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Influence of Electrolyzer Design of Gas Cl2 As A Indoor Desinfection Desinfectant on Baktery Decreasing (Tuberculosis Prevention Efforts On Families)

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ABSTRACT

Tuberculosis (TBC) is a contagious disease that is a world and Indonesia problem. Failure of TB control of failed medication, making it difficult to cure. The disease is caused by Micobacterium Tuberculosa that live in various environments, and is able to infect after being in the open air for several days, especially in a humid place. Micobacterium Tuberculosa enters the human body and damages the lung tissue. Control of this disease through disinfection of air space with Cl2 gas from salt water electrolysis. The results of previous research of electrolysis with a salt content of 100g/l decreased the highest germ rate, which is equal to 56 CFU/m3 (84.5%).

The purpose of this research is to know the effect of Electrolyzer Design on the decrease of bacteria and to find the Electrolyzer Design which mostly decrease the bacteria of Sleeping air of tuberculosis patient.

This type of research is experiment with pre test and post test design. Variable free research of various Design Electrolyzer (I, II, III), and the dependent variable of bacterial air decrease of TB patient room. The population in this study was all home of TB patients in D.I. Yogyakarta. Samples of research as many as 45 houses in Puskesmas Gamping II Sleman yogyakarta, consisting of 23 houses of tuberculosis patients and 22 houses around the patient. The data were analyzed using Anova statistic test with α = 0,05.

The results of research have influences of various Electrolyzer Design (I, II, III) to the decrease of air bed bacteria bacteria. Electrolyze I design can decrease the highest bedroom air bacteria.

Keyworld: *Electrolyzer, Design, Gas Cl2, Indoor Desinfection, Desinfectant*

INTRODUCTION

Tuberculosis (TB) is a contagious disease that is still a problem in the world. According to Harahap (2010)[1], Indonesia is one of the countries that have problems against TB disease. The failure of TB control in Indonesia is caused by a treatment that takes between 6-8 months. TB patients are difficult to cure because they stop treatment (droup) after feeling healthy even though the treatment process has not been completed. The disease is caused by Micobacterium Tuberculosa.

According to Jawetz (2001)[2] bacteria have traits that distinguish themselves from other living things, such as: multicellular organisms, prokaryotes (lacking cell nucleus membranes), generally have no chlorophyll, have body size between 1-5 microns, free life as parasites , And can live in various ligkungan.

Breeding media of bacteria such as in air, water, food, and medical devices. Air is as one of the bacterial breeding media that cause disease has a very important influence in the process of disease transmission. One

