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DEVELOPING BIO-DEGRADABLE LOW-DENSITY POLYETHYLENE USING CELLULOSE AS ADDITIVES IN THE CLIMATE CONDITION OF BANGLADESH

Dr. Ruhul Amin[1*] and Shahina kader[2]

[1]Associate professor, Bangladesh University of Engineering and Technology, Dhaka-1000, Bangladesh, Email: ruhulaminbuet@gmail.com
[2]Department of Chemical Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh Email:sk.ama100502@gmail.com
*Corresponding author: Dr. Ruhul Amin; Email: ruhulaminbuet@gmail.com

Abstract*- Low density polyethylene is widely used in packaging, agricultural product, healthcare and other applications. They are very recalcitrant and remain inert to degradation and deterioration to their accumulation in the environment, therefore creating serious environmental problems. The development and the use of degradable plastic can sort the problem. This research is representing the improvement of the biodegradability of the polythene by adding cellulose in different proportion. Hybridizing plastic films were prepared by the premixing the film grade polythene pellets with 0, 5 to 10% of cellulose additives with a controlled temperature between 180°C to 250°C in an extruder machine and turned into a film by Hydraulic press. The mechanical strength of the soil polymer films was measured by Tensile Testing Machine and observed that the addition of cellulose decreases mechanical strength of polyethylene. Observation is carried out to determine the film tensile strength* in a *basic medium that effect on the film. Finally, the weight loss of hybridized cellulose-polymer increases with increasing the addition of cellulose.*

Keywords: Degradation, polyethylene, additive, cellulose, mechanical strength.

1. INTRODUCTION

Plastic is a word that originally meant ‘easily shaped or molded’. It only recently became a name for a category of materials called polymers. The word polymer means “a substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g., many synthetic organic materials used as plastics and resins.” Polymers are made of long chains of molecules. Polymers abound in nature. Cellulose, the material that makes up the cell walls of plants, is a very common natural polymer [1]. Over the last century and half humans have learned how to make synthetic polymers? Synthetic polymers are made up of long chains of atoms, arranged in repeating units, often much longer than those found in nature. It is the length of these chains, and the patterns in which they are arrayed, that make polymers strong, lightweight, and flexible. In other words, it’s what makes them so plastic [2]. These properties make synthetic polymers exceptionally useful, and since we learned how to create and manipulate these, polymers have become an essential part of our lives. Especially over the last 50 years plastics have saturated our world and changed the way that we live [3]. There is a need of about 300 million metric ton plastic products around the world. This is certainly a huge number. The main challenge that plastic products throw at us is that plastics are not easy to get disposed of. The residue of plastic products can cause serious environmental pollution, so this is a matter of serious concern [4]. For easier disposal of plastic products environment friendly plastics can be brought into action. These environment friendly plastics can be classified as (i) Bio-plastics: Made from natural materials such as corn starch, cellulose etc. (ii) Biodegradable plastics: Made from traditional petrochemicals, which are engineered to break down more quickly. (iii) Recycled plastics: which are simply plastics made from recycled plastic materials rather than raw petrochemicals [5]. Degradable plastics can be made by adding different kinds of additives. Cellulose is the most abundant natural polymer on earth, constituting a virtually inexhaustible source of raw material for creating environmentally friendly and biocompatible products that do not compete with the food chain as well as the main component in plant tissues [6,7] So cellulose can use as the additive to LDPE (Low-density polyethylene) for making degradable plastic. The addition of additives are justified when the useful life of the plastic remains sufficiently long, the mechanical properties are not declined and the disintegration of the product after its useful life occurs in a short time frame (6 to 12 months). In this study, we investigate the influence of cellulose on the degradation behavior of plastic films prepared by mixing the film grade polyethylene pellets with different amounts of cellulose.

2. MATERIALS AND METHODOLOGY

2.1 Materials

The film grade low density polyethylene obtained from SABIC, Saudi Arabia and biodegradable additives cellulose is collected from Bangladesh.

2.2 Sample Preparation

Plastic films were prepared by first premixing the film grade polyethylene pellets with cellulose additive. Additive loadings were 0, 5 and 10 percent mixed with pure polyethylene. Subsequently, the mixer was fed to an extruder to produces the film.

