ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XV, NR. 1, 2008, ISSN 1453 - 7397

Liliana Daniela Moșteoru, Mihai Jădăneanț, Svetlana Moșteoru

A Structural–Functional Basis for Dry Heat Sterilization

Sterilization is one of the moast important method to prevent infection. This paper focuses on the most common and most safe method used for sterilization: sterilization by dry heat. The process takes place in a specially isolated oven at a certain temperature for a certain time. Sterilization by dry heat is accomplished by conduction. The possibility of adjusting sterilization temperature to high enough levels ensures the eradication of all potentially dangerous existing life forms. The purpose of this study is to present the principles and methods of sterilization, like the thermal processes that takes place during a complete cycle as well as the analysis of the thermal field in order to obtain the desired performances.

Keywords: *dry heat sterilization, microorganisms, gravity convection ovens*

1. General matters regarding the quality of sterilization

Sterilization refers to any process that effectively kills or eliminates transmissible agents (such as fungi, bacteria, viruses, prions and spore forms etc.) from a surface, equipment, foods, medications, or biological culture medium. Sterilization can be achieved through application of heat, chemicals, irradiation, high pressure or filtratio.

To kill all microorganisms we must destroy them by heat. All life forms can be extinguished by heat if we apply it at a high enough temperature for a sufficient period of time. If the sterilization process is effective in destroying bacterial spores, all other pathogenic and nonpathogenic miroorganisms are presumed killed. The spore test, or biologic monitor, is the only true test of sterility.

This paper focuses on the most popular method for sterilization, using the hot air oven, sterilization by dry heat (fig. 1). The standard setting for a hot air oven is one hour at 180 °C. Dry heat has the advantage that it can be used on powders

and other heat-stable items that are adversely affected by steam (for instance, it does not cause rusting of steel objects).

The principle behind dry heat sterilization is conduction. Heat is absorbed at the exterior surface of an item and is passed inward until the entire item has reached the sterilization temperature.

Figure 1. Dry heat sterilizers

Dry heat can take the form of still or convection. Still heating uses no blowers or moving air. Convection heating uses blowers or fans to keep the heated air moving, reducing the time it takes to heat the environment to the setpoint. Made of stainless steel, carbon steel, or other suitable metals, typical dry heat sterilizers can be used to sterilize medical and non-medical contaminated appliances (fig.2).

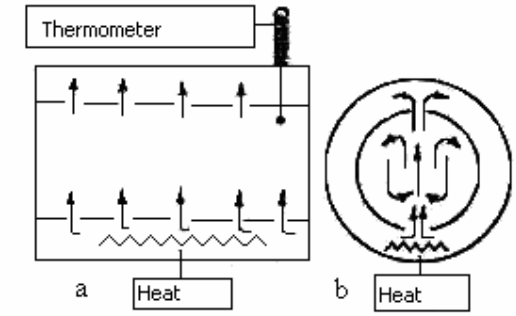

Figure 2. Dry heat sterilizer drawing

Dry heat sterilizers were developed to accomplish workplace goals of high output and low cost while being environmentally friendly. Dry heat sterilization requires no water, and uses less energy and requires less maintenance than traditional sterilization methods.

2. Technical solutions

The purpose of this study is to compare the behaviour of three different insulation materials: mineral wadding, glass wadding and nobasil (an ecological material), used for padding the walls of dry heat sterilizers, to see which of them has a better quality and ensures higher technical and functional qualities for dry heat sterilizer.

To compare the dry heat sterilizer's wall, an analysis of the three insulation materials is necessary, in order to determine the thermal field inside the wall. For this propose we used a program based on numerical models. The modelling of the thermal regime is an important matter because:

- The temperature influences the performance and reliability of the devices
- Ensuring a good insulations provides a low electric consumption and safety during use
- The thermal regime influences the possibility of drastically reducing the bacterial threat in a short period of time, to the level fit after sterilization

The temperature field is analyzed and compared with the thermal conductivity and specific heat of the insulation analysis (fig.3).

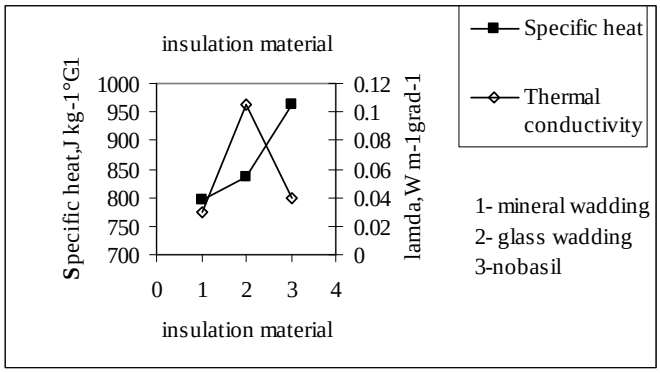

Figure 3. Specific heat and thermal conductivity for the three insulation materials (comparison)

Based on these results we can use graphic representation for the distribution of temperature, the gradient of temperature and the flow of temperature, thus offering a real image regarding the temperature status in the dry heat sterilizer's wall (fig.4).