way of controlling bacteria is by disinfection. Disinfection is the process of reducing the number of disease-causing bacteria or potentially pathogens by physical or chemical means (Depkes, 2002)[3].
Mycrobacterium tuberculosis (Depkes, 2007)[4] has a propagating nature in a slow time, which is about 15-20 hours. This condition allows the bacteria Mycrobacterium tuberculosis remains able to infect humans despite having been in the open air for several days, especially in a humid place. These bacteria are not resistant to the disinfectant (Wahyu, 2008)[5].
Bacteria Mycrobacterium tuberculosis can infect several organs even though that is often the lungs, depending on the type of spreading in the patient's body. In general there are 2 types of bacterial spread of Mycrobacterium tuberculosis in the body of the patient through the inhalation of bacteria contained in the droplet into the respiratory tract of the patient (per inhalation) and transmission through direct contact (per kontinuitatum). Bacteria Mycrobacterium tuberculosis can enter the lungs of patients through the air, reproduce form colonies and continuously damage the lung tissue. Lung tissue that is damaged by bacterial infection will appear white patches (spots) on the results of chest x-rays. The extent and severity of lung tissue damage in patients with tuberculosis will increase if not treated promptly and promptly (Jawetz, 2001)[2].
House or Bedroom that has a good air circulation, then sputter sparks will carry airflow. Conversely, if the air circulation is not good, then this sputum spark will remain in the Sleeping Room and potentially become a medium of effective transmission. Mycrobacterium tuberculosis infects an intact skin tissue where as a good outer body defense system. However, if there is damage to this tissue, although only small size causes susceptible to infection by various diseases including tuberculosis. The most commonly infected skin areas are on the injured part such as the skin of the face, limbs and hands (Rusnoto, 2008)[6].
Control of Mycrobacterium tuberculosis can be done in various ways, according to Depkes (2002)[3], among others: air screening system (eg use of AC), Self Closing Door (example: use of doorm with disinfectant placed on the door), radiation system (eg use Ultraviolet rays), and spraying system disinfectant in the room (Sutrisno, 2002)[7].
Disinfectants are the materials used to carry out disinfection. General disinfectants of chemicals, when their use is continuous and inappropriately dose, has a negative impact on the environment. The impact of the use of disinfectants, among others, can cause changes in taste, color, odor in water, and cause resistance to germs or bacteria. Disinfectants can also be carcinogenic at high levels, may cause skin, eye and respiratory irritation, and produce residues. Chlorine gas is one of the polished disinfectants of the brine electrolysis process.
Chlor in everyday life is very beneficial to humans. When chlor (Cl) binds to sodium (Na) salt-shaped NaCl, which is always used in the manufacture of daily food. According Giyantini (2004)[8], that chlorine can be used as a disinfectant in drinking water treatment, as a material to kill germs in the water.
Chlorination is the process of administering solid chlorine into water that has undergone a filtration process. This phase is a germ-killing step, among other bacteria and fungi. Chlorine in the form of gas (Cl2) is toxic to germs. How to get Cl2 is easy, cheap, fast, and efficient (Aulia, 2012)[9].
The mechanism of chlorine as a disinfectant is to inhibit the enzymes involved in carbohydrate metabolism. The advantages of Cl disinfectants are easy to use, and the types of microorganisms that can be killed with these compounds are also quite extensive (Ericaa, 2010)[10]. Chlorine gas can be prepared by a method of electrolysis of brine (NaCl) which produces 2 Na in solid form and Cl2 in the form of gas, which is toxic in certain amounts can be used as a material for Sterilization of Bed Room (deadly microorganisms). According to the Decision of the Governor of DI. Yogyakarta (2002)[10], in the Sleeping Room chlorine gas content is allowed a maximum of 1 ppm.
The electrolysis reaction of the NaCl salt solution produces the gas bubbles H2 and the OH ¬ ions (bases) in the cathode and the Cl2 gas bubbles at the anode. The formation of OH-ions in the cathode can be evidenced by the color change of the solution from the clear to the turbid (Kusnoputranto, 2005)[12]. The Cl2 gas exiting

the anode is released into the air, functioning as a disinfectant for the Sleeping Room. The nature of Cl2 can kill germs that exist in the air of sleeping room TB patients. TB germs and other germs in the Sleeping Room died by the presence of Cl2 gas, so there is no transmission of TB disease in healthy families.

The process of electrolysis of salt water can be done easily and cheaply. Preliminary test results in the laboratory found that gas Cl2 can reduce the number of germs of the bedroom. Chlorine gas as a disinfectant Air bed germs should not exceed 1 ppm which means in the Sleeping Room Cl2 gas content in air maximum of 1 ppm. (Governor of DIY, 2002)[11]. The condition is caused by one of the toxic properties of Cl2 can cause irritation in the human eye, it is necessary to determine the appropriate salt level. The use of Cl2 gas needs careful calculation, so that optimal results are obtained. Based on the description, it is necessary to calculate the level of Cl2 which can kill germs in air, but not exceed the standard (<1 ppm).

The use of Cl2 gas from electrolysis of NaCl salt water at exposure within 10 minutes of Cl2 gas content of 0.0216 ppm and does not exceed the standard. Based on the results of Ganefati (2013)[13], it is known that the electrolysis of brine with the concentration of 100 g/l, 150 g/l and 200 g/l, the application time for 10 minutes, then the content of 100 g/l, Bedroom from 73.5 CFU/m3 to 10.66 CFU/m3 or lower the germ rate by 85.5%. The use of 100 g/l has fulfilled the standard of 700 CFU / m3 (Permenkes RI No. 1077 / Menkes / V / 2011)[14]. The process of electrolysis of brine by means of a device called an Electrolyzer is a gas-generating device Cl2 from salt water electrolysis to disinfection of indoor fouling (Indoor Desinfection).