Extrusion and Processing Condition: The blend mixture of cellulose and polyethylene is then kept into the screw extruder. The temperatures of the heating zones were set at 160°C and 250^{o}C.

2.3 Degradation Studies of Cellulose Mixed LDPE in Soil

The degradability of the films in soil was determined in this study. The films were buried in soil. The films were buried for three months and samples were drawn at regular intervals and evaluated for degradation. Samples were taken out from soil and then weight and mechanical properties were measured.

Figure 1: Sample being buried in Soil for Degradation Studies.

Figure 2: Samples taken out from soil for measuring weight and mechanical properties.

2.4 Degradation Studies of Cellulose Mixed LDPE in NaCl and NaOH solution

Chemically assisted degradation was also studied in this project. 5% and 10% solutions of both NaCl and NaOH were prepared. Samples were put into separate bottles for a period of two months and they were taken out after 30 and 60 days for measuring weight and mechanical properties for degradation studies.

Figure 3: Samples kept in NaCl and NaOH solution containing bottles.

Figure 4: Sample in NaOH solution.

2.5 Sample Analysis Methods

- Weight Measurement at regular intervals of 30 days
- Measuring mechanical properties by Tensile Testing Machine

Weight Measurement: At first initial weight was measured before burying the samples in soil and before placing it in NaCl and NaOH solutions. These samples were taken out at a regular interval of 30 days and weights were measured again. From these data loss of weight in percentage was measured.

Measuring mechanical properties by Tensile Testing Machine: Tensile strength was measured by Tensile Testing Machine.

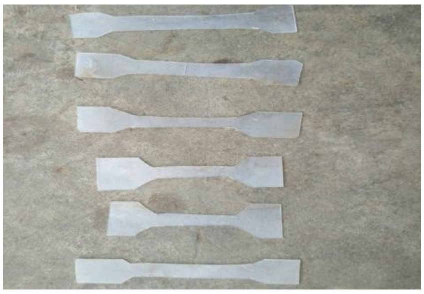

Figure 5: Samples Prepared for measuring tensile strength.

3. RESULTS AND DISCUSSION

3.1 Weight Loss Comparison

From the figure 6, it can be seen that the percentage loss of weight of the samples increases with the addition of Cellulose. As time went by, more degradation in weight took place.

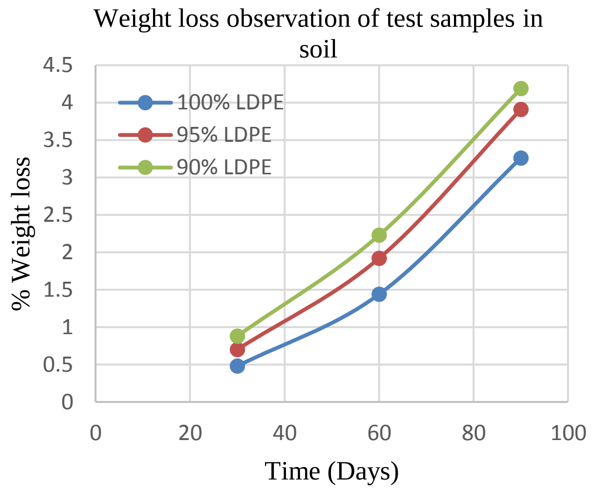

Figure 6: Relationship between % weight loss and composition with time in soil

3.2 Weight Loss Observation of Test Samples in 5% and 10% NaCl Solutions

From the figure 7, we can see that, the percentage weight loss of samples increases with both the percentage of cellulose in the sample and the concentration of NaCl solutions. The value of percentage of weight loss ranges from 0.3% from almost 3% for various compositions of cellulose and concentrations of NaCl solutions.

