DOSE RATE INFLUENCE IN THE RESPONSE OF THE AMBER 3042 PERSPEX DOSIMETER, BATCH L.

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ABSTRACT

The answer of the dosimetry systems is affected by several factors , as the temperature, humidity, light, concentration of oxygen, dose rate, energy spectrum and one can also add the technological conditions of the irradiation process. It should be known as these factors influence in each one of the different dosimetry systems and this way to minimize their effect in the value of the absorbed dose and to obtain exact values .
The objective of this paper is to know the influence of the dose rate in the value of the absorbed dose in the Amber 3042 Perspex dosimeters, Batch L, for different measurement wavelengths, as well as, the relation between the post-irradiation time and the induced specific absorbance value in function of the absorbed dose.

INTRODUCTION.

The Perspex dosimeters (Red, Clear and Amber) are employed to study the dose distribution and the routine control of the absorbed dose in industrial applications as the sterilization of medical products, biological materials and food preservation, but this kind of dosimeters are affected too by several factors, it which should be studied to know its influence on the absorbed dose value, besides if the conditions of use are unusual, for example are exceptionally high or low irradiation temperatures or there are to be delays of several days before measurement, then equivalent calibration conditions should be used [1-4].
All gamma radiation dosimetry techniques used for practical measurements in the 1,0 to 50,0 kGy radiation processing dose range depend on the measurement of some chemical or physical quantity which relates indirectly to absorbed dose in water-equivalent material. For an ideal technique the quantity measured would depend on absorbed dose only and no other factor, an ideal which is difficult to achieve in practice but can be considered to be one of the ultimate goals of all development on new radiation-sensitive systems for dosimetry [5].
Miller et al. pointed out that the irradiation conditions used in practice can be quite different from those used in calibration and that this could be a source of dosimetry inaccuracy. In most irradiation plants the dosimeters are exposed to changing dose rates and temperatures, whereas in calibration steady conditions are normally used [6]. For this reason the aim of the present paper is to know the influence of the dose rate in the

absorbed dose value in the Amber 3042 Perspex dosimeters, Batch L, for different measurement wavelengths, as well as, the relation between the post-irradiation time and the specific absorbance (K^*) value in function of the absorbed dose.

MATERIALS AND METHODS.

All irradiations of the Amber 3042 Perspex dosimeters, Batch L, were carried out in a research facility, type PX-γ- 30, with cobalt-60 sources. The three dose rate values were determined with the Fricke dosimeter, it was prepared according to Prieto methodology [7]. For the dose rate studies the irradiations were done in a lead jacket with polyethylene foam, which provided electron equilibrium conditions and the calibration position was located in the center of the inferior area of the irradiation chamber [8].
The irradiations were carried out to temperature of 40 ± 1 °C, because it is the temperature value of the irradiation chamber without refrigerant liquid and the dosimeters were stored at 25 °C and relative humidity of 60-70 %.
The dosimeter thickness, X_i (mm), was determined with a micrometer of a precision of ± 0,01 mm and the absorbance values were measured in a LKB-Biocrom Ultrospec II 4050 spectrophotometer, for wavelength values of 603 and 651 nm and the room temperature was 25 °C. The absorbance values were determined at the 24 hours, 7, 14, 21,30 days.
The Amber 3042 Perspex dosimeters, Batch L, according to the manufacturer [4], present different dose ranges in dependence of the measurement wavelength. The dose range from 1,0 to 15,0 kGy is for the wavelength of 603 nm and the dosimeters were irradiated to dose values of 1, 5, 10 and 15 kGy and for the wavelength of 651 nm the range is from 1,0 to 30,0 kGy and the dosimeters were irradiated to dose values of 1, 5, 10, 15, 25 and 30 kGy. The dosimeters were irradiated in sets of three for each dose value.
The calibration process was made according to the norm E 1276 of the American Society for Testing and Materials (ASTM) [9]. The K^* value of each dosimeter it was calculated by the following expression:

$$K^* = A_i / X_i \ (mm^{-1})$$

Where:
A_i is the absorbance value of each irradiated dosimeter.

RESULTS AND DISCUSSION.

