Enhancing The Dielectric Properties Of EPDM Rubber Filled With ATH By Gamma Radiation

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***Abstract*—A deferent of ecological stressors in nuclear power plants (NPPs), like temperature, radiation, vibration, can influence the degradation of the insulation of the electrical power and instrumentation and control (I&C) cables. This work is using gamma radiation up to 350KGy to reinforce the electrical properties of the Ethylene propylene rubber (EPDM) full of with aluminum hydroxide (ATH). The electrical properties of the EPDM/ATH rubber compounds are evaluated . The results show that the electrical properties are enhanced by radiation for EPDM /ATH compound quite unfilled EPDM.**

Keywords—(Dielectric properties; EPDM rubber; EPDM/ATH rubber; engineering applications safety Radiation (cables)).

Introduction

cables [1] utilized in in nuclear power plants (NPPs) displayed to debasement in light of different organic introductions, for occasion, warm, ionizing radiation, moistness, voltage, etc. Contamination of the association coat and electrical confirmation layer had been seen as a calculate that conceivably controls the restrain of associations to work past their covered-up course of action life [2]. Over extended times of organization, the polymeric security and coat may interior long-term miss the stamp, not, appropriate presently appropriately guaranteeing the association and maybe prompting current-arcing and related misfortune of drive or control work [3]. Ethylene propylene elastic (EPDM) and cross-connected polyolefin (XLPO) were two critical cables coat materials utilizing in NPP since of their unimaginable electrical separator, moo thickness, and moo gathering fetched [4]. Inorganic fillers were commonly included into the polymer lattice to move forward the rigid nature, fire retardancy, and scratched region restriction of polymers. Through different kinds of nanofillers, metal oxides were normally picked as nanoparticles in nanocomposites. It had been accounted for that the presentation of modest quantities of Al_2O_3, TiO_2, and SiO_2 nanoparticles can cause an ascent of permittivity inside the composites [5-7] as a result of the upper permittivity of those nanofillers comparative with the framework. A tremendous augmentation of permittivity occurs with a restricted amount of those nanofillers because of their high conductivity yet that was joined by high dielectric setback and a major decreasing of breakdown quality [8-10].

Pieces [11] of ethylene-propylene-diene flexible containing mixes of aluminum hydroxide (ATH) and carbon dim (HAF) as a filler were made, for the application as security in electric wires and cables. It was found that the synthesis contains 15 phr of HAF, was hazardous to the electric properties. Simply the synthesis with 170/7.5 (ATH/HAF) demonstrated the perfect execution. It was discovered that the piece contains 15 phr of HAF, was risky to the electric properties. Simply the structure with 170/7.5 (ATH/HAF) indicated the perfect execution. The [12] updated dielectric and warm properties of micron BN filled EPDM were practiced by making its co-filled composite with extension of a restricted number of nano-BN particles. The dielectric steady, dielectric misfortune digression and conductivity of co-filled composites were by and large improved near with micron–filled accomplices the [13] essential attributes of EPDM (Ethylene Propylene flexible) which was applied as high voltage insurance materials were portrayed. polymer blends were applied as high voltage insurance materials. EPDM rubber was inadequate in atmosphere insurance from Silicone flexible. It was found that the development of carbon dim reacts in an amazing suffering property of EPDM elastic with no degradation of following check.

The electrical after check of EPDM rubber was improved by including Alumina trihydrates (ATH) as filler. The compound indicated amazing physical properties and ease in examination with Silicone elastic. Likewise, the predefined EPDM compound was not second rate compared to the silicone elastic for the open-air insulating materials. The outcomes [14] of electrical property estimations on EPR-based assurances of low-voltage power cables used in NPP were investigated. The models withstand to animate developing through the simultaneous use of high temperature and gamma-radiation and accordingly dielectric response at different frequencies were explored. Results exhibited immense assortment of the electrical of developed connections at low frequencies, the real and whimsical bits of permittivity were extended with developing time, accumulated part and sentiments of uneasiness applied showing extraordinary association with extending at break, which decreases as a segment of level of insulation maturing. In this paper, dielectric properties of EPDM loaded up with 20 phr ATH (S20) and unfiled EPDM (S0) is upgraded by gamma radiations utilizing various dosages.

