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Electrical conductivity dosimetric characteristics of gamma-irradiated food salt

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Abstract

The electric conductivity characteristics of sodium chloride solution , have been studied in the present work considering its usage as a high dose dosimeter "accidental dosimeter" in the case of a nuclear fallout . Aqueous solution of gamma-irradiated food salt was investigated for dosimetric purpose using the electrical conductivity method. It was found that the solution containing [10-100]%(w/w) of food salt the most sensitive to radiation .

The variation of electrical conductivity of all the solution was found to increase linearly with absorbed dose in the range (3-120) kGy. Reproducibility ,radiation dose response ,dose rate, and stability can have been studied.The results of this preliminary study show that food salt solution may be applied to a simple electrical conductivity detector for dose measurement in the dose range (3 – 120)kGy .

Keywords :Electrical conductivity, dose response, γ-radiation, dosimetry, dosimeter

1-Introduction.

Control of sodium chloride concentration at a salt dissolver where solid salt is dissolved in water, is highly important because of the electrolysis efficiency .A conventional way of measuring the concentration of supersaturated sodium chloride solution has been performed by using non-contact type sensors e.g Gamma-ray density meter.

The radiation responses of sodium chloride have been studied by many researchers in order to be use as a dosimeter and other properties of these material [1-5].This study ,that was undertaken in order to characteize the aqueous food salt solution as a dosimeter in the dose range 3-120kGy ,makes use of a new method based on the measurement of electrical conductivity of food salt for routine dosimetry process control.

2-Materials and methods.

The food salt was purchased from local market, and was used without chemical treatment .Sucrose was irradiated in the solid form ,with Cs-137 gamma radiation mark(IV TLD Dosimeter irradiator), made by (J.L.shepherd and Associated Company), California [6], at room temperature and covering the dose range from 3-120 kGy at dose rate 0.56 Gy /min. To establish electron equilibrium during irradition, food salt samples were put in a container made of Plexiglas[7].The gamma-irradiated food salt was dissolved in distilled water immediataly after irradiation at room temperature. In this way aqueous solution with different concentration from [10-100]% (w/w) was prepared. The electrical conductivity measurements were performed using a conventional conductimeter supplied form HANNA instruments mark ISTRDISTR1 1297, Portugal.The measurments were made at a constant temperture of 25 ^{0}C.

3-Results and discussion.

3-1.Concentration effect

The effect of the concentration on the electrical conductivity of food salt solution is shown in fig.(1).The behavior of the electrical conductivity of the solution with concentration is nearly linear. Salt contains NaCl, which forms electrolyies when dissolved in water, most of which become ions so the electrical conductivity increase with increase concentration . The carriers of electrical charge are ionic in nature, not electronic .This is shown by the fact that electrolysis of the crystal takes place, its constituent elemments being liberated at the electrodes in conformity with Faraday 's law.[8].

3-2.Radiation response

The result of the influence of the salt solution concentration on the electrical conductivity prepared from irradiated solid salt sample in the dose range3-120 kGy is shown in Fig. 2 .These data indicate a linear response of the electrical conductivity to the dose of a gamma radiation. The slope of the curves which was plotted as a function of solution the salt concentration is shown in Fig.3 .

3-3.Dose rate effect

In order to investigate the effect of the dose rate on the electrical conductivity of common salt solution 10% (w/w), a set of samples has been Irradiated to (20)kGy at two different dose rate one of which 0.0012 mGy/minute and the other 0.56 Gy /minute we see that the effect of the dose rate is very small , see Table (1).

3-4. Reproducibility

The evaluation of the overall variation coefficient for electrical conductivity of the irradiation of the solution salt by using the equation $CV\%=\sigma/D\times100\%$. For each sample calculate the mean read –out value D, and the standard deviation σ of the 10 individual read – out values from the mean for that samples.[9]

Table (1) Effect of dose rate on the Electrical conductivity of common salt irradiated to (1) kGy..

Dose rate	Electrical conductivity of salt solution from(10)% respectively
0.0012mGy / minute	24
0.56 Gy / minute	24

To find out the CV% of the solution salt sample under study , the same sample after was being exposed to a dose of 30 kGy 10 times and then their electrical conductivity read after radiation. The overall variation coefficient was calculated to be 1.5 % that means the food salt solution has good reproducibility.

3-5.Post-irradiation stability

The influence of post-irradiation storage on the conductivity of salt solution was investigated .The samples were measured immediately after dissolution at room temperature. Fig. 4 represents the evolution of conductivity of salt solution from(20)% at 40 kGy up to 30 day .The result demonstrated a very small decrease of electrical conductivity during the elapsed period of time of 30 days.

4.Conclusion

From the electric conductivity it is different concentrations of the solution salt that is a good material for dosimetry application .Conductivity –response is linear up to the radiation dose of 120 kGy, the dose rate is very good and post-irradiation stability remains constant during the next 30 days .Although further work is required , preliminary investigations of the electrical conductivity properties of NaCl suggest that it may be a useful accidental as an dosimeter for high dose.

