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Review Article

Creep and Mechanical Properties of LDPE Multilayer Films Used as Warmhouse Covers

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ABSTRACT

The purpose of this study is deteriorating effect of natural ageing on tri-layer and mono- layer polyethylene films, used as glasshouse cover in the North Africa environment. The films were handed out by Agrofilm and composed of low denseness polyethylene (LDPE), holding admixture (e.g., color, infrared and ultraviolet stabilisers). Those films were used to strengthen and set up a real glasshouse situated in the northern of Algeria. The influence of growing old was, controlled by watching the modifications in mechanical (robustness and flexibility) features. The study has been conducted during a period of nine months of natural ageing. The films have been spontaneously matured and grow older. The results display that the environmental components have deteriorating effects on the sustainability and all properties mechanical of the polyethylene film. The study illustrate clearly that the degradation parameters evaluated are directly linked to standard for estimating the efficiency of using warmhouse farming. The consequence of temperature and UVA radiation generated the most significant degradation on the film surface and accordingly a decrease in the whole life existence of the material. The results revealed that the investigated climatic conditions have essential deteriorative effects on the performance of the film. The correlation between the modification in the material structure and the degradation in the film properties is discussed.

Keywords: LDPE; Mono-layer and tri-layer films; Ageing; Degradation

INTRODUCTION

Weak intensity of polyethylene LDPE is one the most employed materials in plasticulture and its utilization as agricultural warmhouse covers is common applic ation. The principle characteristics that have granted its success are especially its illuminance and clarity. However, despite its good chemical inertness, polyethylene all organic substances degrade slowly under the combined influence of heat, solar ultraviolet (UV) radiation, mechanical stress, and chemical agents [1-3]. Low intensity polyethylene LDPE is actually the most worldwide known warmhouse covering material in the countries of the Saharan region. They point out of LDPE film to atmospheric conditions, such as solar beams in the range of 290-400 nm, damage its chemical formula and consequently its mechanical and Physical properties [4]. The influence of different effects and multiple ageing determinants on the degradation of the film are usually controlled by calculating specific critical properties of the mechanical. Chemical adjustments in the PE polymer constraction can justify the degradation mechanisms. Changes in selected properties (e.g. mechanical physical and chemical) can be used to monitor the evaluation of ageing. So far, the principle property employed by industry for characterizing the degradation of PE is the elongation at break. According to relevant international standards, a lowering below the limit of 50 % [5,6]. They have demonstrated that molecular orientation during film blowing influences tensile properties and are higher in the direction of the covalently bonded carbon-carbon chain than in the crosswise path that is dominated by weaker vander bonds. Environment conditions such as solar rays , temperature, humidity, rain, snow fall and other environmental pollution influence ageing and mechanical properties of LDPE warmhouse covers [7,8]. Deterioration attitude of mono-layer LDPE films employed as glasshouse or so called conservatory house covers has been studied by lot of authors. However, the degradation behavior of

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multi-layer films is very lacking. Few studies, have considered the effect of ageing in the North–Africa climatic conditions [9]. In our study, the effects of ageing on the mechanical properties and comportment of a film made of tri-co-extruded layers of LDPE in a tough and severe environment of changeable temperature and UV radiation are investigated. The exposure has been performed over a time period ranging and from 0.0h to 6480 h (9 months). This study could be expanded to cover more areas with different environmental conditions to establish a generalized standard.

MATERIAL AND METHODS

Material Two different films (mono-layer and three co-extruded layers LDPE), developed and provided by Agrofilm SA (Setif-Algeria), were employed in this study. Using tri-layers coextrusion technology. The total size of the three co-extruded layers film is 180µm with the proportions of ¼, / ½, and ¼ in the layers. The raw LDPE (before extrusion) has density of 0.923 g/cm3 and the average molecular weight is in the range 90000-120000. The melt flow index (MFI) of the raw LDPE is 0.33 g/10min and the MFI with stabilizer is 10g /10min. The primary color of the film is milky yellow. The real structure of the film is not known (Kept confidential by the supplier). The usually used warmhouse cover is made from a mono-layer film with 180 µm, same as the overall width of the tri-layer LDPE film. It has been demonstrated from the supplier that selfsticking between the three coextruded layer happens under an extrusion temperature of 70°C.

Exposure protocols

Climatic conditions undergone by the roof are displayed in north Algeria.

