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# Design and Implementation of an Ozone System for the Biological Waste Area of Health Centers

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***Summary***

*The benefits of ozone when applied to pathogenic loads have been reported in various publications, however, the technical characteristics of these for their design and implementation are not always published. The objective was to develop a bibliographic search, to be the basis of the minimum technical specifications that a prototype ozone system should have that allows its use in the biological waste area of a health center in the city of Tacna, achieving an important part such as the electrical circuit of the same. Four databases were reviewed: Science Direct, IEEE, Scopus, SAGE Publications Inc., and the search engine Google Académico was used, from which 201 articles were obtained, of which eight were used as the basis for what is proposed as a technical specification in a TRL 5. It was concluded that the state of the art provides information that channels levels of TRL that one expects.*

## INTRODUCTION

Technologies can help reduce all kinds of gaps for the benefit of society (Tejada et al., 2023). One of these technologies is the application of Ozone, which, due to its various properties, allows for an always constant and very dynamic state of the art. In the case of using it for pathogens, it is that there is a greater dynamism, it may be because they are not always the same. So, since the Ozone generator patented by Nikola Tesla in 1896, research work has been carried out related to microorganisms that affect people's health. Among these investigations, there is the project financed by the Jorge Basadre Grohmann National University (UNJBG) of the city of Tacna, which would allow the construction of a prototype of an ozone system, so that it can reduce the pathogenic load in the area of biological waste in a health center of the city. That is why the search began in four databases of machines, generators or ozone systems, which allow information to achieve a design and adaptation of these to date.

## METHODS

The search for information in the databases of Science Direct, IEEE, Scopus, SAGE Publications Inc. and also in the Google Scholar search engine was taken into account. 201 items were selected for the "hospital ozone machine" chain, of which 66 were read in full, and eight are found with the information that allowed the information for the development and implementation of an ozone system that would be located in the biological waste area. The design of the method considered the existing bibliographic review, its analysis by all authors, to arrive at the design and proposal that will be required in its manufacture.

## RESULTS

The benefits of ozone in the body, as in the case of its combination with antioxidants in age-related macular (dry) degeneration, was proven by Chávez et al. (2008), as 96% of patients who used this treatment recovered their visual acuity. But it is not only in treatments that the presence of ozone use can be seen, but also in its germicidal capacity, as pointed out by Fernández-Torres et al. (2010), they recognize that Ozone maintains a widely published germicidal capacity, due to its oxidizing power and the speed with which it reacts with biological molecules, the kinetics of ozone inactivation on microorganisms can be seen. For the authors Fernández-Torres et al. (2010), analyzing the effect on the inactivation process that occurs when the by-products are achieved with ozone, allowed them to conclude that the permeability of the membrane of microorganisms is affected by ozone, achieving an increase in the concentrations of substances reactive to thiobarbituric acid due to lipid peroxidation processes. In both cases, as in other research works, the benefits of ozone are appreciated, as investigated by Fernández et al. (2014), who compared three ozone generators, one for domestic use and Cuban-made and two other foreign, for compliance with Mexican environmental health regulations (NOM-180-SSA1-1998), concluding that the three equipment showed first-order inactivation kinetics and one of the foreign ones presented higher percentages in the elimination of Escherichia coli ATCC 25922, in the order of 99.99% inactivation and at a rate of 0.165 s-1 higher than the other two. On the other hand, the bibliographic review allowed us to identify that in hospitals, as indicated by Lara-Fernández et al. (2020), healthcare-associated infections have high costs, so they investigated the microbiological and cost results that are achieved with the use of ozone at the Institute of Neurology and Neurosurgery of Cuba. What they analyzed was the environmental microbiological status, the number of deaths in general, due to sepsis, and the consumption of antibiotics during January - June 2019. The results showed that the consumption of antibiotics decreased by a third in the 12 environments where they were applied, in addition the number of deaths was lower compared to the period of the year prior to the intervention, so they conclude that ozone in high-risk hospital areas was useful and favored the reduction of antibiotic consumption, hospital stay and mortality from healthcare-associated infections. Another team investigated in this bibliographic review was the OZONEY SL developed at the National Center for Scientific Research of Cuba by Pérez and Araujo (2013), who sought to be able to face, with a control and protection circuit, the lack of water to be treated. This new control circuit considerably improved the inadequate supply of water to be treated, thus making it possible to save energy carriers. The work of Buntat et al. (2023) also made it possible to identify the effectiveness of ozone-based sterilization of surgical equipment in various ozone machines. The authors Mosca et al. (2022) also appreciated that in hospitals, outpatient clinics, clinics, and healthcare centers, the common problem of hospital or nosocomial infections can be seen, so they decided to run a 4.0 machine that produces ozone and UVC rays, achieving its design and development for use in care centers with favorable results. Another experience was that of Sharma and Hudson (2008), who also identified that bacterial infections continue to represent a threat to health in different health environments, so they developed a portable ozone-generating machine, equipped with a catalytic converter and a humidifier, which sought the inactivation of 15 species of bacteria of medical importance. They applied 25 ppm for 20 minutes at a humidity of 90%, so 3 log10 colony-forming units, A. baumannii, C. difficile and methicillin-resistant S. aureus, were inactivated, so they conclude that ozone is a valuable decontamination tool in relation to bacteria.

