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Polyolefin blend

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Abstract—*The invention is directed to Polyolefin blend to study the effect of linear low density polyethylene (LLDPE) on mechanical and rheological properties of local homopolymer polypropylene . In the experimental study, five formulations of PP and LLDPE viz. 95/5, 85/15, 75/25, 65/35 and 55/45 Wt % were prepared for injection moulding machine. Then different tests were carried out such as tensile test as mechanical test and the melt flow index (MFI), Melt density of the blend has been determined as rheological test. Results obtained addition of linear low density polyethylene (LLDPE) to polypropylene in most cases decreased the tensile strength of polypropylene. Also obtained decreasing in melt density of the polypropylene material while melt flow index (MFI) is increased. The results showed improvement on the mechanical and rheological properties of polypropylene . The work recommends the optimum compound provided the good performance of PP/LLDPE blend is (65/35) weight ratio % respectively.*

Keywords— Polypropylene; LLDPE; Polyolefin, blend.

1. INTRODUCTION

Polypropylene (PP) compounds have been used in large quantities in numerous fields of applications for many years. The success of (PP) compounds lies in its extremely advantageous price/volume/performance relations, with the result that polypropylene composition successfully penetrates field traditionally occupied by other engineering plastic material such as (ABS) and nylon. Considerable efforts have been made to extend the application of polypropylene composition to fields where engineering thermoplastic have been used. Particularly in the automotive industry for the production of bumpers, heater housings, door pockets and trimmings, timing belt covers cladding. Other common fillers include Calcium carbonate, kaolin, mica and carbon black, while glass fiber is still one of the most commonly used fibrous reinforcements in polypropylene (Nor Azura Abdul Rahim et al., 2010). Khartoum Petrochemical Company (KPC) Sudan produces two grades of polypropylene homo polymer under ASTM standard those are extrusion grade (KPC_{113}) and injection grade (KPC_{114}). KPC Sudan products have been distributed into wide area including Sudan, Egypt, Ethiopia, Kenya and Syria etc. Hence polypropylene is inexpensive and available raw material for local market in Sudan. Sudanese polypropylene (PP) market demand in 2012 about 9329.2ton/month (3327 ton/month for extrusion grade and 6002.2ton/month for Injection grade). The domestic polypropylene plant (KPC) caters to local demand about 1500 ton/month (about 16.1%)and 7829.2 ton/month are imported from outside Sudan (83.9%).

LDPE and LLDPE have unique rheological or melt flow properties. LLDPE is less shear sensitive because of its narrower molecular weight distribution and shorter chain branching. During shearing process, such as extrusion, LLDPE remains more viscous and, therefore, harder to process than LDPE of equivalent melt index. The lower shear sensitivity of LLDPE allows for a faster stress relaxation of the polymer chains during extrusion, and, therefore, the physical properties are susceptible to changes in blow-up ratios. In melt extension, LLDPE has lower viscosity at all strain rates. This means it will not strain harden the way LDPE does when elongated. As the deformation rate of the polyethylene increases, LDPE demonstrates a dramatic rise in viscosity because of chain entanglement. This phenomenon is not observed with LLDPE because of the lack of long-chain branching in LLDPE allows the chains to slide by one another upon elongation without becoming entangled. This characteristic is important for film applications because LLDPE films can be down gauged easily while maintaining high strength and toughness. The rheological properties of LLDPE are summarized as "stiff in shear" and "soft in extension". It is not taken in most curbside pickups in communities. LLDPE can be recycled though into other things like trash can liners, lumber, landscaping ties, floor tiles, compost bins, and shipping envelopes (J. A. Brydson, 1999) Polyethylene was introduced initially as a special purpose dielectric material of particular value for high-frequency insulation. With increasing availability the polymer subsequently began to be used for chemical plant and, to a small extent, for water piping. Since World War II there has been a considerable and continuing expansion in polyethylene production and this, together with increasing competition between manufacturers, has resulted in the material becoming available in a wide range of grades, most of which are sold in the lowest price bracket for plastics materials. For many purposes these limitations are not serious whilst in other cases the correct choice of polymer, additives, processing conditions and after-treatment can help considerably.

