CLEISEANO EMANUEL DA SILVA PANIAGUA
(ORGANIZADOR)

Collection:

APPLIED CHEMICAL ENGINEERING 2

Atena Editora
Ano 2022

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APRESENTAÇÃO

The e-book: “Collection: Applied Chemical Engineering 2” consists of seven book chapters. The first and second chapters sought to apply computer simulation both to analyze the flow of water from the faucet, evaluating from the fluid dynamics and volume of the liquid, as well as the behavior of the air-particle interaction and the variables that influence: temperature, pressure and particle velocity volume, the pressure and velocity of particles inside an aerosol can.

The teaching of chemistry is still seen as an abstract and meaningless science in the student’s daily life, since most basic education institutions do not have spaces for carrying out laboratory practices. In this context, researchers from the state of Maranhão, Piauí and Recife proposed the use of music as a facilitating tool in the learning process that was called CHEMUSICS.

Chapter 4 discusses the benefits of using energy production from the sugar-energy sector, especially from sugarcane bagasse residues that can sustain the Brazilian energy matrix.

Chapters 5 to 7 evaluated the issue of solid waste management and contamination of water resources. Chapter 5 presented a review study regarding the generation of waste from cemetery activities, as well as the potential impact on the environment and public health. Chapter 6 presented the potential of pumice in the adsorption of metals present in galvanic effluents. Finally, chapter 7 presents the development of a bimetallic Fenton catalyst supported on natural zeolite for the removal of dyes in aqueous matrices.

In this perspective, Atena Editora has been working with the aim of stimulating and encouraging researchers from Brazil and other countries to publish their work with a guarantee of quality and excellence in the form of books and book chapters that are available on the Editora’s website and elsewhere. digital platforms with free access.

Cleiseano Emanuel da Silva Paniagua

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RESUMEN: Los primeros cementerios se construyeron bajo tierra o al pie de los templos religiosos por ser considerados lugares sagrados, a partir del siglo XVIII, con el advenimiento de enfermedades como el cólera y la peste bubónica, surgió la necesidad de crear necrópolis alejadas de zonas urbanas. . Sin embargo, la falta de planificación urbana y de interés público provocó una nueva centralización de los cementerios debido a la ausencia de planificación urbana en los municipios brasileños. Desde la creación de la primera legislación, Resolución n° Consciente de que la mayoría de los cementerios en los municipios brasileños existen desde hace más de 60 años, el gobierno municipal debe adoptar medidas paliativas para minimizar la generación de residuos y la adopción de prácticas funerarias con menor riesgo de contaminación ambiental. Ante ello, numerosos estudios señalan a las necrópolis como un lugar de enorme potencial de contaminación ambiental por los residuos que generan, que pueden ser: *i*) líquidos (necrocoro y agua para limpieza de tumbas); *ii*) sólidos (velas, flores artificiales y naturales, materiales de construcción, huesos, etc.) y gaseosos (desprendimiento de gases por actividades de putrefacción cadavérica). En ese contexto, este trabajo tuvo como objetivo revisar el estado del arte sobre el tema en los últimos cuatro años (2018-2021) y presentar algunas sugerencias para acciones mitigadoras, tales como: *i*) una mejor gestión de los residuos; *ii*) monitoreo de la calidad del agua y del suelo; *iii*) implantar crematorios en los cementerios existentes; y *iv*) construcción de nuevos cementerios de acuerdo con la legislación vigente. La literatura actual señala las actividades de los cementerios como un gran problema de salud pública que demanda la necesidad de tratar con mayor responsabilidad las actividades de los cementerios y la necesidad de reformular la legislación y establecer políticas públicas dirigidas a las actividades de los cementerios.

PALABRAS CLAVE: Crematorios, necrochorum, necrópolis, contaminación ambiental y salud pública.