MATERIALS AND EXPERIMENTAL TECHNIQUES

I. MATERIALS

the materials used in this work are business evaluation of EPDM (ethylene-propylene adaptable Herlene, audit HS63) made by Unimers India Restricted (in a joint effort with Uniroyal Chemical Co., USA. Also, ATH(Aluminum Hydroxide $Al(OH)_3$ Oxford Research office .Other adaptable included substances, for outline, stearic dangerous, zinc oxide, arranging oil, disease expectation pro, and sulfur were of exchange grades. All the materials used in this pursuit start from El Nasr Pharmaceutical Chemicals Co. Cairo, Egypt.

III .Preparation of samples and irradiation

EPDM rubber tests are blended in with 0,20 phr of ATH and a couple of differing fixings, for representation, (Stearic dangerous, Zinc oxide, Oil, cell backing, Sulfur, and calcium carbonate). The blending of the adaptable is done on a lab two-move plant (Farrel-UK,152 mm and 330 mm) at a contact degree of 1:1.4, as showed by ASTM D3182[15]. The Wavering Disk Rheometer (Alpha-UK, MDR 2000) measures the entire restoring characteristics of an elastomeric compound. Trial of around 5 g are cutting from a readied sheet and set inside the rheometer, at a predefined temperature as showed by ASTM D-2084[16] at 160C0 for EPDM mixes. The representations are vulcanized in a water driven press (Farrel-UK) at 160 C0 and weight of 150 kg/cm2 for a period of 4.5 min for EPDM mixes. A C060 wellspring of gamma office Canadian Gamma Cell (Ge 220) converses with at the National Center for Radiation Investigate and Innovation (NCRRT) with rate 2 KGy/h is used for gamma-radiation

A. Equations

IV-Dielectric Measurements

Real permittivity values (ε'), imagine permittivity (ε''), which form the complex permittivity of the simples is given below:

$$\varepsilon = \varepsilon' + j\varepsilon'' \qquad (1)$$

The dielectric loss tangent ($tan\delta$), can be computed by following equation

$$\tan\delta = \frac{\varepsilon''}{\varepsilon'} \qquad (2)$$

The dielectric consistent of a fabric is related to the polarizability, in specific to the dipole polarizability, which emerges from structures with a changeless electric dipole that can alter introduction in an connected electric field. The genuine permittivity regards envision permittivity, the dielectric misfortune digression, and ac conductivity of the investigated tests were settled at different frequencies amplifying from 100 Hz to 100 kHz utilizing the AG-4311B RCL-meter (Ando-Japan). The cases were circles 30 mm in breadth and of 4 mm thick. A guardian ring capacitor sort NFM 5/T from WTW, which could be a standard cell, was utilized. The cell was adjusted utilizing plates of realized permittivity regards and the bumble in and entireties to ± 1% and ± 3%, separately [17].

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named "Heading 1," "Heading 2," "Heading 3," and "Heading 4" are prescribed.

RESULTS AND DISCUSSION

1. Dielectric properties

1.1 Real permittivity (ε')

Figure 1 shows that the real permittivity values (ε') versus frequency for samples S0 and S20 with gamma radiation 0, 150, 350 KGy. It is observed that (ε') of sample S20 is higher than S0, also it decreases with the increasing of frequency for all samples. (ε') of all samples have a maximum value at low-frequency region (nearly 1 Hz) and then decreases rapidly up to 1000Kz. A stable behavior of real permittivity as a function of frequency is shown up to about 10 kHz. Also, it is observed that (ε') increases with the increase of absorbed radiation, and the value of (ε') at 150KGy is higher than the value at 350 kGy and then the value of (ε') is decreasing again. For example, at room temperature and 10 kHz frequency, (ε') of S0 (un-irradiated sample) is 3.53, whereas the same sample at (150 kGy) is 4.39. The increasing of (ε') value with radiation is attributed to the formation of

Hardly any imperfections locales in the band gaps of EPDM because of event of chain scission and revisions of connecting bonds. These deformities taps the charge transporters exist in the band hole of the polymer/polymer mix test. Subsequently the radiation expands the capacity of the EPDM polymer/mix tests to store charges provided by the drop down menu to differentiate the head from the text.