Making Electrolyzer is the application of Appropriate Technology (TTG), so the community can be independent in prevention of TB disease transmission. Until now there has not been found the right Electrolyzer design in lowering the air bacteria Bed Room tuberculosis patients. **Formulation of the problem**; (1) Is there any effect of various Electrolyzer Design in reducing bacterial air of Tuberculosis Bed room ? and (2) Which Electrolyzer design is the most widely decrease the bacteria of Sleeping Room of Tuberculosis patient?. **The Research purposes**: (1) Given the influence of various Electrolyzer Design on the decrease of air bacteria of Sleeping Room of TB patient; (2) Known Electrolyzer Designs that most decrease the bacterial air bed room TBC patients. **The Benefits Research** CL2 gas-generating electrolyzer can decrease airborne bacteria of patient's sleeping area and used by society in prevention of TB transmission to family.

RESEARCH METHODS

This research was conducted experimentally with pre test and post test design.

	Pre-test	Treatment	Post-Test
Experiment 1	O_1	X_1	O_1’
Experiment 2	O_2	X_2	O_2’
Experiment 3	O_3	X_3	O_3’

Information

O (1,2,3): the amount of early air bacteria

O (1,2,3): the amount of air bacteria after disinfection using Electrolyzer Design I, II, and III (prost test)

X (1,2,3): Electrolyzer Design (I, II and III).

Research Variables and Operational Definition

1. Research variables

a. The independent variables in this research are various Electrolyzer Design (I, II, III)
b. The dependent variable in this study is the decrease of airborne bacteria in the sleeping room of TB patients.

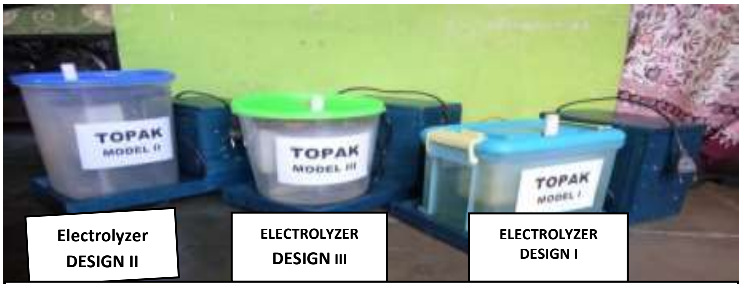
2. Operational Definition

a. Independent Variable

Various Electrolyzer Designs (I, II, III) are

1. Electrolyzer Design I is a tool for electrolysis of salt water with a plastic box jar with a height of 17.5 cm.
2. Electrolyzer Design II is a tool for electrolysis of salt water with a plastic tube jar with a height of 23.5 cm.
3. Electrolyzer Design III is a tool for electrolysis of salt water with plastic tube jar with a height of 20.5 cm.

The full explanation can be
seen in Figure 2 as follows:



Figurar 2 Electrolyzer Design

b. Dependent variable

Decrease of airborne bedroom bacteria is the number of bacteria obtained from the difference between the pre-test bacteria number and post test result of laboratory examination CV. Cemix Pratama Yogyakarta.

Population and sample

1. The population in this study is the home of TB patients in the area of Puskesmas Kabupaten and Kota in D.I. Yogyakarta
2. Samples of TB patients in the working area of Puskesmas Gamping II Sleman Yogyakarta, sampling with stratified random sampling technique with the following steps:

Special Region of Yogyakarta consists of 4 regencies and 1 city, then conducted draw to get 1 regency / city, got result of Sleman regency. Sleman District has 25 Puskesmas, then conducted a draw to get 1 Puskesmas with the results of Puskesmas Gamping II Sleman Yogyakarta as the location of the study. Area of Puskesmas Gamping II there are 23 houses of tuberculosis patients plus 22 houses that coexist with tuberculosis patients (through drawing). The sample size was 45 divided into 3 groups, each (15 houses) for Experiment I, Experiment II, and Experiment III. Occurrence of transmission to the family, one of the efforts by disinfection of sleeping room patients by using electrolyzer equipment producing gas Cl2 as a disinfectant to reduce the number of bacteria. The process of producing Cl2 gas through salt water electrolysis. This research used Electrolyzer Design I, II, and III.