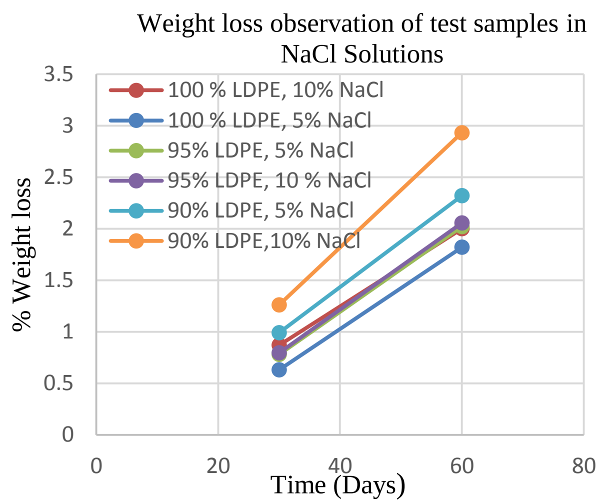

Figure 7: Relationship between % weight loss and composition in NaCl solutions

From the figure 8, it can be said that, the percentage weight loss of samples increases with both the percentage of cellulose in the sample and the concentration of NaCl solutions. The value of percentage of weight loss ranges from 0.25% from almost 2.1% for various compositions of cellulose and concentrations of NaOH solutions.

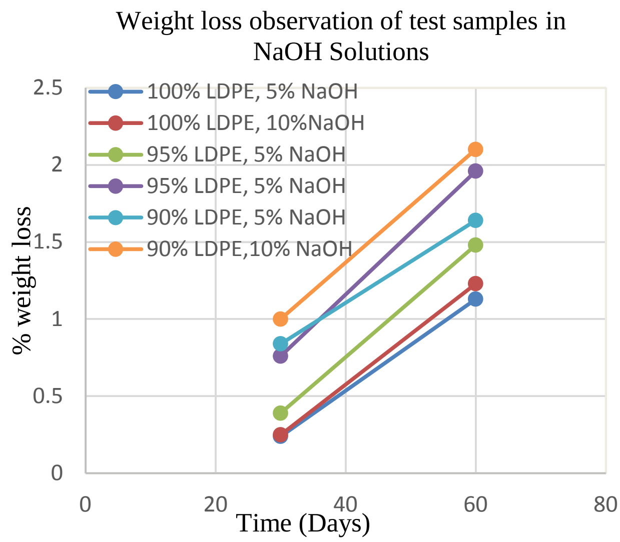

Figure 8: Relationship between % weight loss and composition in NaOH solutions

3.3 Comparison of Change in Tensile Strength

It is clear from the graph above that Tensile Strength keeps on decreasing with additional percentage of cellulose. Pure LDPE shows the highest tensile strength whereas 90% LDPE shows comparatively lower strength. For a specific composition of cellulose the strength kept on decreasing with time. For 95% LDPE sample the value of tensile strength decreased from 6.78 to 6.35 MPa from day 0 to day 90.

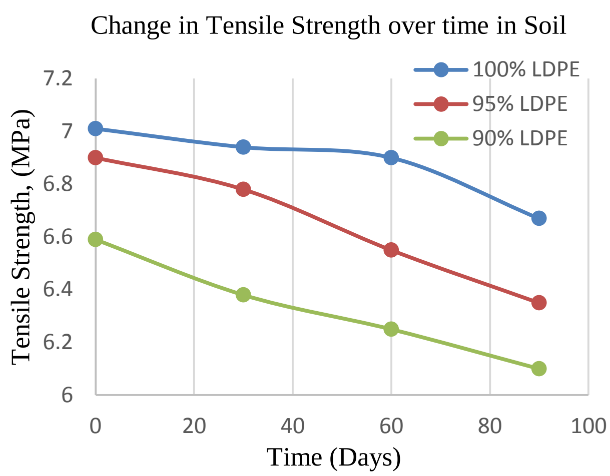

Figure 9: Relationship between Tensile Strength and composition with time in Soil

3.4 Change of Tensile Strength over Time in 5% NaCl Solution

For 100 % LDPE the value of tensile strength remains almost unchanged in 5% NaCl solution. But for 95% and 90% LDPE the value of Tensile strength keeps on decreasing with time. For 90% LDPE sample the value was initially 6.79 MPa and after 60 days it became 6.39 MPa. This change is quite significant.

