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Mechanical and Optical Properies of Poly Lactic Acid Modified Linear- Low Density Polyethylene / Low Density Polyethylene (Lldpe/Ldpe) Blend Blown Film

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Abstract **-** Poly lactic acid (PLA) is well known aliphatic poly-esters derived from corn and sugar beets, and degrades into nontoxic compounds in landfill. Melt blending of poly lactic acid and linear low density polyethylene (LLDPE) was performed in an effort to toughen polylactic acid. Melt blending of linear low density polyethylene (LLDPE) and polylactic Acid (PLA) and Low density poly ethylene (LDPE) were performed in a twin screw extruder with post extrusion blown film. The blend compositions were optimized by mechanical properties. On the basis of this, LLDPE 80 wt % LDPE 20 wt% and 1-4 wt% poly lactic acid (PLA) were found to be an optimum composition. The blends were characterized according to their mechanical and optical behavior. This blend may be used for packaging application.

Keywords **-** *PLA/LLDPE/LDPE Blend, Mechanical properties, Melt blending.*

I. INTRODUCTION

The introduction of a new class of polyethylene, linear low density polyethylene (LLDPE), gives the possibility of obtaining a new class of blends (LDPE/LLDPE) that are easily processable with good mechanical properties. Owing to the good process ability, flexibility, and extensibility of low-density polyethylene (LDPE) and advantageous mechanical performances of linear low-density polyethylene (LLDPE), a number of studies on the structure property of LDPE/LLDPE blends have been conducted. In recent years, blends of various polyolefin have received more attention for two main reasons. Firstly, polyolefin's form most of the plastic waste and their recycling leads to mixtures without separation. 'Secondly, blends of polyolefin provide new materials with tailored properties for specific end use application several studies have been performed to investigate the main properties of such blends.

There is very limited available information on the mechanical properties regarding tensile strength, Dart Impact test, Tear resistance test, Burst strength test and Gas permeability test of PLA modified LLDPE/LDPE blend. In this paper, PLA modified LLDPE/LDPE blend is developed and analyzed.

EXPERIMENT DETAILS:

Material used

- LLDPE blown film grade (SABIC LLDPE 118W, Density-0.918gm/cc, MFI-1gm/10min)
- LDPE general purpose film grade (RELENE-24FS040, Density-0.922 gm/cc, MFI-4 gm/10 min.) Manufactured by Reliance Polymers.
- PLA Sheet extrusion grade (REVODE-101, Density 1.25gm/cc, MFI-2-10 gm/10min.) Supplied by HISUN.

PREPARATION OF LLDPE/LDPE/PLA BLEND:

The linear Low Density polyethylene (LLDPE), Low Density Polyethylene (LDPE), and Poly lactic Acid (PLA) were delivered in the form of pellets. PrimarilyLLDPE, LDPE and PLA were dried in an air circulating oven at 40 °C for 6 hours prior to blending in order to remove moisture before processing. The basis of composition was based on the percentage weight ratio between LLDPE, LDPE and PLA (Table-1). Later these blends were melt blended in a BERSTORFF High Performance co-rotating twin-screw extruder(ZE-25). The dia meter of the screw was 25 mm and the ratio of the length to the dia meter (L/D) was 48 at a speed of 200 r.p.m. and the temperature profile performed during

compounding of all blends was 160/170/180/190/ 200/210/220 ^{o}C for the barrel zone temperatures. (Table-2). The extruded strands were air-dried and pelletized. After the blending of polymer blown film were prepared by mono layer blow moulding machine.