Data analysis

Table 1
One-Sample Kolmogorov-Smirnov Test

		Design I	Design II	Design III
N		15	15	15
Normal Parameters[a]	Mean	31.2727	19.2273	15.9091
	Std. Deviation	1.02771E1	5.37756	4.01135
Most Extreme Differences	Absolute	.241	.225	.226
	Positive	.141	.225	.226
	Negative	-.241	-.105	-.138

Kolmogorov-Smirnov Z	.799	.745	.750
Asymp. Sig. (2-tailed)	.545	.636	.628

Test distrbution is normal

The data of the measurement result of the decrease of the number of Bed Room germs after the disinfection using salt electrolysis was done by data normality test (1-Sample K-S), got the result of all reaction time with p (Asympsig 2-tailed) in sequence 0,545; 0.636; And 0,628 which mean normal distributed data then done Anova test with α = 0,05. The results of the complete data normality test are described as follows:

RESEARCH RESULTS

The decrease of airborne bacterial number based on research result of Ganefati (2013) 11, from the use of Electrolyzer with salt content of 100 g / l; 150 g / l; And 200 g / l with the research location at the residential lecturer Poltekkes Kemenkes Yogyakarta found that the salt content of 100 g / l decreased the highest germ rate, which is equal to 56 CFU / m3 (84,5%). Complete data reduction of germs can be seen in Figure 2 as follows. Figure 2 shows that in the experimental group III (levels of 100 g / l), the highest number of germs decreased when compared to the control group, the experimental group I and the second experimental group.

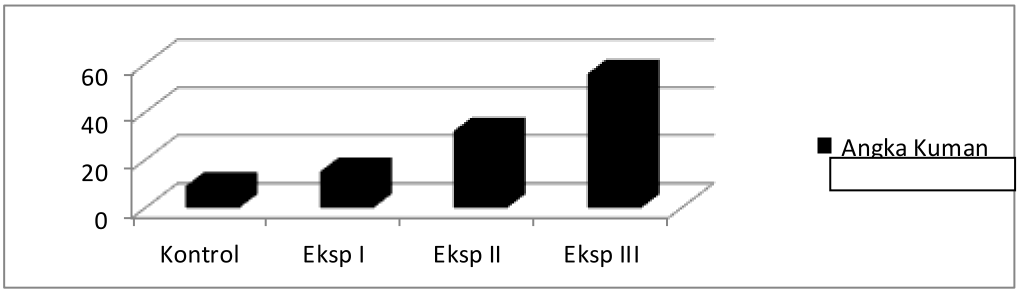


Figure 2

Average Decrease of Air Spatial Infertility Rate After Clinf disinfection using Elektrolizer with Variation of Salt Water Content

The results of the Ganefati (2013) 11 study were used as a basis for determining the salt content of 100 g / l by varying the Electrolyzer Design. Measurements of reduction of airborne bed bacteria of Electrolyzer (I, II, and III) design groups can be seen in Table 3 as follows. The mean of decrease of air bacteria resulting from disinfection of the sleeping room of tuberculosis patients using Cl2 gas from brine electrolysis in Table 3 with Electrolyzer Design (I, II, and III) 31,2 CFU / m3 (60,8%); 19.2 CFU / m3 (57.3%); And 16.9 CFU / m3 (47.5%). The largest decrease in germs in Design I was 31.2 CFU / m3 (60.8%), while the lowest in Design III was 16.9 CFU / m3 (47.5%).

Table 3 Decrease of Airborne Bacteria of Tuberculosis Room Using Various Electrolyzer Design (I, II and III)

No	Decreased Bacteria (10^{-5} CFU/m^3) on Electrolyzer					
	Design I		Design II		Design III	
	Amount	%	Amount	%	Amount	%
1	19,0	45,8	19,0	60,3	15,0	48,4
2	23,5	49,0	20,5	60,3	22,5	66,2
3	34,5	59,0	14,0	53,8	22,0	52,4
4	36,0	72,7	19,5	58,2	10,0	44,4
5	34,0	59,1	32,0	64,0	12,0	47,1
6	40,5	65,3	15,5	60,5	19,5	55,0
7	25,5	75,0	17,5	45,9	18,5	44,0
8	18,0	38,9	19,5	56,5	17,0	49,3
9	24,5	47,6	12,5	52,1	12,5	36,8
10	46,0	82,1	17,5	55,6	15,5	43,1

11	34,5	65,1	15,0	58,8	20,0	45,5
12	34,5	63,9	24,5	62,8	15,5	50,0
13	46,0	82,1	17,5	55,6	15,5	43,1
14	35,0	58,5	23,0	57,5	23.0	48,7
15	15,7	48,0	20,0	58.8	20,5	38,6
Total	467,2	-	287,5	-	236,0	-
Average	31,2	60,8	19,2	57,3	16,9	47,5

Comparison of the reduction of bacteria from indoor desinfection using Electrolyzer Design I, II, and III can be seen in Figure 3 as follows. Figure 3 shows the result that Electrolyzer Design I can reduce the highest number of bacteria when compared with Electrolyzer Design II, or Electrolyzer Design III.