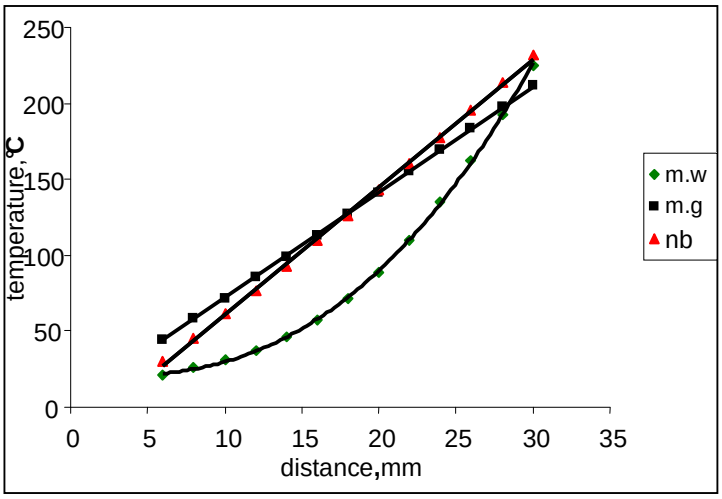

Figure 4. Thermal field inside the dry heat sterilizer's wall for the three insulation materials

Based on experimental data we considered for these parameters a five order polynomial equation with temperature dependence ($f(T) = aT^5+bT^4+cT^3+dT^2+eT+f$), as being precise. The coefficients for the five order temperature dependence for mineral wadding, glass wadding and nobasil were presented in Table 1.

The experimental data shows similar behaviour between mineral wadding and nobasil and they present a good quality for insulation. The amount lost heat is lower in this case.

Table 1.

Material	Temperature					
	a	b	c	d	e	f
mineral wadding	-0.0011	+0.0427	-0.4261	+1.0103	+2.4408	+14.489
glass wadding	-0.0011	+0.0511	- 0.904	+7.3934	-16.198	+32.843
Nobasil	-0.0012	+0.0472	-0.5304	+2.0061	-1.1169	+17.893

3. Conclusion

- The knowledge of the structure of the thermal field inside the wall of the dry heat sterilizer is of utmost importance in order to avoid the unpleasant efects that appear when certain limits of temperature are crossed. By not following the sterilizing protocol, it is impossible to reduce the bacterial theat in a short period of time.
- Using the computer program we have proposed, it is possible to determine the temperature in various sites thus obtaining more reliable results.
- A low power consumption can be reached by a proper thermal insulation using adequate insulating materials.
- The temperature influences the performance and the reliability of the device.
- Experimental data show that nobasil is similar to mineral wadding. Its ecological components are an advantage that place it on the position of a possible candidate for insulating dry heat sterilizers.

Dry heat sterilization is one of the most secure available technologies nowadays due to its simplicity. Newly brought improvements to medical devices have allowed a maximum security, safety and efficiency to be achieved regarding their use. The possibility of adjusting sterilization temperature to high enough levels ensures the eradication of all potentially dangerous existing life forms. By understanding the issues regarding the temperature distribution, an improvement in the durability and design of the device has been made.

References

[1] Buiuc D., *Microbiologie generală,* Ed. Medicală Iaşi, 1990

[2] S.S. Block *Disinfection, sterilization and preservation* Lea and Febiger, Philadelphia, London, 4th ed., 1991

[3] Cosmovici L., Georgescu, C., Ionescu, I., *Instrumente, aparate şi materiale destinate practicii medicale*. Catalog, Bucureşti, Ed. Medicală, 1974

[4] A Dauphin, J.C. Darbord *Hygiène hospitalière pratique*. Ed. Médicales Internationales, Paris, 2e éd., 1988

[5] Moşteoru L. Jădăneanţ, M. - *Utilizarea unui program de calcul în vederea determinării structurii câmpului termic pentru diferite materiale izolatoare* Conferinţa naţională de Termotehnică cu participare internaţională, Ediţia a V-a 26-28 mai 2005 Craiova

[6] Pop G. Mihai, Leca Aureliu ş.a.: *Indrumar - Tabele, nomograme şi formule termotehnice*, Editura Tehnică Bucureşti, 1987

[7] Spaulding, E. H.: *Desinfection, sterilization and prezervation*, Philadelphia, 1977
[8] *****International Hospital. Equipment and solutions
[9] ***** National Library of Medicine

Addresses:

- Liliana Daniela Moșteoru, Ph.D., Politehnica University of Timișoara, Mechanical Engineering Faculty, lilianamosteoru@yahoo.com
- Prof. Dr. Eng. Mihai Jădăneanț, Politehnica University of Timișoara, Mechanical Engineering Faculty, Mihai Viteazu no.1, Timisoara 300223, Romania, E-mail: mihaij@mec.utt.ro
- Svetlana Moșteoru, medical student, Victor Babeş University of Medicine and Pharmacy Timişoara