BRAZILIAN NECROPOLIS (CEMETERIES): POTENTIAL ENVIRONMENTAL IMPACTS GENERATED BY WASTE FROM CEMETERIAL ACTIVITIES AND THE IMPENDING THREAT TO PUBLIC HEALTH

ABSTRACT: The first cemeteries were built underground or at the bottom of religious temples because they were considered sacred places, from the 18th century onwards, with the advent of diseases such as cholera and the bubonic plague, there was a need to create necropolises away from urban areas. . However, the lack of urban planning and public interest caused a new centralization of cemeteries due to the absence of urban planning in Brazilian municipalities. From the creation of the first legislation, Resolution no. Aware that most cemeteries in Brazilian municipalities have existed for more than 60 years, palliative measures should be adopted by the municipal government in order to minimize the generation of waste and the adoption of funeral practices with less risk of environmental contamination. In view of this, numerous studies point to necropolises as a place of enormous potential for environmental pollution due to their generated waste, which can be: *i*) liquids (necrochorum and water for cleaning graves); *ii*) solid (candles, artificial and natural flowers, construction materials, bones, etc.) and gaseous (gas release from cadaveric putrefaction activities). In this context, this work aimed to review the state of the art on the subject in the last four years (2018-2021) and present some suggestions for mitigating actions, such as: *i*) better waste management; *ii*) monitoring of water and soil quality; *iii*) implant crematoria in existing cemeteries; and *iv*) construction of new cemeteries in accordance with current legislation. Current literature points out cemetery activities as a huge public health problem that demands the need to treat cemetery activities with greater responsibility and the need to reformulate legislation and establish public policies aimed at cemetery activities.

KEYWORDS: Crematoria, necrochorume, necropolis, environmental pollution and public health.

1 | INTRODUCTION AND JUSTIFICATION

In Brazil, basic sanitation works (water and sewage treatment, garbage collection, sweeping of places and public roads, sanitary landfills and cemeteries) have always been ignored and/or left aside under the slogan “work underground does not win”. vote, because nobody sees” associated with society’s view that if the garbage is not in the house itself, it can be and/or be discarded anywhere and in any way. The combination of these ways of looking at the chronic problem of sanitation in Brazil means that political representatives do not approve public policies to improve and increase the efficiency of basic sanitation services (CAUDURO; MULLER; RICARDO, 2019; FERNANDES, 2021; SILVA et al. al., 2021; SOUZA; CAVALCANTE, 2020). In this context, cemetery activities are the least understood by both the population and government officials due to the lack of scientific dissemination by the mass media. In addition, the religious issue in relation to the cult and the belief that the body is a temple that hosts the soul created by the superior deity and/or that can be reconstituted at any time by the deity contributes greatly to the maintenance of mismanagement and necropolises (BORDA et al., 2020; FEITOSA; CAMPOS; BANDEIRA,

2020; SILVA, et al., 2021). It is known that necropolises constitute a source with enormous potential for environmental impact that can result in public health problems, since almost 70% of diseases are transmitted through the ingestion of contaminated water (LONGATTI; SANTOS; PERON, 2020; NOBRE; CALIXTO, 2019). Although there is already legislation (CONAMA Resolution 368 of 2006) which establishes the obligation of environmental licensing for works aimed at the construction of new cemeteries, the political interest of not generating burdens with this activity and under the allegation of the lack of specialist professionals to design a project that is ecologically more sustainable and does not pose risks to both public health and the environment (FERREIRA; AQUINO; CORDEIRO, 2020; NASCIMENTO;SENHORAS; FALCÃO, 2018; RAIOL; OLIVA, 2019).