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Blend formulation	**LLDPE (wt %)**	LDPE (wt %)	**PLA (wt %)**
LLDPE/LDPE(80/20)	80	20	0
LLDPE/LDPE/PLA (80/20/4)	80	20	4
LLDPE/LDPE/PLA (80/20/8)	80	20	8
LLDPE/LDPE/PLA (80/20/12)	80	20	12
LLDPE/LDPE/PLA (80/20/16)	80	20	16

Compounding Batch	**Extruder Temperature at different zone (^{0}C)**		**Screw Speed (rpm)**
1) LLDPE/LDPE(80/20) 2) LLDPE/LDPE/PLA (80/20/4) 3) LLDPE/LDPE/PLA (80/20/8) 4) LLDPE/LDPE/PLA (80/20/12) 5) LLDPE/LDPE/PLA (80/20/16)	Zone-1	160^{0}C	200
	Zone-2	170^{0}C	
	Zone-3	180^{0}C	
	Zone-4	190^{0}C	
	Zone-5	200^{0}C	
	Zone-6	210^{0}C	
	Zone-7	220^{0}C	

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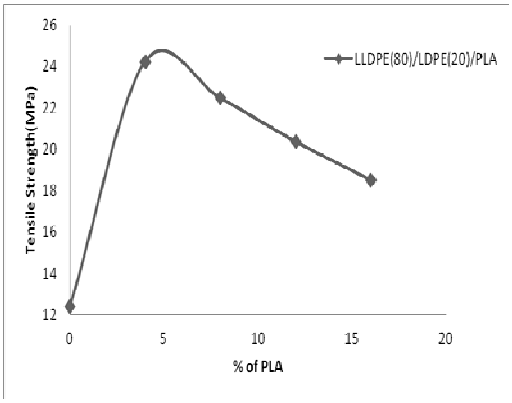
RESULTS AND DISCUSSION:

MECHANICAL PROPERTIES

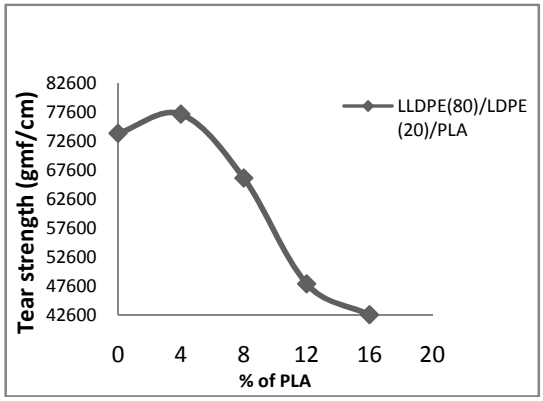
TENSILE PROPERTIES:

From Table-3, The Tensile properties of LLDPE/LDPE/PLA blend's film at different composition are shown in Table-1. The tensile strength and Tensile modulus values of the LLDPE/LDPE/PLA blends showed a decreasing trend with increasing PLA content due to PLA was brittle in nature and acted as filler when it was dispersed in LLDPE. The slight decrement in the tensile properties was observed.



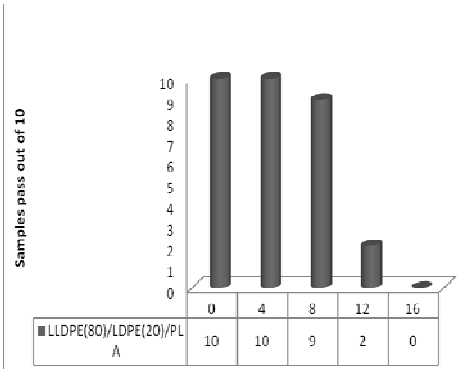
TEAR PROPERTIES:

The tear strength is determined by tear Impact tester. The maximum properties achieved (77333.3) on 4 wt % PLA was added in to the LLDPE/LDPE blend. The property trends show the decrement in the tear strength when increasing the PLA content (8wt % to16 wt %).



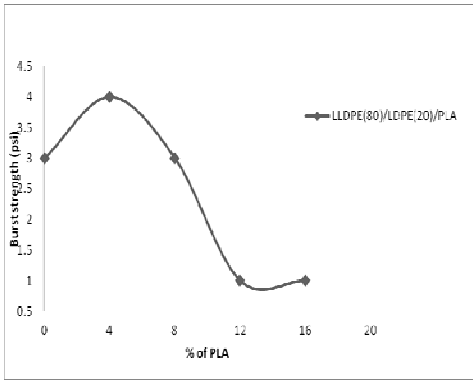
DART IMPACT PROPERTIES:

The dart impact strength determined by dart impact tester for film, neat blend's sample pass 10 out of 10 but adding the PLA content samples pass up to 8 wt% PLA content incorporated into blend due to rigidness of blend film.