With what was reviewed, the specifications that the system should have were raised, this being the considered prototype to be used, under three major components:

Component One: Ozone Production
High-frequency corona discharge, with dialectical ceramics
Five 10g/h reactors for ozone production
Air filter that is an activated carbon catalyst
That withstands temperatures up to 42°C
With a sound level of 74 db
Frequency of 60 Hz.
In stainless steel, weighing from 60 to 63 kg with a height between 1.50 and 1.55 m.

Component Two: Electrical Board
With a capacity of 1,000 w at a voltage of 220 Vac, weighing 8 to 10 kg., with a single-phase electrical system (220 Vac)

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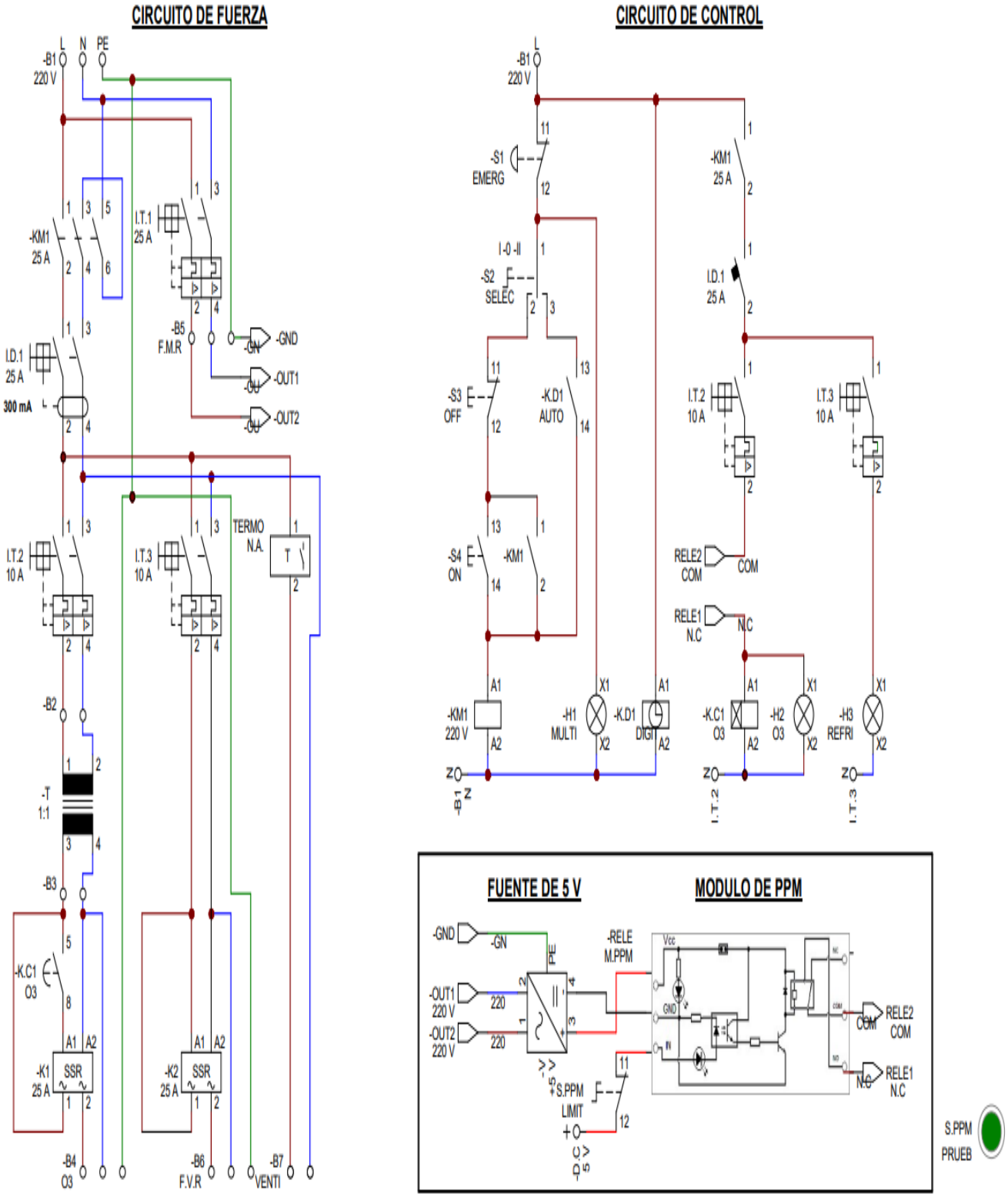
Component Three: Ozone/Air Mixing