The literature presents numerous works (BORDA et al., 2020; COSTA; SILVA; ANTUNES, 2020; HERRERA et al., 2021; LONGATTI; SANTOS; PERON, 2020; SILVA, F. et al., 2021) that present studies of cases in municipalities in all regions of the country, which show the dimension of the problem faced within the municipalities, which further procasts a problem that only increases with the passage of time. Among the studies reported, there are: *i*) breeding sites for the proliferation of the *Aedes Aegypti* mosquito, responsible for the transmission of dengue, zika and chikungunya (NASCIMENTO; SENHORAS; FALCÃO, 2018); *ii*) generation of numerous solid wastes (flowers, candles, construction materials, bones, vegetables from pruning and weeding, abandoned graves, among others) (NASCIMENTO;SENHORAS; FALCÃO, 2018; SOUZA; CAVALCANTE, 2020); *iii*) liquid waste (necrochorum, wastewater from the cleaning of tombs and access roads inside the necropolis) (ARAÚJO et al., 2020; FERREIRA et al., 2021; XAVIER et al., 2018); *iv*) leaching of heavy metals, toxic substances, organic compounds, increased concentration of nitrogen and phosphorus, among others (SILVA; CAMPOS; CUNHA, 2018; SILVA et al., 2021); *v*) release of cadaveric gases [hydrogen sulphide (H_2S), mercaptans, methane gas (CH_4) among others] from inside damaged tombs or during the removal of mortal remains (FERREIRA et al., 2021; LINS, E.; LINS, A.; LINS, C., 2019); *vi*) breeding of insects capable of proliferating diseases (flies, mosquitoes and cockroaches), venomous animals (spiders and scorpions), rodents (mice), birds (pigeons, vultures and others) and microorganisms with pathogenic properties (viruses and bacteria) (MOREIRA et al., 2021; SILVA et al., 2021).

In the recent literature (2017-2021), no work was found that addressed the issue at the national level, that showed the maintenance and/or increase of the problem even in the face of the most current legislation (CONAMA Resolution 368 of 2006) and that presented the main problems triggered in the social and environmental scope due to the negligence of municipal public managers throughout the national territory. In addition, this work intends to contribute to reduce the existing gap in relation to the different aspects that are involved in cemetery activities.

The present work aims to present and discuss the main problems generated by the lack and/or mismanagement of cemetery activities, highlighting the social, cultural,

environmental and public health aspects that can be generated by the inefficiency of the management of necropolises.

2 | ORIGIN AND HISTORY OF CEMETERIES

The terminology of the word cemetery has its origin from the Greek word "*koumeterian*" which means "where I sleep". From the origin of Christianity, the term was replaced and came to be called "post-mortem resting place", which assigns meaning to places and spaces destined to bury deceased people, corpses, which means "flesh given to worms" (COSTA; SILVA; ANTUNES, 2020; FERREIRA; AQUINO; CORDEIRO, 2020; NOBRE; CALIXTO, 2019). Depending on the municipality and region, the name cemetery receives other denominations, such as: sheep, holy field, necropolis and sepulcrary. In addition, it receives some nicknames: the city of feet together or the famous last address (ARAÚJO et al., 2020; BAUM et al., 2020; FEITOSA; CAMPOS; BANDEIRA, 2020; SOUZA; CAVALCANTE, 2020).

The act of burial has been taking place for millennia, as it is characterized as an act of keeping the living closer to their loved ones who have died. In the Neolithic period (from 10,000 to 3,000 a. C.) corpses were placed in natural caves and closed with a rock. However, in the Christian period there are two biblical accounts of the use of the cave as a tomb. The first in the Gospel of John chapter 11 and verses 38 to 45 is the account that Jesus went to the place where the body of Lazarus was and raised it. The second, in chapter 20 and verses 1 to 10, refers to the burial and resurrection of Christ himself also in a cave (FERREIRA et al., 2021; MOREIRA et al., 2021; SILVA et al., 2021).

In the Middle Ages (from the 5th to the 15th century) the dead were thrown/left/abandoned in open places which caused the spread of many pathogenic microorganisms from the bodies. In the 18th century, from the knowledge of various diseases such as cholera and bubonic plague, cemeteries emerged as an alternative to move the dead away from the living, providing a better quality of life in urban centers. However, this practice will reveal that cemeteries are places with enormous potential for pollution and that they need to evaluate future areas, based on technical studies that assess the: *i*) geographic aspects (location, soil type, water table depth and slope of the terrain); *ii*) social (type of burial, construction of residences around the cemetery area); *iii*) environmental (form of burial, water and soil contamination, generation and disposal of solid waste) and; *iv*) cultural and religious (the generation of waste, breeding sites for the Aedes Aegypti mosquito, establishment of crematoria for final disposal of cadaveric remains and cemeteries only with cremation) (FERREIRA; AQUINO; CORDEIRO, 2020; SOUZA; CAVALCANTE, 2020). This work will be limited to presenting and discussing social and environmental aspects in the national context.