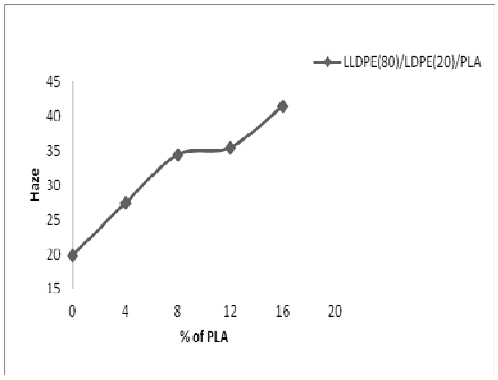
BURST STRENGTH TEST

The burst strength of the LLDPE/LDPE/PLA blend was maximum (4 psi) at 4wt % PLA incorporated in to the blend. The lowest value of the burst strength observed at 8 to 12 wt % PLA.The film of 12 to 16 wt % PLA in to blend, busted at 1 psi due to the interaction, chain entanglement, and stress-induced crystallization behaviour of PLA with LLDPE/LDPE blend during post extrusion blown film in melt blending.

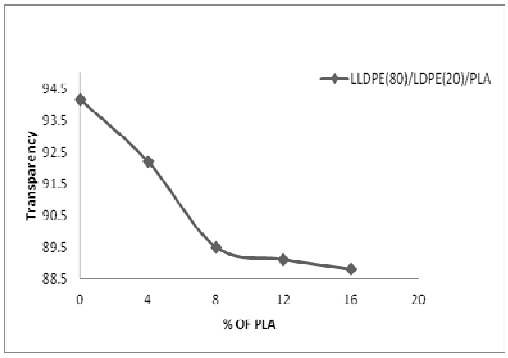


OPTICAL PROPERTIES:
HAZE PROPERTIES

Haze properties determined by Haze tester. The Haze properties were increase with adding of PLA content. The maximum properties achieved (41.4) at 16 wt % PLA incorporated In to the blend due the opaque nature of the PLA .The neat polymer blend (LLDPE/LDPE blend) has lowest (19.8) haze properties.



TRANSPARENCY: Neat LLDPE/LDPE blend has highest transparency (94.17) but adding the PLA content in to the blend, transparency was decrease linearly due to the least transparency of PLA.



CONCLUSION:

The LLDPE/LDPE/PLA polymer blends were prepared at melting conditions in a twin screw extrusion mixer and then after a post extrusion blown film extruder. The mechanical properties of the polymer blends depended on the component polymer ratios. Among the Investigated samples, the polymer blend had the optimum tensile strengths at 80/20/4 (LLDPE/LDPE/PLA).

The mechanical and optical properties concluded at different formulation of LLDPE/LDPE/PLA blend as following manner:

[1] Tensile properties significantly improved at 4 wt% PLA incorporated into blend (80/20/4 LLDPE/LDPE/PLA). Properties decreased linearly 8 to 16 wt% when PLA added into blend.

[2] Dart impact strength has greatest properties obtained at 4 wt% PLA into blend.

[3] Tear strength properties shows similar trends as tensile strength, maximum properties achieved on 4 wt% PLA.

[4] Burst strength also show optimum properties at 4 wt% PLA incorporated into blend.

[5] Transparency and Haze both are important properties of film; this is cleared by observed result. Results were show relation between transparency and Haze properties. Maximum transparency achieved on neat polymer LLDPE/LDPE blend. Properties showed that transparency is decreasing when PLA % increasing into blend. Haze results showing opposite trends than transparency. Haze increasing with adding PLA content; maximum Haze observed at 16 wt% PLA into blend composition.

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