2. Materials and Methods

2.1Polypropylene (PP)

Table 1 shows the specifications of Polypropylene – extrusion grade product supplied by Khartoum Petrochemical Company (KPC, Sudan), in powder with the following particulars:

Table 1: The specifications of Polypropylene – extrusion grade

Trade name	**KPC Polypropylene** (PP 113)
Density	0.910 g·cm^{-3}
Melting point	230 °C
Melt flow index (MFI)	30 g/10 min (230°C, 2.16 kg).
Tensile stress at Yield	27.5 MPa
Flexural Modulus	1000MPa
Izod impact resistance	25 J/m
Heat deflection temperature (HDT)	74°C

2.2 Linear Low Density Polyethylene (LLDPE)

Specification of LLDPE in present work supplied by SABIC (Saudi Arabia) blow moulding grade in pellets with the following particulars in table 2:

Table 2: The specifications of LLDPE – blow moulding grade

Trade name	**LLDPE-218N**
Density	0.924 g·cm^{-3}
Melting point	190 °C
Melt flow index (MFI)	20 g/10 min (190°C, 2.16 kg).
Melt temperature	193 – 232 °C
Tensile stress at Yield	12 MPa
Flexural Modulus	260 MPa
Dart Impact Strength	5 g
Vicat Softening Point	98 °C

3. Experimental work

3.1 Blending of PP/LLDPE

In the experimental study, blends of PP/LLDP were prepared according to the required compounds as 95/5,85/15, 75/25, 65/35and 55/45 to make up a total of 100 g. The samples were prepared in injection moulding machine at 180 °C – 250 °C. The processed samples were allowed to cool at room temperature for 48 hours and50 ± 5 % humidity. Then different tests were carried out such as tensile test as mechanical test. Also melt flow index (MFI) and melt density of the blend has been determined as rheological test. The formulations of blends to produce PP/LLDPE blends are shown in table 3.

Table 3: The formulations of polyolefin blends (PP/LLDPE blends)

Sample no	**Materials**	
	PP (wt %)	**LLDPE (wt %)**
1	95	5
2	85	15
3	75	25
4	65	35
5	55	45

3.2 Testing methods

Different tests were carried out such as tensile test as mechanical test and the melt flow index (MFI), Melt density of the blend has been determined as rheological test.

4. Testing and Results

4.1Mechanical test (Tensile strength test)

The tensile strength of PP was 19.7kgf.Addition of LLDPE (5, 15, 25, 35 and 45wt %) to PP decreased the tensile strength of PP. These observations were also in agreement with Clive Maier and Teresa Calafut (1998) and Kock, Aust, Grein, Gahleitner (2014), The Tensile strength of PP/LLDPE and compound are shown in table 4 and Figure 1.

Table 4: Tensile strength of PP/LLDPE

Sample	The tensile strength (kg_f)
PP_{113}	19.7
1	15.63
2	14.99
3	9.71
4	8.95
5	4.84

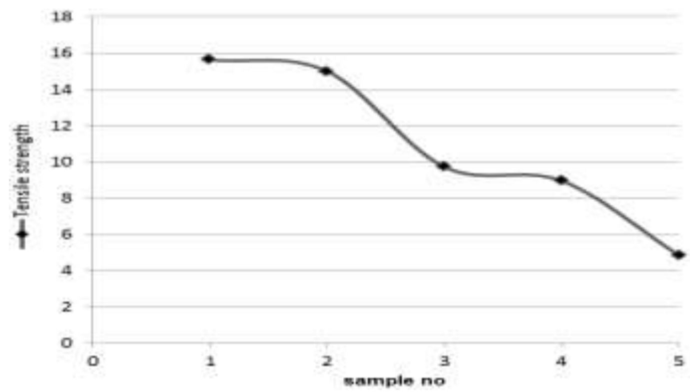

Fig. 1, Tensile strength of PP/LLDPE

4.2 Rheological test

4.2.1The melt flow index (MFI)

The melt flow index (MFI) test is used to investigate the flow properties of polypropylene and PP/LLDPE blend. The HDT of PP and PP/LLDPE blends are shown in Table 5. Figure 2 shows the effect of LLDPE contents on the melt flow index of PP. The Melt flow index (MFI) of PP was 4.8(g/10min). The addition of LLDPE (5, 15, 25, 35 and 45wt %) to PP increased the MFI. The result showed that with increasing LLDPE concentrations, the melt flow index of the composite increased.. From the results of the melt flow index test, in general, the obtained results are in good agreement with the literature such as Abu Ghalia et al (2011) when the effects of LLDPE on the PP are considered, respectively.