3 | SOCIAL AND ENVIRONMENTAL ASPECTS AROUND A CEMETERIAL ACTIVITY

In Brazil, a mostly Christian country, people do not evaluate death from the perspective of a natural process of the condition of their own existence, implying the generation of affective bonds that prevent many people from understanding the process of death and nourishing hope under the belief that one day everyone will be resurrected "bringing life to one who has already died and decayed" which is based on two in the Gospel of John: the resurrection of Lazarus and of Christ himself. In this sense, many people venerate their dead ones through the construction and maintenance of tombs, periodic visits and the national holiday dedicated to the veneration of the dead (day of the dead) destined, essentially, for this purpose.

3.1 Social aspects: social inequality within a cemetery

Brazil constitutes a country where social inequality is structural and institutional in any segment of society, like a cemetery in which inequality is seen by the graves or by the way of burying someone. During the pandemic period (2020-2021) in Brazil this can be observed by different media that alerted or denounced the neglect with the bodies of people who died due to the worsening of the COVID-19.

In the state of São Paulo and especially in the city of São Paulo and a wider region, the Vila Formosa cemetery is the largest necropolis in Latin America both in terms of number of buried bodies (more than 1.5 million) and in size (763175 m^2), being used for burials, mainly of people from the poorest classes (C, D and E) as shown in Figure 1.

Figure 1: Aerial view of the Vila Formosa cemetery in the city of São Paulo/SP.

Source: Authors' collection (2022).

The Vila Formosa cemetery, during the pandemic, opened shallow graves close to the ground and without any preparation to receive those killed by COVID-19. However, the bodies were thrown into a ditch opened by tractors and buried by earth or placed close to the ground and covered by earth, as shown in Figure 2.

Figure 2: forms of burial at the Vila Formosa cemetery in the City of São Paulo before, during and after the pandemic period in Brazil.

Source: Authors' collection (2022).

These and other images were featured on the front page of the renowned American newspaper The Washington Post, gaining recognition both in Brazil and abroad. The Vila Formosa cemetery is already the second largest cemetery in the world, second only to the Islamic necropolis Wadi-us Salaam in Iraq, which has more than five million people buried and has been in existence for 1400 years (NOBRE; CALIXTO, 2019; OLIVEIRA , 2019). Cemetery activities constitute a "public service", within the scope of municipalities, where social inequality is most often seen, which manifests itself in various ways within a cemetery, such as: *i*) type of grave (inhumation or tombstone); *ii*) the style and size of the tomb; *iii*) the location of the pit; *iv*) whether or not it is cleaned with due frequency, among others. Therefore, cemeteries are a "portrait" of the worst ills within a city and are characterized as a favela (NASCIMENTO; SENHORAS; FALCÃO, 2018; RAIOL; OLIVA,

2019; SILVA; CAMPOS; CUNHA, 2018). Upon completing a period of ten years from the date of burial, the exhumation of bodies and the transfer of mortal remains to drawers takes place, as shown in Figure 3 of the Vila Formosa cemetery.

Figure 3: process of exhuming remains buried more than 10 years ago; (b) drawers intended to receive the mortal remains at the Vila Formosa cemetery in São Paulo.

Source: Authors' collection (2022).

Others can be seen as a cemetery area and with high visibility that can cause environmental problems from other areas of relevance that can be generated as the potential for environmental impact that can constitute such environments in future public health problems.