Cannon that operates with an atmospheric pressure of the area, with a stainless steel tube, with a diameter of 12 cm. and that the mixture is of the forced air type

For its development, it was taken into consideration that the electrical circuit should have the following distribution:

Figure 1 Electrical Circuit




This allowed the following system where the part near the floor is component 1, on top of which component 2 can be seen and in the upper part component 3, already located in the biological waste environment of the San Francisco Health Center in the city of Tacna.

## DISCUSSION

The information found in the bibliographic review has been used and the details have been improved with the experience of the researchers, it is hoped that when the tests are developed, the results that were obtained in relation to the reduction of the pathogenic load can be obtained.

## CONCLUSION

State of the art provides information that channels the levels of TRL that one desires and there are few publications on ozone systems.
A level of TRL five was achieved and the line of research can continue.

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Jorge Basadre Grohmann National University

**Conflict of Interest Statement**

The authors declare that they have no conflict of interest with the information contained in this document

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**REFERENCES:**

1. Buntat, Z., Sidik, M., Nawawi, Z., Jambak, M., Kurnia, R., Arum, A., & Fitria, S. (2023). Design and development of ozone-based surgical equipment sterilizer. International Conference on Electrical Engineering and Computer Science (ICECOS), 186–191. https://doi.org/10.1007/978-3-031-16281-7_30
2. Chávez Pardo, Iris, Thais González Rodríguez, Noris, Avilez Carmenate, Elizabeth, & Cardoso Guillén, Elias. (2008). Ozone and antioxidants in age-related (dry) macular degeneration. Medical Archive of Camagüey Journal , 12 (3) Retrieved August 30, 2025, from http://scielo.sld.cu/scielo.php?script=sci_arttext &pid=S1025-02552008000300003&lng=es&tlng=es.
3. Fernández, I., Sánchez, E., Fernández, L., Bataller, M., & Álvarez, C. (2014). Comparative evaluation of the disinfection capacity of domestic ozone generating equipment for water treatment. CENIC Ciencias Biológicas, 42(2), 77–82.
4. Fernández-Torres, I., Bataller-Venta, M., Hernández-Castro, C., Sánchez-Urrutia, E., & Morales-Chacón, Y. (2010). Antimicrobial activity of by-products generated by the reaction of ozone with microorganisms. CENIC Ciencias Biológicas, 41(2), 121–125. Retrieved from https://www.redalyc.org/pdf/1812/ 181220595006.pdf
5. Lara-Fernández, G. E., Ariosa-Acuña, C. M., Borroto-Rodríguez, V., Puerta-Armas, Á., Ortiz-Hernández, R., & Villalobos-Morales, C. (2020). Ozone as a method of disinfection of the hospital environment. Acta Médica Costarricense, 62(2). Retrieved from https://www.scielo.sa.cr/scielo.php?script=sci_arttext &pid=S0001-60022020000200072
6. Mosca, R., Mosca, M., Revetria, R., Currò, F., Briatore, F. (2023). Fighting Hospital Infections with Engineering 4.0. In: Valle, M., et al. Advances in System-Integrated Intelligence. SYSINT 2022. Lecture Notes in Networks and Systems, vol 546. Springer, Cham. https://doi.org/10.1007/978-3-031-16281-7_30
7. Pérez Gómez, C., & Araujo Ruiz, J. (2013). Control and protection circuit against lack of water to be treated, for OZONEY-SL ozone generator equipment. CENIC Ciencias Químicas, 44, 120–127. Retrieved from https://www.researchgate.net/profile/Juan-Antonio-Araujo-Ruiz/publication/260391074
8. Sharma, M., & Hudson, J. B. (2008). Ozone gas is an effective and practical antibacterial agent. American Journal of Infection Control, 36(8). https://doi.org/10.1016/j.ajic.2007.10.021