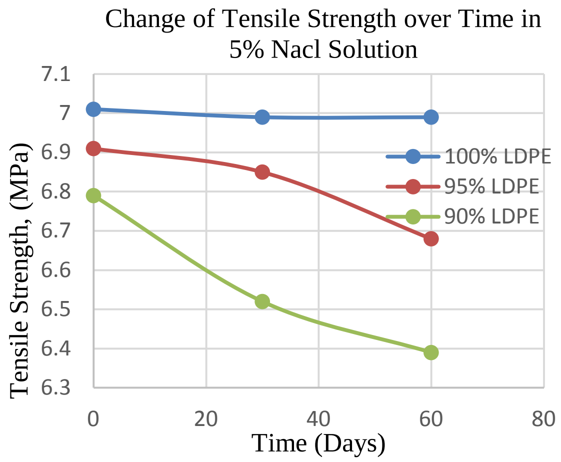

Figure 10: Relationship between Tensile Strength and composition with time in 5% NaCl solution

3.5 Change of Tensile Strength over Time in 10% NaCl Solution

For 10% NaCl solution all of the samples lost their tensile strength over time. But comparing with the graph for 5% NaCl solution, 95% LDPE sample shows quite irregular change.

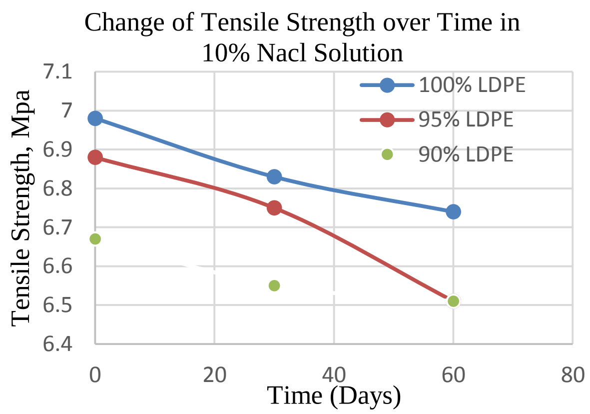

Figure 11: Relationship between Tensile Strength and composition with time in 10% NaCl solution

3.6 Change of Tensile Strength over Time in 5% and 10% NaOH solution

From the below two figures, we can see that the change in concentration of NaOH solution have little effect on the change of tensile strength.

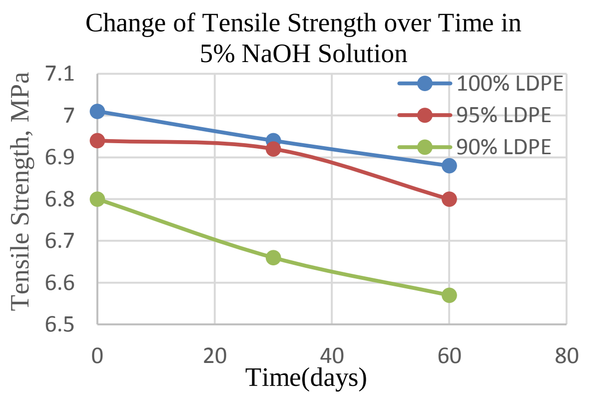

Figure 12: Relationship between Tensile Strength and composition with time in 5% NaOH solution

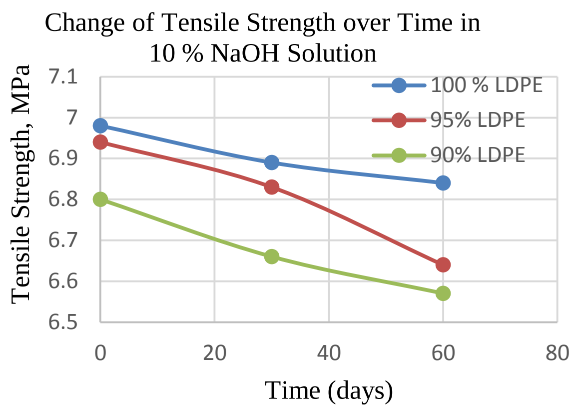

Figure 13: Relationship between Tensile Strength and composition with time in 10% NaOH solution

4. CONCLUSION

Cellulose is a naturally and commercially available material which appears to be a promising source from fibre for the production of degradable plastic. The main drawback involved in the use of this cellulose-polyethylene mixture lower mechanical strength and higher the degradation with respect to the pure polyethylene. The degradation of the cellulose-polyethylene plastic was observed in soil, NaCl and NaOH medium and observed that the an increasing addition of cellulose increase the extent of degradability. the film tensile strength is also slightly affected by the a basic medium and decrease with increase of cellulose content in polyethylene. However, It has been demonstrated that good reduction of mechanical properties and strength of polymer resulted as increasing amount of cellulose in polymer.

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5. REFERENCES

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