3.2 Environmental aspects: sources of contamination, interference with solid and liquid waste and the real threat to the public health of the population

In Brazil, despite the existence of legislation (CONAMA Resolution 368 of 2006) that recognizes the numerous environmental impacts arising from cemetery activities and, consequently, requires environmental licensing based on Environmental Impact Studies (EIA) and Environmental Impact Report (RIMA) for the construction of new ventures for this purpose (FERREIRA; AQUINO; CORDEIRO, 2020; NASCIMENTO; SENHORA; FALCÃO, 2018; RAIOL; OLIVA, 2019). However, the lack of interest by the municipal public power both in improving the operating conditions of existing cemeteries, as well as in the construction of new ventures in line with current legislation and that have a good solid waste management plan. In addition, cemetery activities are not treated with due importance in relation to the enormous potential for environmental impact, constituting one of the main sources of contamination in urban perimeters in cities and which acts silently and almost imperceptibly by society, which can cause: *i*) the diversity of solid, liquid and gaseous waste; *ii*) the release of microorganisms with pathogenic potential that reach subsoil waters; *iii*)

the production of necrochorume; *iv*) the release of toxic and heavy metals from bodies in a state of putrefaction and; *v*) leaching of organic and inorganic substances that reach groundwater, among others (CECCONELLO; CENTENO; SIQUEIRA, 2019; FERNANDES, 2021; MOREIRA et al., 2021; SILVA; CAMPOS; CUNHA, 2018).

Chemical pollution starts from the decomposition of corpses by microorganisms present in the body itself, as well as others generated by the anaerobic environment established by the graves in the form of shallow open pits and without proper soil waterproofing, in disagreement with the legislation in force (CONAMA Resolution No. 368 of 2006). Once the decomposition process is initiated, substances with a strong unpleasant odor are produced, namely the amines cadaverine and putrescine. The first comes from the decarboxylation reaction of lysine by the action of the decarboxylase enzyme. Putrescine, on the other hand, is generated by the decarboxylation of the non-essential amino acid ornithine and produced by the body it self from arginine, according to the reactions shown in Figure 4.

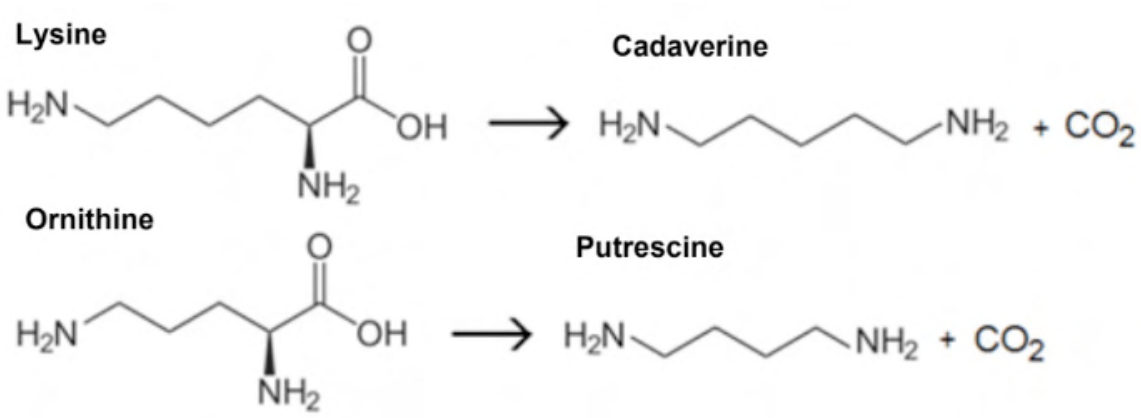

Figure 4: production of cadaverine and putrescine amines from amino acids. Lysine and Ornithine.

Source: Authors' collection (2022).

According to the decarboxylation of the amino acids Lysine and Ornithine that produce, respectively, the amines Cadaverine and Putrescine that have amine groups ($-NH_2$) at the end of both molecules. These groups are responsible for the nauseating and unpleasant odor exhaled by the tombs and which are commonly felt in the carcasses of dead animals. In living organisms, the presence of these amines in higher concentration may be indicative of failures in the metabolism of amino acids (FERREIRA et al., 2021; LONGATTI; SANTOS; PERON, 2021; NASCIMENTO; SAM, 2022).