Table1.The weathering condition was usually typical in North Algeria. Table1.The power emitted and the average temperature /moisture during ageing. Two warm houses have been built specially for studying the impact of the natural ageing on the performance of the LDPE cover .Samples have been taken every month over a duration time of nine months. To ensure the data reproducibility, large square samples of 30cm sides were cut, at each ageing period, from the cover from which sufficient test samples were prepared to conduct the experiments required. The Tensile tests (creep) The creep comportment of polyethylene films is mainly controlled by distortion of the amorphous phase, which itself affected by the numerous crystallinity and the tautness of the tie molecules. Using agricultural compounds to produce structural building outcome, often demand enhancement of their mechanical properties, especially the creep efficiency .Previous studies in the field revealed that the creep of agricultural compounds differ with the type and content of matrices, coupling treatment, where the relative performance of the fiber-matrix interface is significant compared with the viscoelastic of the compound.

RESULTS AND DISCUSSION

Creep-recovery behavior The creep test performance of the unblemished /pure and naturally aged films (up to a period of 9 months) was examined by assessed the creep-recovery test. The load was applied on a specimen in a direction parallel to the average molecular orientation obtained during the film processing [14]. The recovery starts immediately after the stress removal and for a period of 24h as well. The creep-recovery behavior was calculated for different exposure time (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 months) in figure 1.

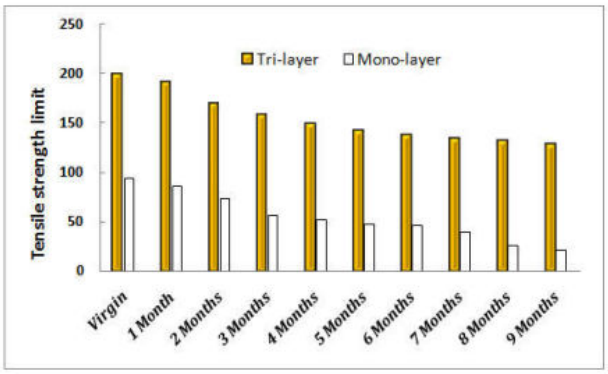

Figure 1: Total strain curves of monolayer and tri-layer films at different ageing periods.

The performance of a polymer during disclosure to rude environments can be highly intensified by adding the photostabilizing additives such as ultraviolet absorbers, quenchers, free radical scavengers. Hindered amine as photostabilizers, HALS and ultra violet absorbes (UVA) are frequently employed. Stabilizers pevent oxidation and so its negative effects on the average molecular weight and therefore the drop of the mechanical properties. Gachter et al.

Figure 2 presents the variation of modulus of elasticity while growing elderly. Such deterioration in the mechanical comportment of the mono-layer and tri-layer films of LDPE is due to the modification emerging with ageing in the molecular structure of the material. Polymeric molecules are huge, on the molecular scale, and their unique valuable characteristics are entirely a result of their size. Any damage in chain length decreases the tensile force and became a cause of permature failure. The progressive changes in the molecular structure due to ageing do not permit the polymer chains to redesign as before and lay down additional resistance following the initial of the material.

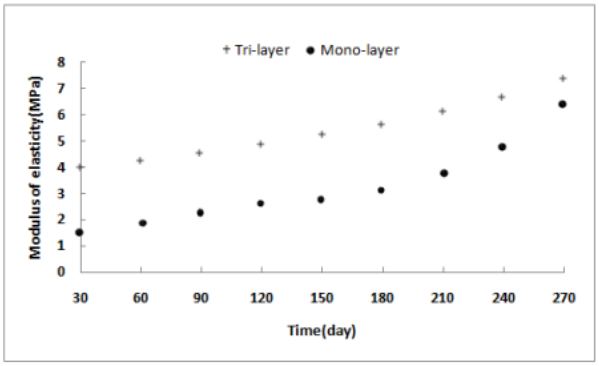

Figure 2: The variation of modulus of elasticity with ageing time.

Test d'anova Figure 3 presents the variation of the modulus of elasticity during the growth of the aging of the mono-layer and tri-layer film. Such a deterioration in the mechanical behavior of singlelayer and tri-layer LDPE films is due to the modification appearing with aging of the molecular structure of the material.

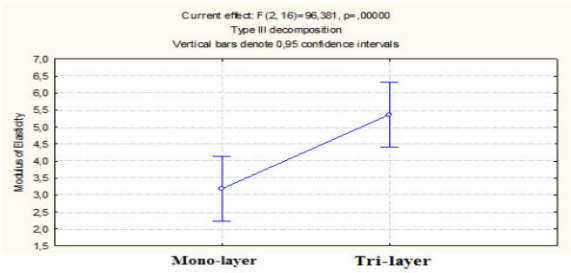

Figure 3: The variation of the modulus of elasticity during the growth of the aging of the mono-layer and tri-layer film.

Table1: Univariate tests of significance for modulus of elasticity over-parameterizes model type 3.

