scholar.unand.ac.id/82310/.

[19] L. A. Yoshi and S. A. Wibawa, "Pengaruh pH dan Dosis NaOCl terhadap Penurunan Kadar COD dan Klor Bebas pada Pengolahan Limbah Cair The Effect of pH and NaOCl Dose on the Reduction of COD and Free Chlorine at Wastewater Treatment," vol. 13, no. 2, pp. 120–126, 2018, doi: https://doi.org/10.23955/rkl.v12i1.2018.

[20] N. I. Said and P. T. Lingkungan, "Disinfeksi untuk proses pengolahan air minum," vol. 3, no. 1, pp. 15–28, 2007, [Online]. Available: https://media.neliti.com/media/publications/248554-disinfeksi-untuk-proses-pengolahan-air-m-fd31e57d.pdf.

# Naskah Prosiding-Cl2-TB-Revisi

ORIGINALITY REPORT

| 17% | 7% | 2% | 14% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | Submitted to Universitas Sebelas Maret<br>Student Paper | 12% |
| 2 | eprints.poltekkesjogja.ac.id<br>Internet Source | 2% |
| 3 | zombiedoc.com<br>Internet Source | 1% |
| 4 | journal.ubm.ac.id<br>Internet Source | 1% |
| 5 | ejournal.unsri.ac.id<br>Internet Source | 1% |
| 6 | www.paperdigest.org<br>Internet Source | <1% |

| | | | |
|---|---|---|---|
| Exclude quotes | On | Exclude matches | < 5 words |
| Exclude bibliography | On | | |

# Naskah Prosiding-Cl2-TB-Revisi

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

**Instructor**

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5