Toxic and heavy metals (density ≥ 5.0 g/mL), in the ionic form, generate greater concern due to their high mobility in soil and in surface and groundwater due to the soil

leaching process, with ions being most commonly found: Cd^{2+}, Ba^{2+}, Cu^{2+}, Cr^{6+}, Mn^{2+}, Ni^{2+}, Fe^{2+} and Fe^{6+}, Al^{3+} and Zn^{2+}. In addition, metals have the property of accumulating along the entire food chain and are present in high concentrations as humans occupy the penultimate trophic level of any food chain, making corpses one of the largest sources of contamination by metal ions (ARAÚJO et al., 2020; LINS, E.; LINS, A.; LINS, C., 2019; RAIOL; OLIVA, 2019; SILVA; CAMPOS; CUNHA, 2018). Other substances of an inorganic nature are found in concentrations above that established by legislation, both in surface and underground waters, as well as in the soil nearby and inside the cemeteries, among the substances we can highlight: *i*) ions from salts present in cadavers (Cl^-, HCO_3^-, Ca^{2+}, Na^+, NH_4^+, NO_3^-), which can influence electrical conductivity, alkalinity and soil hardness in underground and surface waters; *ii*) increase in the concentration of nitrogen and phosphorus, resulting from the decomposition of amino acids and proteins, which can cause an increase in nutrients in the soil and the proliferation of undesirable plant species and the eutrophication of aquatic bodies that can harm the entire aquatic biota; *iii*) generation of substances that intensify odor in cemeteries such as H_2S (hydrogen sulphide), CH_4 (methane gas) and CO_2 (carbon dioxide) (NACIMENTO; SENHORAS; FALCÃO, 2018; RAIOL; OLIVA, 2019; SILVA; CAMPOS; CUNHA , 2018).

The necrochorume is a slurry, viscous, cloudy, grayish-brown liquid, with acrid and fetid odors; consisting of 60% water, 30% mineral salts and 10% degradable organic substances. In addition, it is a liquid with a density greater than that of water (1.23 g/mL) and has a high Biochemical Oxygen Demand (BOD) from cadaveric decomposition (ARAÚJO et al., 2020; BAUM et al., 2020; FERREIRA; AQUINO; CORDEIRO, 2020; LONGATTI; SANTOS; PERON, 2020; OLIVEIRA, 2019). This liquid is produced from the process of putrefaction of corpses and, mainly, during the first year of burial and presents numerous microorganisms, such as: bacteria that degrade organic matter (heterotrophic bacteria), proteins (proteolytic bacteria), of lipids (lipolytic bacteria) and those excreted by corpses, including: *Escherichia coli*, *Enterobacter*, *Klebsiella e Citrobacter*, *Streptococcus faecalis*; *Clostridium perfringes* e *Clostrídeum welchii* (CECCONELLO; CENTENO; SIQUEIRA, 2019; COSTA; SILVA; ANTUNES, 2020; FERREIRA et al., 2021; MOREIRA et al., 2021; SILVA et al., 2021).

Solid waste constitutes the largest composition of waste generated in cemetery activities, including: *i*) leaves and tree branches; *ii*) candles and artificial plants; *iii*) remains of construction materials; *iv*) fragments of clothing, objects and bones of corpses during the exhumation of bodies, among others. These wastes are collected and sent for final disposal in areas that are mostly unsuitable for disposal, such as dumps or nearby urban locations. The remains are disposed of in ditches or ossuaries that occupy increasingly larger spaces in the cemetery perimeter, since there are no crematoria in almost all of the numerous necropolises present in Brazilian municipalities (ARAÚJO et al., 2020; FEITOSA; CAMPOS; BANDEIRA, 2020; NOBRE; CALIXTO, 2019; SILVA; CAMPOS; CUNHA, 2018).

Given this context, there is a need to implement actions that minimize the numerous environmental impacts to the soil and surface and groundwater that are responsible for the transmission of more than 70% of disease transmitters through the water environment and cause numerous diseases that afflict the health of the population. . The need to create public policies aimed at improving the infrastructure of cemeteries with financial support from state and federal governments. In addition, the implementation of crematoria that can be built and managed through a consortium between municipalities, especially those with smaller populations and lower revenue.