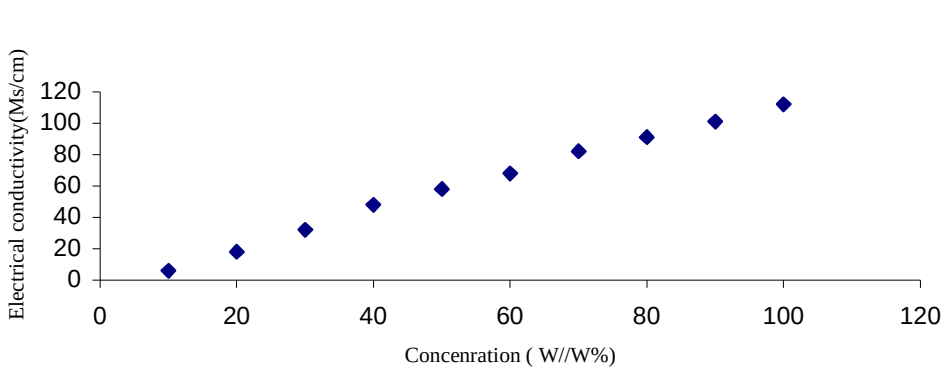

Fig. 1 Electrical conductivity with different salt consenteations

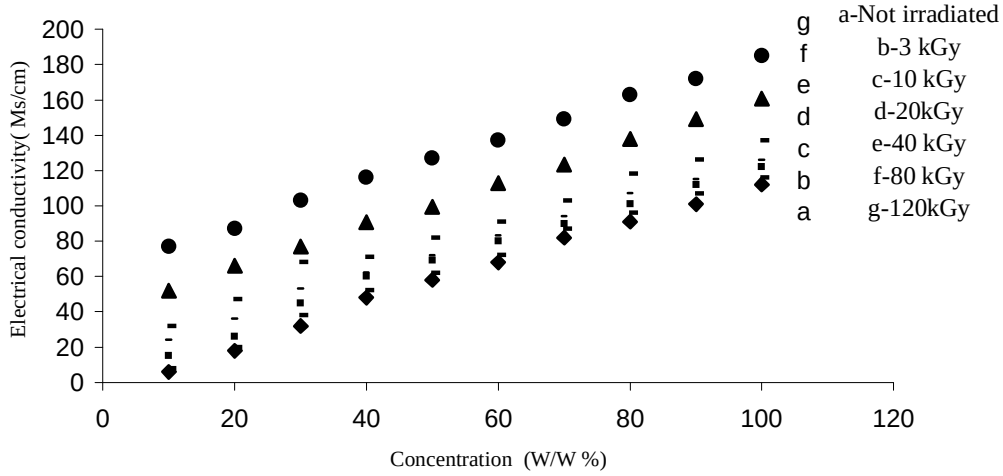

Fig. 2 Electrical conductivity plotted against concentration of water solution of irradiated solid salt in the dose range 1-120kGy.

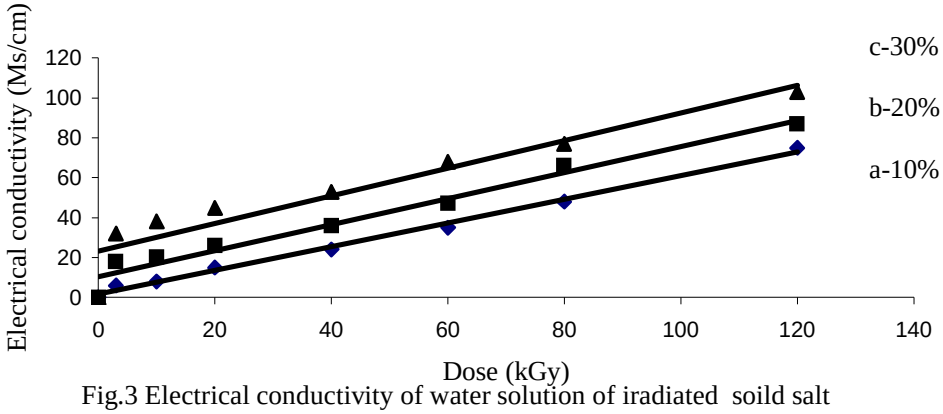

Fig.3 Electrical conductivity of water solution of iradiated soild salt plotted with absorbed dose for the concenteation from (10-30)%(w/w).

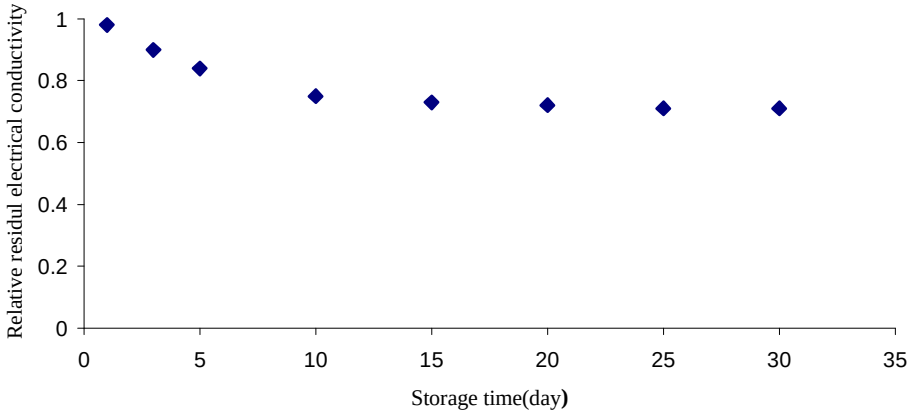

Fig.4.The effect of storage time after irradiation on Electrical conductivity of gamma-irradiated table salt.

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الخلاصة

درست خصائص التوصيل الكهربائي لمحلول ملح الطعام بتركيز مختلفة من (10-100)%w/w لاستعماله لقياس الجرعة الإشعاعية العالية من أشعة كاما، حيث لوحظت استجابة جيدة للتوصيل الكهربائي مع الجرعة ضمن المدى(3-120)kGy ، كما درست خصائص التوصيل الكهربائي من ناحية عدم الاعتماد على معدل الجرعة والاسقرارية في درجة حرارة الغرفة . تشير هذه الدراسة إلى إمكانية استخدام محلول ملح الطعام كمقنن إشعاعي للجرعة العالية من kGy (3-120).