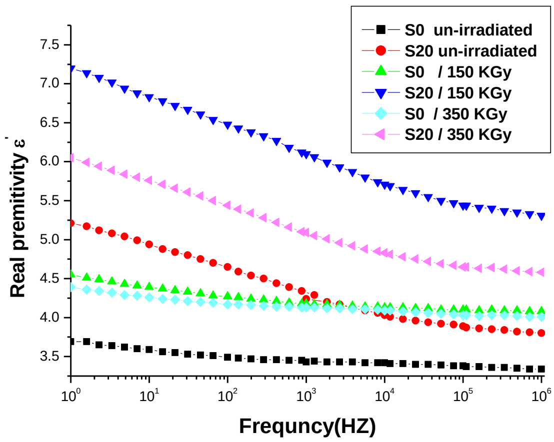

Fig .1 Variation of permittivity of S0 and S20 versus frequency with deferent gamma doses

1.2 Imagine permittivity (ε'')

Figure 2 shows that, the variation of the imagine permittivity (ε'') of sample S20 (unirradiated and irradiated) is higher than S0 ((unirradiated and irradiated) as a function of frequency at room temperature. it reveals that (ε'') decreases with increasing frequency However, (ε'') increases with increasing absorbed radiation till 350 KGy. And it is observed that (ε'') at 150KGy is higher value than ε''at 350 KGy.

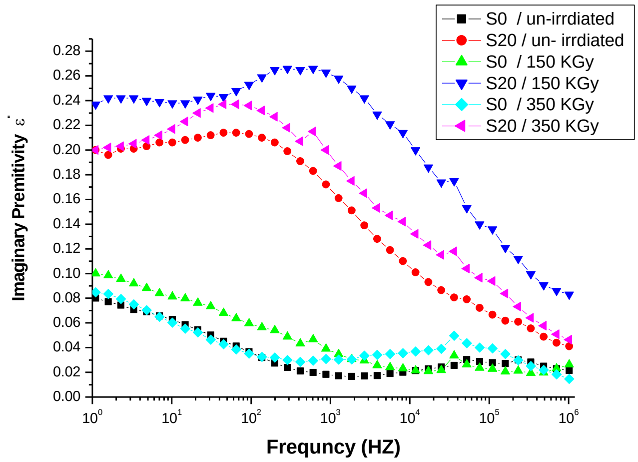

Fig.2 Variation of Imagine permittivity of S0 and S20 versus frequency under deferent gamma doses.

1.3 AC Conductivity (σac)

The dielectric conductivity (σac) can be observed from Figure 3. It is observed that σac for all samples are increasing. It can be noticed that the σac for all sample is a minimum value of low frequency up to 10 kHz and then increases rapidly with increasing frequency. Almost all samples show similar behavior up to 10 kHz, which is typical for hopping conduction, in this range there is not much change in AC conductivity with frequency.

From frequency 10^4, it is shown rapid increase in AC conductivity of samples S20 which are irradiated than the samples of S0. That is because Ions and free radicals are formed and partially trapped in the bulk of the material [10]. Also, it can be observed that the increase in AC conductivity with increasing in irradiation dose is ascribed to the degradation of EPMD. σac of S20 at 150KGy is higher than σac of S20 at (350 KGy) . σac of the sample S0 is the same values at frequencies 10KHZ and then is increasing with irradiation 150KGy till 800 KHz .