4 | CONCLUSIONS

Cemetery activities implemented and managed in all Brazilian municipalities urgently need to be treated as a public policy project aimed at sanitation and public health, since the necropolises have a high environmental impact capacity.

The municipal public power needs to assume responsibility for the implementation of palliative actions in order to minimize the conditions that favor the environmental impact. In addition, the new cemeteries need to be built respecting the technical criteria and the environmental legislation in force at the time of the implementation of new projects aimed at this purpose.

The Ministry of the Environment, through CONAMA, needs to propose to the National Congress the reformulation of the legislation in force (Resolution no. 368 of 2006) in order to establish more rigorous criteria and broader and more diversified studies in order to implement areas destined for cemetery activities.

Municipal managers need to create committees in order to establish a solid waste management plan from necropolises in accordance with the National Solid Waste Policy (PNRS) implemented by Law No. 12,305 of 08/02/2010. In addition, the creation of an inter-municipal consortium in order to build a crematorium for common use, in order to contribute to the reduction of bones exhumed or disposed in the drawers. Municipalities need to create environmental awareness actions in order to show the population that certain practices of worship and veneration of the tomb can directly or indirectly impact negatively on public health.

REFERÊNCIAS

ARAÚJO, T. M. et al. Factors associated with soil contamination: Decomposition, treatment of corpses and funerary materials. **Brazilian Journal of Health Review**, v. 3, n. 6, p.18145-18157, 2020. https://doi.dx/10.34119/bjhrv3n6-213

BAUM, C. A. et al. Influence of cemeteries on groundwater contamination by phenolic compounds. **Journal of Environmental Sciences**, v. 14, n. 3, p. 39-48, 2020. http://dx.doi.org/10.18316/rca.v14i.6211

BORDA, W. F. et al. Environmental analysis of the area of a necropolis in Frederico Westphalen – RS. **Environmental Monographs Magazine**, v. 19, e10, 2020. https://doi.dx/10.5902/2236130843074

CAUDURO, F.; MULLER, C. R.; RICARDO, G. S. The problem of Brazilian cemeteries and the environment – Case Studies. **Holos Environment**, v. 19, n.4, p. 515-527, 2019. http://dx.doi.org/10.1495/holos.v.19i4.12341

CECCONELLO, S. T.; CENTENO, L. N.; SIQUEIRA, T. M. The necropolises and their environmental impacts: A case study of the São Lucas cemetery, Pelotas/RS. **Environmental Management and Sustainability Magazine**, v. 8, n.4, p. 110-130, 2019.

COSTA, L. A.; SILVA, P. A.; ANTUNES, P. A. Analysis of cemetery activity on water quality in Presidente Prudente-SP. **Geosul**, v. 35, n. 76, p. 298-325, 2020. http://doi.org/10.5007/2177-5230.2020v35n76p298

FEITOSA, J. F. F.; CAMPOS, T. I. L.; BANDEIRA, J. S. Environmental management of cemeteries: a literature review and research suggestion. **Santa Catarina Environmental Act**, v. 17, n.1, 2020. https://dx.doi/10.24021/raac.v17i1.5333

FERNANDES, D. A. Public policies and their adequacy to environmental law aimed at cemeteries. **Law Magazine**, v.13, n.3, 2021. https://doi.org/10.3236.1/2021130313284

FERREIRA, A. S.; AQUINO, R. M.; CORDEIRO, J. Characterization of the public vertical bioinsurance cemetery located in the municipality of Santa Bárbara (Minas Gerais). **Research, Society and Development**, v.9, n.3, 2020. http://dx.doi.org/10.33448/rsd-v9i3.2427

FERREIRA, T. C. et al. Analysis of impacts and damage potential of the composition and percolation of necrochorume in the soil. **Brazilian Journal of Development**, v.7, n.3, p. 25094-25112, 2021. https://doi.org/10.34117/bjdv7n3-287

HERRERA, A. E. et al. Parasitological analysis of feces and soil samples from a cemetery in a city in the interior of the state of São Paulo.**Prospectus**, v. 3, n. 2, p. 98-108, 2021. https://doi.org/10.5281/zenodo.5834313

LINS, E. A. M.; LINS, A. S. B. M.; LINS, C. M.M. S. Negative environmental impacts generated by cemetery: Case Study. **International Journal of Advanced Science and Research**, v. 4, p. 16-19, 2019.

