고밀도 폴리에틸렌에 있어서 전계의 세기의 영향

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Pigment Influence in High Density Polyethylene Electrical Strength

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Abstract : In this work, the TiO2 pigment influence in HDPE dielectric strength was analyzed. Chemical and structural characterizations were made to identify changes during the processing and your influence in the electrical properties. Formulations containing 0, 0.5, 1, 2.5, 4 and 6 of titanium dioxide were processed by extrusion and injection molding with stabilization -antioxidants, ultraviolet stabilizers and plasticizers. The electrical strength tests were analyzed by the statistical distribution of Weibull, and the maximum likelihood method. The high concentrations present lower values to electrical strength. The parameter could be using to insulator particles dispersion. The TiO2 concentration variation shows that these incorporations implicate strength values increase has a maximum (5,35MV/cm). High pigment concentration induces a little falls in property values. Observing the parameter, minimum experiment electric field (Ebmin) and electric strength value, found that the best electric perform formulation was the formulation with 2.5% TiO2 weight.

Key Words : HDPE, Pigment, Electrical strength, Structural Characterization

1. Introduction

Polymeric materials will be using like electrical insulations, mainly in the substitution of the ceramic materials either electrical energy distribution. The insulators need to be good electrical, chemical and mechanic performance. It is necessary that use agents to auxiliary the material life increasing - antioxidants, ultraviolet stabilizers and plasticizers. The most important propertythat characterizes the electrical performance is the electrical strength that means maximum voltage per thin unity without fail. This property is influenced by chemical composition, structure and microstructure, experimental conditions like temperature, tension application time, and sample and electrode geometry, ambient, etc. [1-2]

Following the literature [1-3] the physics and morphological factors are that contributes to the polymers dielectrical rupture but these are influenced by chemical factors. The combination these factors implicate in the studies to understand the polyethylene electrical characteristics. In the literature have contradictions information about the material additivation the titanium dioxide. For LDPE, KHALIL and co-workers [4] showed that the TiO2 induce a decrease to dielectrical strength. Others works [5, 6] show that this pigment auxiliate in the increase to electrical strength. UEKI [3] showed that the pigment dispersion is a factor that has an influence in the electrical strength.

2. Experimental

The high-density polyethylene, HDPE, in form of powder without pre-stabilizers was supplied by Ipiranga Petroqumica S.A. (Brazil). It has a melt flow of 0.01g/min and density of 0.952 g/cm3. Several HDPE formulations were prepared using the HAAKE system at 150C with different percentages -from 0 to 6%, of titanium dioxide, TiO2 (from TIBRAS - Brazil), the antioxidant (AO) IRGANOX B215 from CIBA-GEIGY (0.2% in weight), the UV stabilizer (UV) TINUVIUM from CIBA-GEIGY (0.2% in weight) and the plasticizer magnesium stearate (MgEst) from HERZOG (0.02%). The formulations were incorporated into pure HDPE by a twin-screw extruder and after that chopped. The formulation above described is usually employed for the use of polyethylene in electrical applications. Samples with thickness of about 50 m were molded by pressing the polymeric material between hot plates (180 C) under 25 kN of applied force (2.5 ton).

3. Results and Discusion

COPARD [7] and UEKI [3] had related the value with the conducers' particulates in the polymeric matrix. They found that high values indicate a best particulate dispersion. UEKI had observed that this relation were most definite when the distribution was calculated by graphic method. The Figure 1 shows the relation with .E in the studied formulations. When the value is analyzed is possible identify that the formulations F4, F6 e F9 have the highest value. It is possible observe in the Figure 1 that both methods, the value has a tendency to increase with E decrease. This doesn't happen with the formulation F7 that is out of this tendency for both methods. The difference in the and .E behavior can be understood because the rupture mechanisms are different when comparated with formulations with carbon black (conductor) instead of titanium dioxide (insulator). From result of Figure 4 can be affirm that, independent of the method, the value can be used to measure the TiO2 dispersion in the polymeric matrix. Comparing the value with OIT results is possible to observe that high value has a good additive dispersion and this fac

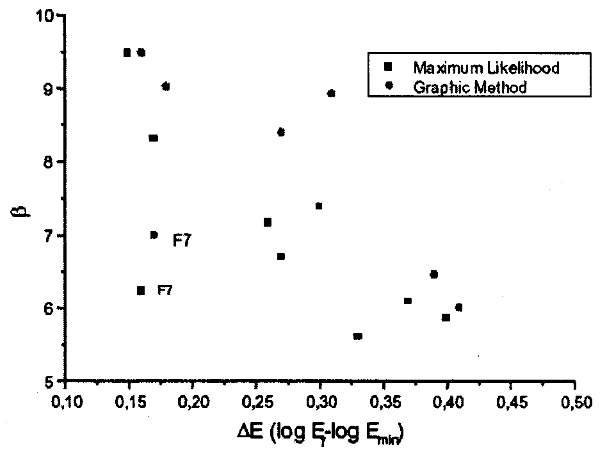

Fig. 1. Relation between and (log E-log Ebmn) for the formulations.

4. Conclusions

The tested samples showed good dielectric strength value, producing results for the maximum likelihood method and linear regression method. The value didn't change significatively with the different additive incorporation and the highest value was to 1% TiO2 in weight. The parameter, showed coherent values and it can be used to describe the particulate dispersion in the polymer. It was observed a tendency in the decreasing value with an increasing E value. The Ebmin value increased with the TiO2 additive in the formulations. So the reability was increased until 4% in weight. Analyzing the data, it is possible to determinate that the formulation F6 was the best electric performance because it has a high Ebmin value and the value showed that the particulate dispersion is good and this sample has a low dispersion experimental data.

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References

[1] Ieda, M., IEEE Transaction on Electrical Insulation, Vol. EI-21, n3, p.206-224, June (1980).

[2] Phillips, P.J., IEEE Transaction on Electrical Insulation, Vol. EI-13, n2, p.69-81.(1980)

[3] Ueki, M. M., Zanin, M. , IEEE Transaction on Electrical Insulation, EI-15, N5, p. 382-388,(1999).

[4] Sandra Ieee Transactions On Dielectrics And Electrical Insulation Vol. 11 (5) p.855-860 (2004).

[5] Khalil, M., S., Zaky, A, A, Hansen, B., S., IEEE Conference on Electrical Insulation on Dielectric Phenomena, p. 143-148, (1985).

[6] Kolesov, S., N., IEEE Transaction on Electrical Insulation, EI-15, N5, p. 382-388, (1980).

[7] Coppard, R., Bowman, J., Dissado, L., A, Rowland, S., M., Rakowski, R., T., Journal of Physics D: Applied Physics, Vol. 23, p. 1554-1561, (1990).