Table 5: MFI of PP/LLDPE blends

LLDPE load (wt %)	**MFI (g/10min)**
PP_{113}	4.87
LLDPE	26.25
1	5.23
2	7.82
3	14.86
4	20.08
5	24.25

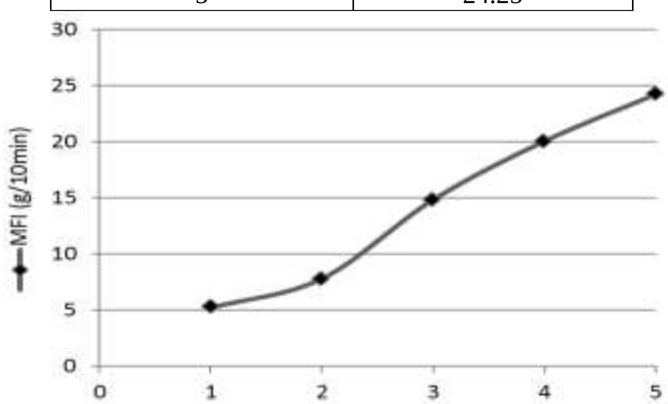

Fig. 2، MFI of PP/LLDPE blends

4.2.2Melt density test

The melt density test of PP/LLDPE and compound are shown in Table 5 and Figure 3. The melt density of PP/LLDPE blend was 0.786g/cm^3. The result showed addition of LLDPE (5, 15, 25, 35 and 45wt %) to PP has increased melt density of polypropylene. This result may be directly related to the undeform ability of the filler and its lack of contribution to the flow (G.Karian, 2003).

Table 5: The melt density test of PP/LLDPE

Sample No	The Melt Density (g/cm^3)
PP_{113}	0.786
LLDPE	0.746
1	0.779
2	0.747
3	0.737
4	0.729
5	0.700

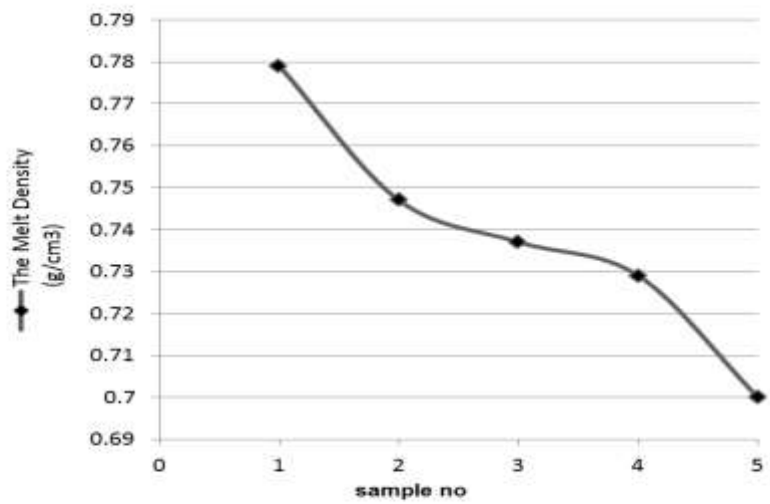

Fig. 3، the melt density test of PP/LLDPE

4.3 PP/LLDPE blend tests summary:

The summary of PP/LLDPE blend is shown below in table 6

Table 6: PP/LLDPE blend tests summary

Sample no	MFI (g/10min)	The Melt density (g.cm^3)	Tensile test kg_f
1	5.23	0.779	15.63
2	7.82	0.747	14.99
3	14.86	0.737	9.71
4	20.08	0.729	8.95
5	24.25	0.700	4.84

5. Conclusion

Addition of linear low density polyethylene (LLDPE) to polypropylene ($PP_{KPC\text{-}113}$) in most cases decreased the tensile strength and melt density of polypropylene. While melt flow index (MFI) is increased. The results showed improvement on the mechanical and rheological properties of polypropylene ($PP_{KPC\text{-}113}$). The work recommends the optimum compound provided the good performance of PP/LLDPE blend is (65/35) weight ratio % respectively.

6. References

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