LONGATTI, C. A.; SANTOS, G. B.; PERON, K. C. Solutions for the environmentally correct disposal of necrochorume. **Brazilian Journal of Development**, v. 6, n.4,p.18377- 18348, 2020. https://doi.dx/10.34117/bjdv6n4-127

MOREIRA, M. L et al. Environmental management in cemeteries: a case study in two cemeteries in the city of Pelotas (RS). **Magazine in Agribusiness and Environment**, v.14, Supl.2, 2021. https://doi.org/10.17765/2176-9168.2021v14Supl.2.e9137

NASCIMENTO, F. L.; SENHORAS, E. M. Comparative environmental analysis of urban cemeteries and sanitary landfills. **BOCA Newsletter**, v. 9, n. 25, 2022. https://doi.org/10.5281/zenodo.5832139

NASCIMENTO, F. L.; SENHORAS, E. M.; FALCÃO, M. T. Necroples and the environmental impacts: municipal public cemetery, Boa Vista –RR. **Baru**, v. 4, n. 2, p. 236-256, 2018. https://doi.dx/10.18224/baru.v4i2.687

NOBRE, M. D. S.; CALIXTO, A. I. The perception of the residents of Bairro do Socorro about the cemetery and its implications for sustainability. **Brazilian Journal of Scientific Management**, v.10, n.1, p.101-116, 2019. http://doi.org/10.6008/CBPC2179- 684X.2019.001.0009

OLIVEIRA, C. S. Sustainability in the complexity of horizontal cemeteries – the role of critical environmental education. **Brazilian Journal of Animal and Environmental Research**, v. 2, n. 6, p. 808-1839, 2019.

RAIOL, P. D.; OLIVA, P. C. Environmental study of the Vila de São Joaquim do Ituquara cemetery (Pará, Brazil). **Brazilian Journal of Development**, v. 5, n. 12, p. 30193-30207, 2019. https://dx.doi//10.34117/bjdv5n12-150

SILVA, F. C. et al. Analysis of Trace Metals in Unsaturated Zone in Cemetery Soils. **Ibero-American Journal of Humanities, Sciences and Education**, v. 7, n.5, 2021. https://doi.org./10.51891/rease.v7i5.1172

SILVA, M. B. S. et al. Vulnerability and socio-environmental implications: A case study in the Cemitério do Tapanã, Belém -PA. **Brazilian Journal of Development**, v.7, n.4, p. 39923-39932, 2021. https://doi.org/10.34117/bjdv7n4-450

SILVA, R. B. P.; CAMPOS, M. C. C.; CUNHA, J. M. Potential for soil contamination resulting from cemetery activity. **Ibero-American Journal of Environmental Sciences**, v. 9, n. 2, p. 1-10, 2018. https://doi.org/10.6008/CBPC2179-6858.2018002.0001

SILVA, R. B. P. et al. Physical and chemical attributes of soils in cemeteries in the Amazon, Brazil. **Valore Magazine**, v. 6, e-6004, 2021.

SOUZA, M. R. R.; CAVALCANTE, K. L. Study of compliance with environmental legislation in a cemetery in the city of Senhor do Bonfim-BA. **Id on Live Multidisciplinary and Psychology Journal**, v. 14, n.50, p. 1-13. https://doi.dx/10.14295/idonline.v14i50.2403

XAVIER, F. V. et al. Use of vertical electrical sounding integrated with chemical and microbiological analyzes in the preliminary diagnosis of soil and groundwater contamination in the municipal cemetery of the city of Rio Claro (SP). **Environmental Sanitary Engineering**, v. 23, n.2, p. 333-344, 2018. https://dx.doi//101590/S1413-41522018152375

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