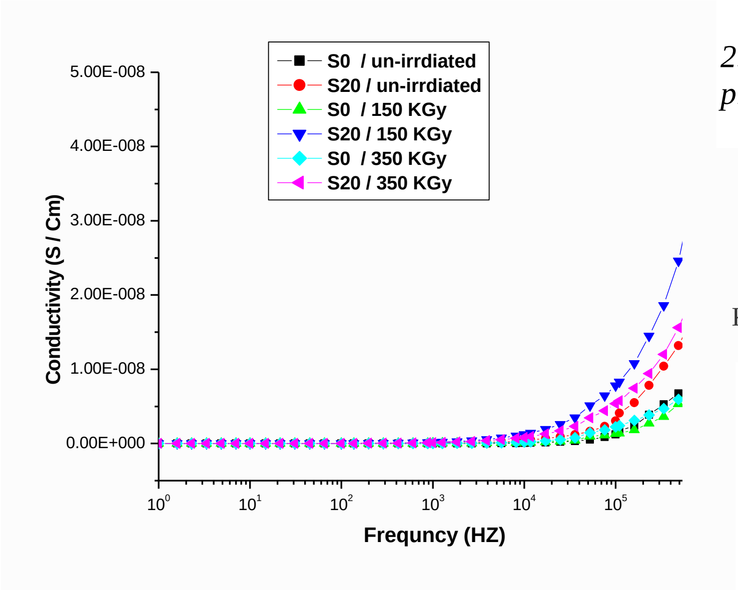

Fig .3Variation of conductivity of s0, and s20 versus frequency with deferent gamma doses

1.4 Dissipation factor

It is shown in Figure 4, the dielectric loss $tan\delta$ of sample S20 (unirradiated and irradiated) is higher than (S0) as a function of frequency at room temperature. Also from the Figure 4, it reveals that the $tan\delta$ decreases with increasing frequency. However, $tan\delta$ of un-irradiated sample S20 is higher than irradiated sample till frequency 1KHz and then irradiation sample S20 is higher than un-irradiation sample . It is observed that $tan\delta$ has same value at low frequency till 1 KHz at 150KGy and 350 KGy, also, $tan\delta$ at 150 KHz is higher than the value at 350KGy at 1000KHZ.

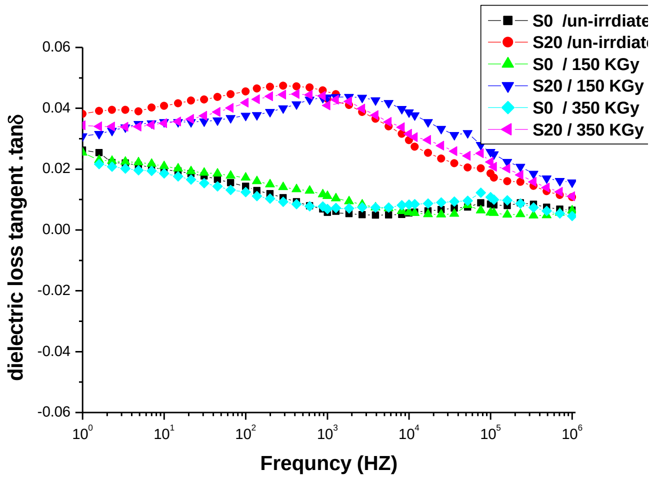

Fig .4 Variation of dielectric losses $tan\delta$ of S0 and S20 versus frequency with gamma radiation

2. *Effect of gamma radiation on the dielectric properties*

From figure 5, it is observed that the permittivity S20 is higher than the permittivity of S0 and also it is increasing with increasing absorbed radiation till 150 KGy. And then it is decreasing. The first value of S20 increases from 3.8 to 5.31 in the range from 0 up to 150 KGy .the first value of S0 increases from 3.4 to 3.8 in the range 0 up to 150 KGy .

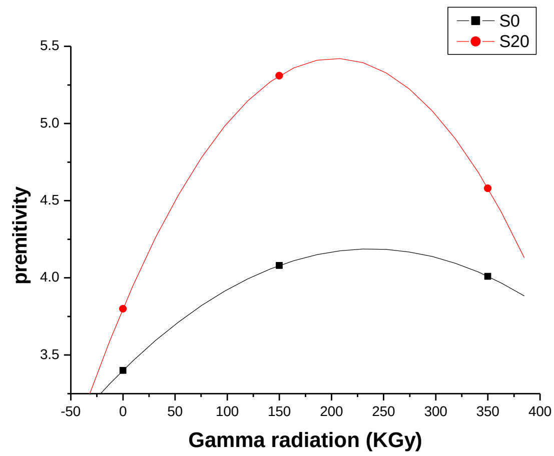

Fig.5 .Variation of permittivity of S20 and S0 with deferent gamma doses at 10^6 HZ

From figure 6, it is observed that the ac conductivity of S20 increasing with increasing γ-radiation. Gamma radiation has a considerable good effect on conductivity. There is an observed increasing in conductivity with radiation till 150 KGy. This is due to ionization radiation leading to increase in the number of charge carriers, then the conductivity is starting to decrease with increasing gamma radiation up to 350KGy . This observation can be attributed to increase in the number of free ions due to increase absorbed radiation .At this stage the high number of free ions makes recombination and dimmers formation process less effective in the system. Dimmers formation tends to depopulate the free ions, and also tend to cover the electrode. All these combine and lead to eventual decrease in conductivity despite the initial increase [18]. Ions and free radicals are formed and partially trapped in the bulk of the material [19]. Thus the conductivity of the irradiated samples showed higher conductivity than that of unirradiated samples for . Similar behavior was observed for all the samples . The electrical conductivity of the polymer material depends on the presence of free ions connected chemically with macromolecules.