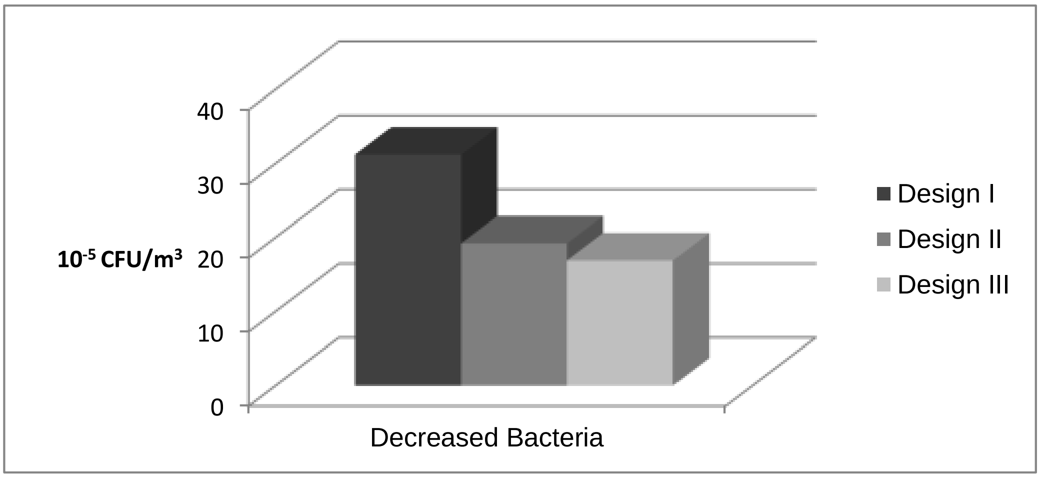


Figure 3
Mean of Decreased Figures of Air Bed Room of Tuberculosis Sufferer After Conducted Cl2 Disinfection Using Electrolyzer Design (I, II, III)

STATISTICAL TEST RESULTS

Anova test results obtained p = 0,000 which means that there is influence of various Electrolyzer Design (I, II, and III) to the decrease of airborne tuberculosis bed bacteria in the area of Puskesmas Gamping II Sleman Yogyakarta, followed by LSD test obtained between Design I and Design II = 0.02 means that there is a significant difference between Design I and Design II; Between Design I and Design III p = 0,000 means that there is a significant difference between Design I and Design III; And between Design II and III p = 0,554 means there is no difference between Design II and Design III, to see more statistical test results in Table 4 and Table 5 as follows.

Table 4 Test Anova

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1698.924	2	849.462	19.303	.000
Within Groups	1848.284	42	44.007		
Total	3547.208	44			

Table 5 Multiple Comparisons
Scheffe

					95% Confidence Interval	
(I) BE	(J) BE	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound

Electrolyzer Disain I	Electrolyzer Disain II	11.98000*	2.42231	.000	5.8329	18.1271
	Electrolyzer Disain III	13.88000*	2.42231	.000	7.7329	20.0271
Electrolyzer Disain II	Electrolyzer Disain I	-11.98000*	2.42231	.000	-18.1271	-5.8329
	Electrolyzer Disain III	1.90000	2.42231	.737	-4.2471	8.0471
Electrolyzer Disain III	Electrolyzer Disain I	-13.88000*	2.42231	.000	-20.0271	-7.7329
	Electrolyzer Disain II	-1.90000	2.42231	.737	-8.0471	4.2471

*. The mean difference is significant at the 0.05 level.

DISCUSSION

Implementation of the research conducted in Bed Room tuberculosis patients and surrounding homes in the work area Puskesmas Gamping II Sleman Yogyakarta Each sample taken samples of airborne bacteria each 15 homes. Disinfection by placing Electrolyzer on the floor (middle of the bedroom). The collection of air sesimes for bacterial number examination is performed at 1 (one) point, in every corner and in the middle of the Bedroom. Examination of the number of germs is done in the laboratory of PT Cemix Pratama. The salt solution amounts to 100 g/l or 100 g of salt in 1 lt of well water.

