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Mini-Review

Healthcare Waste Treatment by Microwave: Critical Parameters and Future Perspectives

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Minireview

Medical or healthcare waste (HCW) are defined by WHO (World Health Organization) as "waste that is generated in the diagnosis, treatment or immunization of human beings or animals". Management of such waste include properly handling and disposal to reduce risk for healthcare operators but also for citizens reducing the probability of microorganism diffusion [1-5]. Complexity of sanitary structures and the characteristics of treatments provided influence the production of HCW, in terms of quantities and composition [6,7]. Production ranges from 1,3 to 2,5 kg every occupied bed and every day and from 0,5 to 1,0 in developing countries [7,8]. Some specialized structures can reach higher rate of production: for example, in Italy, specialized sanitary structure Ismett, has produced more than 13 kg/occupied bed every day as a mean value of the years 2010-2012 [5]. It is known that around 75-90% of HCW produced in a healthcare facility is not dangerous; the remaining 10-25 % can be considered dangerous and among these, only the 10% is infectious [9]. Infectious waste is "material suspected to contain pathogens (bacteria, viruses, parasites or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts", as defined by WHO [9].

Two typologies of procedures are suitable to treat infectious waste: disinfection, which reduce the number of pathogen microorganisms but doesn't reach the complete destruction of all microorganisms or spores; and sterilization, which would remove all microorganisms, including spores. Sterilization of healthcare waste, classified as possibly infectious, are often treated with a steam process. Microwave (MW) treatment is an alternative technology to steam treatment. Also, the mechanism is not completely understood, some Authors published about thermal and non-thermal effects of MW in the sterilization [1,2], the content of moisture is a critical variable for the effectiveness of the process. To be sure of inactivation of pathological microorganism microwaves must penetrate inside the thickness of the waste.

For this goal:

A. a good design of the resonant cavity the chamber where the waste is put or go through is required [10];

B. the power applied to magnetrons (MW generating devices) in W/kg of waste should be choose appropriately [8];

C. shredding waste before feeding to obtain a homogeneous mass is a critical step.

Microwave irradiation is a suitable tool also for inactivation of biohazardous solid waste. Moisture content must be strictly controlled to guarantee the inactivation process. Otherwise, there will not be certainty of complete inactivation inside the biohazardous waste. In the future microwave technologies will have benefits, compared to autoclaves steam process, if appropriate control of heat and fluid moisture content would be more precise. Thus, only microwave technologies allowing this should be utilized also for treatment of non-homogenous infectious solid waste. There are several HCW treatment systems using microwave commercially available (e.g. Sanitec systems) with batch or semi-continuous feeding. Often these units are sold with all accessories and could be easily relocated inside the area of the healthcare facility. Often HCW is generated at many different places and then transported to the nearest treatment plant. Waste transport, especially for hazardous waste, should be done with particular care. Microwave technology has the advantage that can be implemented on-site in the healthcare facility which generated the hazardous/infectious waste, avoiding the need for transport. This is useful for developing countries where there are often lack in serious control of waste transport. Another critical aspect of the issue is that MW systems requires qualified and trained operators to manage the process.

Finally, the aspect of costs is another critical point. Compared to the best-known autoclave technologies, microwave irradiation

gives the possibility to save energy and operating costs if all the process is well managed and controlled. In the last decades several patents have been obtained for the sterilization of medical waste, as for example the US Patent "Machine for neutralizing the bacterial content of hospital waste…." by Salda L et al., 2016. MW sterilization technique, therefore, needs a standard method for validation of the effectiveness of the process in the most possible realistic conditions. Procedure using sealed vials used with traditional autoclaves are not representative of the realistic situation when using MWs: MW have better effect on the liquid inside vials than on solid waste where pathogen microorganisms are distributed on the surfaces of solid particles.

References

1. Celandroni F, Longo I, Tosoratti N, Giannessi F, Ghelardi E, et al. (2004) Effect of microwave radiation on Bacillus subtilis spores. Journal of Applied Microbiology 97(6): 1220-1227.
2. De Pomerai DI, Smith B, Dawe A, North K, Smith T, et al. (2003) Microwave radiation can alter protein conformation without bulk heating. Federation of European Biochemical Societies (FEBS) Letters 543(1-3): 93-97.
3. Komilis D, Fouki A, Papadopoulos D (2012) Hazardous medical waste generation rates of different categories of health-care facilities. Waste Management 32(7): 1434-1441.
4. Lanza PA, Insinga C, Maida CM, Nicosia S (2015) Produzione di Rifiuti a Rischio Infettivo e Indici di Complessità in un "Centro Trapianti"- Ingegneria dell'Ambiente 2(4): 2015.
5. Lanza PA, Maida CM, Benanti L, Giliberto G, Nicosia S (2018) Sterilizzazione con Microonde di Rifiuti Sanitari: determinazione diretta dell'efficacia del processo – Ingegneria dell'Ambiente 5(2): 2018.
6. Liberti L, Tursi A, Costantino N, Ferrara L, Nuzzo G (1994) Optimization of infectious hospital waste management in Italy. Part I. Waste production and characterization study Waste Manage Res 12(5): 373.
7. Nicosia S, Lanza PA, Lima A, Mosca M (2008) Rifiuti Sanitari: i "coefficienti di produzione unitaria" in due casi - studio Bollettino dell'Ordine degli Ingegneri della Provincia di Palermo. Dario Flaccovio Editore, Italy.
8. Oliveira EA, Pisani R Jr (2015) Influencia do meio suporte na inativacao de endosporos de Bacillus atrophaeus em residuos de servicos de saude por micro-ondas. Eng Sanit Ambient 20(2): 289-296.
9. WHO World Health Organization (2014) Safe management of wastes from health-care activities. II Edition, edited by Y Chartier et al. Geneva: WHO Press.
10. Zimmermann K (2017) Microwave as an emerging technology for the treatment of biohazardous waste: A mini review. Waste Management & Research 35(5): 471-479.