	SS	Degr of Freedom	MS	F	P
Film	3,507,983	2	1,753,991	9,638,102	0
Error	291,176	16			

Anova one way: comparison between mono-layer and tri-layer: highly significant difference (p=0.0000)

There is a highly significant difference between mono-layer layer and tri-layer film (p=0.000). In fact, tri-layers have a very high modulus of elasticity, compared to that of singlelayer.

Table2: Correlations marked correlations are significant at p<,05000 N=9(Case wise deletion of missing data).

	T(℃)		H(%)		Mono-layer		Tri-layer	
	r	P-value	r	P-value	r	P-value	r	P-value
T(℃)	10,000	-	-9,565	0	-7,714	15	-7,760	14
H(%)	-9,565	0	10,000	-	8,430	4	8,694	2

r:Correlation coefficient, p:Meaning

The correlation matrix analysis shows a negative and significant relationship between the modulus of elasticity and the temperature in films.However a positive and highly significant relationship is recorded between the modulus of elasticity and moisture in mono-layer and tri-layer films.

CONCLUSION

The effect of natural elderly growth on the specifics features of mono-layer and trilayer LDPE film employed as a warmhouse roof has been investigated. The most breakdown deterioration in the mechanical characteristics (modulus of elasticity, fracture stress and elongation at break) has been measured. The study reveals that natural ageing of the film in North-Africa is almost equal to a ageing at 40°C. Further, the sunlight radiation is a principle element of degradation and the anti UV additives are not optimized in this film. The combined effect of the temperature and UV-A radiation decrease the life time significantly.

REFERENCES

1. Mourad A.-H. I, Thermo-Mechanical Characteristics of Thermally Aged Polyethylene / Polypropylene Blends, Materials and Design.
2. Mourad A.-H. I, Bekheet N, Al-Butch A, Abdel-Latif L, Nafee D and Barton D C, The effects of process parameters on the mechanical properties of die drawn polypropylene, Polymer Testing.
3. Abdelkader Dehbi, Khaled Djakhdane, Abdel-Hamid I. Mourad Impact of Degradation of Polyethylene Films under Simulated Climatic Conditions on their mechanical behaviour and thermal stability and lifetime.
4. D. Briassoulis and A. Aristopoulou: 'Adaptation and harmonization of standard testing methods for mechanical properties of low-density polyethylene (LDPE) films', Polym.
5. Briassoulis and A. Aristopoulou: 'Document 249/SC 9 N of CEN/TC 249', 2002, Brussels, European CommitteeforStandardization.
6. A. Dehbi, A.-H. I. Mourad and A. Bouaza: 'Degradation assessment of LDPE multilayer films used as a warmhouse cover: Natural and artificial aging impacts.
7. Gruenwald G. Plastics: how structure determines properties. Munich: Hanser Publishers.
8. M Aouinet, K Djakhdane, A Dehbi, D Castronuovo and P Picuno Performance of multilayered LDPE filmsusedaswarmhousecover in semiarid climate.
9. Youssef B, Benzohra M, Saiter J.M, Dehbi A, Hamou A. Ageing Characterization to Determine the Life Duration of Different LDPE Based Devices Used for Warmhouse.
10. F. Henninger and E. Pedrazetti: 'Aspects of warmhouse film stabilization', Plasticulture.
11. K. Djakhdane, A. Dehbi, A-H. I. Mourad, A. Zaoui& P. Picuno The effect of sand wind, temperature and exposure time on tri-layer polyethylene film used as warmhouse roof.
12. Acha BA, Reboredo MM and Marcovich NE. Creep and dynamic mechanical behavior of PP–jute composites: effect of the interfacial adhesion.
13. Sain MM, Balatinecz J and Law S. Creep fatigue in engineered wood fiber and plastic compositions.
14. M Aouinet, K Djakhdane, A Dehbi ,D Castronuovo and P Picuno Performance of multilayered LDPE films used as warmhouse cover in semiarid climate Journal of Elastomers & Plastics
15. Meriam Imane Babaghayou et al. Photodegradation characterization and heterogeneity evaluation of the exposed and unexposed faces of stabilized and unstabilized LDPE films 29 August 2016.
16. R. Gachter, H. Muller, Plastics Additives Handbook, Hanser Publishers, Munich, 1985
17. W.D. Callister, Materials Science and Engineering: An Introduction.
18. Abdelkader Dehbi, Abdel-Hamid I. Mourad, Khaled Djakhdane, Ali Hilal-Alnaqbi Degradation of Thermomechanical Performance and Lifetime Estimation of Multilayer Warmhouse Polyethylene Films Under Simulated Climatic Conditions Polymer Engineering And Science.
19. Josef Ludeschera , Armin Bundea , and Hans Joachim Schellnhuberb,c,1 Statistical significance of seasonal warming/ cooling trends Contributed by Hans Joachim Schellnhuber..