The dose rate values were obtained of 1,28, 2,49 and 3,74 kGy in the calibration position of the irradiation chamber of the research facility, PX-γ-30.
The figure 1 shows the calibration curves of the Amber 3042 Perspex dosimeters, Batch L, in the dose range from 1,0 to 15,0 kGy for different dose rate values, where it is observed that there are no significant dose rate effect in the studied range, however in the figure 2 is shown the calibration curve for the range of dose of 1,0 to 30,0 kGy and it is observed that for of superior dose values of 15,0 kGy if there are differences for a same dose value and different dose rate values, the one which indicates that for the superior part of the range of dose of this system there is influence of dose rate in the response of this dosimetric system .
On the other hand, in the figures 3 and 4 are shown the behavior during the post-irradiation time of the K^* value for different absorbed dose values, for the measurement

wavelength of 651 nm , where it is observed that for all the absorbed dose values there is a fading significant variation of K^* for the different dose rate values, which it belong together with it gotten by other investigators in their studies with another Batch type of this kind of dosimetric system [5, 10].

CONCLUSIONS.

The dosimetric accuracy attainable with the Amber 3042 Perspex dosimeters, Batch L, is affected by the dose rate, besides it was demonstrated that the K^* value is affected significantly too for different dose rate when it is measured for lingering post-irradiation times

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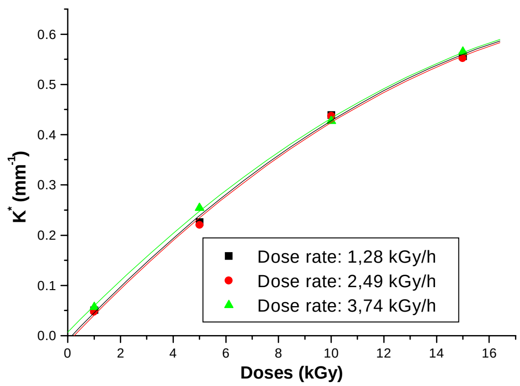

Fig 1: Curve of calibration of the Amber 3042 Perspex dosimeter, Batch L, λ = 603 nm, for three different dose rate values.

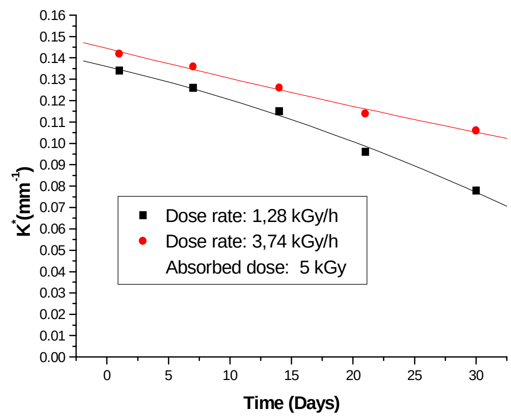

Fig 3: Change in the K^* value during the post-irradiation time for different dose rate values and an absorbed dose value of 5 kGy.

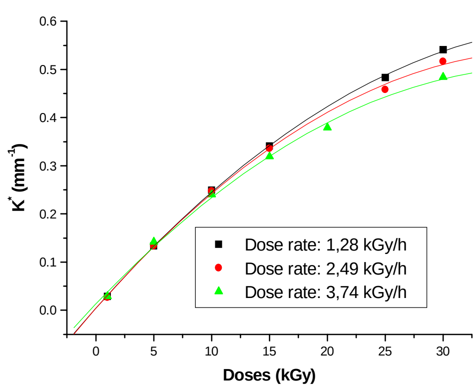

Fig 2: Curve of calibration of the Amber 3042 Perspex dosimeter, Batch L, λ = 651 nm, for three different dose rate values.

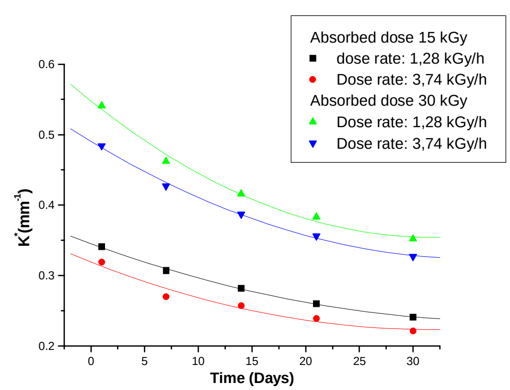

Fig 4: Change in the K^* value during the post-irradiation time for different dose rate and absorbed dose values.