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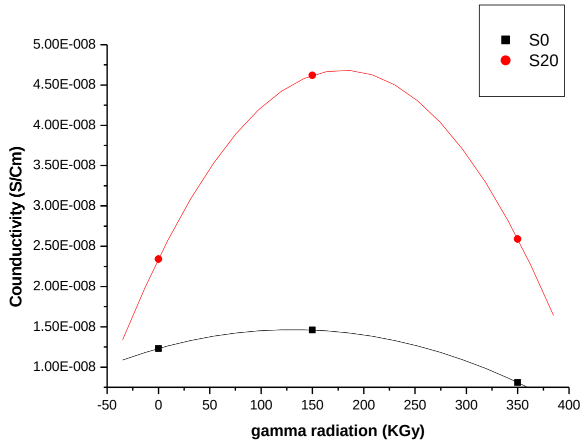

Fig.6 .Variation of conductivity of S20 and S0 with deferent gamma doses at 10^6 HZ

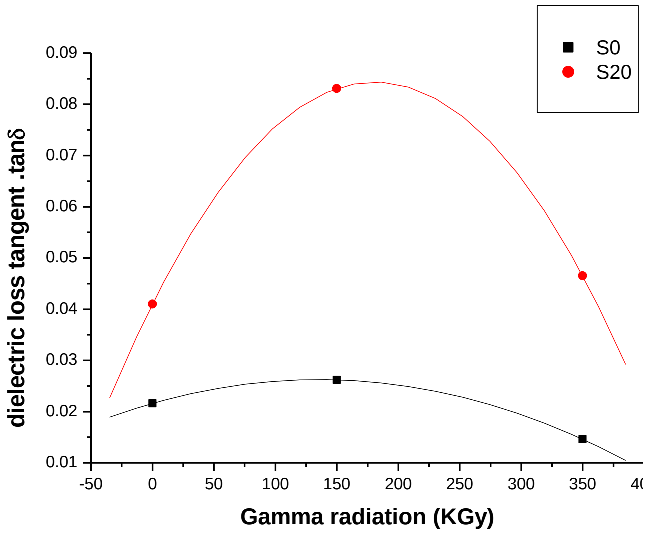

Fig.7 .Variation of dielectric losses of S20 and S0 with deferent gamma doses at 10^6 HZ

Figure 7, shows that dielectric loss $tan\delta$ of S20 is better than $tan\delta$ of S0 with increasing absorbed radiation till 150 KGy and after that is decreasing but still the results of S20 is better than S0 .

CONCLUSIONS

The results show that:

1. *Gamma radiation is considerable effect on dielectric properties for all samples.*
2. *The enhanced of dielectric properties of S20 is better than S0*
3. *The dielectric constant (ε') of S20 at 150KGy increases by 34% than un-irradiated S20 .*

   Then (ε') of S20 at 350KGy increases by 20% than un-irradiated S20 .
4. *The ac conductivity of S20 at 150 KGy increases by 97% than the value of un-irradiated S20. Then* σac *of S20 at 350 KGy increases by 10% than the value of un-irradiated S20.*
5. Dielectric loss $tan\delta$ of S20 at 150 KGy increases by 100% than the value of un-irradiated S20. then $tan\delta$ of S20 at 350 KGy increases by 13% than the value of un-irradiated S20
6. The ac conductivity of S20 increases with increasing the frequency and gamma irradiation.
7. All the results of the real permittivity values (ε') imagine permittivity(ε''), the dielectric loss tangent ($tan\delta$), and ac conductivity (σ_{ac}) for all samples are enhanced at 150KGy, and decreasing at 350KGy but still better than an irradiated samples.

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