This study shows that there is influence of various Electrolyzer Designs (I, II, and III) on the decrease of Bed Room air bacteria (p = 0,000). Electrolyzer Design I is an electrolyzer that most of the bacteria decrease the air space. This situation allows for the difference in the volume of plastic jars used, especially affected by different heights. The height of the plastic jar for Electrolyzer I design is the lowest when compared to Electrolyzer II Design and Electrolyzer III Design. This study of the volume of contents and the size of the electrodes in Electrolyzer I Design, Electrolyzer II Design and Electrolyzer III Design are the same.

Differences in high topes affect the difference in electrode surfaces that enter in the salt solution. The wider the electrode surface enters the brine the more Cl2 gas produced (Damanik, 2015) 15. This condition is evidenced by the average of the decrease of bacteria in Electrolyzer I (31.2 CFU/m3), the most when compared with Electrolyzer II Design (19.2 CFU/m3), and Electrolyzer III Design (16.9 CFU/m3).

Use of Electrolyzer I Design with the working principle of channeling Cl2 gas into the air through channels / pipes that exist in the series of Electrolyzer. According to Depkes (2002)[3], that one of the prevention of TB disease transmission by spraying system disinfectant to Spraying Room air by spraying produce low-pressure air bursts with disinfectant solution with grain which is big enough physically surface become wet.

Disinfection of Cl2 gas with Electrolyzer with the working principle of disinfectant discharge (Cl2 gas) into the air of the Sleeping Room. The nature of Cl2 can kill germs that exist in the air of the Sleeping Room. TB germs and other germs in the Sleeping Room died by the presence of Cl2 gas, so there is no transmission of TB disease in healthy families (Kusnoputranto, 2005) 12.

TB disease is caused by mycobacterium tubercolosa which is a group of bacteria that have the nature of breeding in a slow time, which is about 15-20 hours, and able to infect humans despite having been in the open for several days, especially in a humid place. This bacterium is not resistant to disinfectant substances. The spread of bacteria Mycrobacterium tuberculosis there are 2 (two) types that is through the exploitation of bacteria contained in the droplet into the healthy human respiratory tract (per inhalation), as well as transmission through direct contact (per kontinuitatum). Bacteria enter the lungs of tuberculosis patients through the air, and reproduce forming colonies that continuously damage lung tissue (Wahyu, 2008)[5].

TB Bacteria is one of its properties is not resistant (susceptible) to disinfectant, the presence of Cl2 Gas in the air Bed Room resulted in dead bacteria. Death is caused by the nature of the toxic Cl2 gas, which can kill bacteria and fungi. Based on the results of laboratory tests found that disinfection of the bedroom with gas Cl2 on water content gaam 100 gr / liter can reduce the rate of bacteria as much as 84.5%. This condition proves that Cl2 gas can be used as disinfectant (disinfection material) of Sleeping Room of TBC patient, to prevent the happening of TB disease transmission to family member yag healthy, so there is no new case of tuberculosis.

Air Disinfection of Sleeping Room TB patients also need to be done to prevent the occurrence of other infectious diseases caused by the presence of other germs in the Bedroom. The occurrence of other germ infections will aggravate the condition of TB patients, thus becoming very vulnerable. Other diseases that can be transmitted through the air of the Sleeping Room are ARI, and Influenza.

Based on the standard number of airborne sleeping space germs should not exceed 700 CFU / m3 Sleeping Spaces (Permenkes RI No 1077 / Menkes / Per / V / 2011, on Guidelines for Air Sanitation in Bedrooms)[14]. Result of laboratory test, Bed Room air desinnfection using Cl2 gas from electrolysis of salt water with content of 100 g / l with result of germ rate equal to 56CFU / m3 air, fulfilling requirement of air bed germ number. The calculation of the weight of Cl2 gas shows the number of 0.0649 ppm, while the maximum standard of Cl2 Sleep Bedrooms is 1 ppm (Kepub Gub D.I. Yogyakarta, 2002)[11].

CONCLUSION

There is effect of Bed Desinfection using Electrolyzer Design (I, II, and III) on decreasing Bed Bacteria (p = 0,000)

The average decrease of bacteria after the disinfection of the Sleeping Room by electrolysis method of salt water with Electrolyzer Design (I, II, and III) sequentially ie 51.0 CFU / m3; 32.8 CFU / m3 and 33.7 CFU / m3.

Electrolyzer Design I is the most bacteria-lowering tool of 51.0 CFU / m3 (60.5%).

Recommendations; Air Desinfection of Sleeping Spaces Patients with TBC Cl2 gas from electrolysis of brine using Electrolyzer I Design can be applied in the community.

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