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# STRENGTH IMPROVEMENT OF PP & LLDPE BLEND

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**ABSTRACT**

*PP and LLDPE melt blended in proportion of 60:40, 50:50, 80:20 w/w respectively. The possibility preparing a blend of these polymers with acceptable mechanical properties would lead to a valuable material and be a useful recycling practice. A notable improvement in tensile strength elongation at break and impact strength observed. PP is a nontoxic, recyclable polymer with excellent processabilty, low cost. It is having poor impact properties at low temperatures and this property improved with the formation of blend.*

***Keywords: Polypropylene, Linear Low Density Poly ethylene, Blend, Elongation at Break)***

## I. INTRODUCTION

The polymer blends are mixtures of at least two or more polymers. The blending of two or more polymers is a cheaper and more effective alternative, not only for the development of polymer, but also for getting desired properties in particular polymer blend. The LLDPE is used to modify the mechanical behavior of PP by forming physical blends. The interest in PP and LLDPE is specifically due to the fact that both of these polymers are widely used as important engineering materials in the automotive, electrical and packaging industries. PP LLDPE blends are amongst polymer blends that have to study. In this PP LLDPE Blend we have to study the improvement in the tensile strength, elongation at break, Crack test and impact strength of the blend.The molding shrinkage of PP is less than that experienced with polyethylene but is dependent on such processing factors as mould temperature; melt temperature and plunger dwell time.

One unfortunate characteristic property of PP is the dominating transition point which occurs at about $0^0$C with the result that the polymer becomes brittle as this temperature is approached. Even at room temperature the impact strength of some grades leaves something to be desired. Products of improved strength and lower brittle points may be obtained by block copolymerization of propylene with small amounts of ethylene. Such materials are widely used and are often preferred to the injection molding. The percentage used in blend is 80% PP and rest 20% is LLDPE.

### 1.1 Advantages of Blend

Excellent strength-to-weight and stiffness-to-weight ratios can be achieved by blending. This is usually expressed as strength divided by density and stiffness (modulus) divided by density. These are so-called "specific" strength and "specific" modulus characteristics. It is easier to achieve smooth aerodynamic profiles for drag reduction. Complex double curvature parts with a smooth surface finish can be made in one manufacturing operation. Production cost is reduced with required properties. Blend offer excellent resistance to corrosion, chemical attack, and outdoor Weathering.

### 1.2 Material

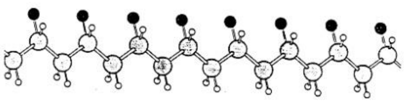
**Polypropylene:** Polypropylene (PP) is a linear hydrocarbon polymer, expressed as CnH2n. PP, like polyethylene (see HDPE, LLDPE) and Polybutene (PB), is a polyolefin or saturated polymer. Polypropylene is one of those most versatile polymers available with applications, both as a plastic and as a fiber, in virtually all of the plastics end-use markets.Polypropylene offers similar properties as polyethylene including low density, good mechanical, temperature, flexing/fatigue, and stress crack resistance and rigidity. It also has excellent color ability and is easily pigmented. Polypropylene is often manufactured as a copolymer to impart different characteristics, such as flexibility and rubbery texture.

The properties of Polypropylene include Semi-rigid, Translucent, MFI 2.5 - 3.5 gms /10 minGood chemical resistance, Tough, Good fatigue resistance, Integral hinge property, Good heat resistance Very Low Density (0.890 - 0.905 g/cm$^3$), Melting range(160$^0$C~165$^0$C), Good surface hardness and scratch resistance, Good dimensional stability.Outstanding Hinge properties.Excellent electrical properties, Steam sterilisable.PP does not present stress-cracking problems and offers excellent electrical and chemical resistance at higher temperatures. While the properties of PP are similar to those of Polyethylene, there are specific differences. These include a lower density, higher softening point (PP doesn't melt below 160$^0$C, Polyethylene, a more common plastic, will anneal at around 100$^0$C) and higher rigidity and hardness. Additives are applied to all commercially produce polypropylene resins to protect the polymer during processing and to enhance end-use performance.

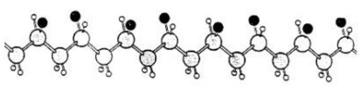
However, the presence of the methyl group attached to every alternate backbone chain carbon atom can alter the properties in a number of ways:

(i) it can cause a slight stiffening of the chain - increasing the crystalline melting point (Tm);

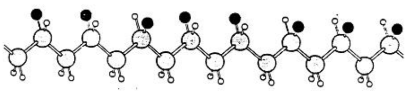
(ii) it can interfere with the molecular symmetry - depressing crystalline and hence Tm.



**Isotactic**



**Syndiotactic**



**Atactic**

In the case of very regular polymers, ISOTACTIC form, and the net result is a melting point some 30°C higher than that for HDPE. The methyl group also has a chemical effect, i.e. tertiary carbon atom provides a site for oxidation - PP less stable than PE, and also peroxides and radiation lead to chain scission rather than cross-linking

**1.3 Linear low density polyethylene (LLDPE)**

It offers good stiffness and impact strength/toughness, excellent environmental stress crack and warp resistance. Ultra-low density polyethylene (ULDPE) is an ethylene copolymer with excellent environmental stress crack resistance, outstanding flex-life and flexes crack resistance, toughness and good seal ability.Higher Density (0.910 ~ 0.925), Higher Melting Range (125˚C), Very good puncture resistance, High ESCR, Good tensile strength, stiffness & creep, Excellent low temperature toughness, Moderate thermal stability, Excellent water vapor barrier.

combustion process. Flame retardants used as additives can either chemically or physically lower the combustibility of plastic materials. Flame retardants impede and stop the propagation at any stage of combustion.

**Blowing agents**: These are chemical agents which produce gases through reactions and help in the manufacture of foams. Azo compounds, which give off nitrogen gas, are widely used as blowing agents.

**Processing aids**: These are high polymeric materials added in small quantities to thermoplastic resins that are difficult to process. Processing aids help to accelerate the melting process, and improve the flow properties of the plastic material during processing. These also contribute towards improving the mechanical properties, unlike simple additives like plasticizers.

## 1.4 Manufacture

Production of polypropylene takes place by slurry, solution or gas phase process, in which the propylene monomer is subjected to heat and pressure in the presence of a catalyst system. Polymerization is achieved at relatively low temperature and pressure and the product yielded is translucent, but readily colored. Differences in catalyst and production conditions can be used to alter the properties of the plastic.Propylene is obtained, along with ethylene, by cracking naphtha (crude oil light distillate). Ethylene, propylene, and higher alkenes are separated by low temperature fractional distillation. From being a byproduct of ethylene in the early 1950's, propylene is now an important material in its own right.

Polypropylene is a major tonnage polymer with a growth rate higher than the norm for such thermoplastics. This growth rate is partially because of the versatility of polypropylene, and hence the wide range of application areas as indicated above. However, in the UK we have always used more polypropylene than in other European countries, e.g. West Germany. This is particularly the case in injection moldings, which elsewhere might well be made from high density polyethylene.

## 1.5 Processing Characteristics

Polypropylene is a relatively easy material to injection mould in spite of its semi crystalline nature. The absence of any real need for high molecular weight, from the mechanical properties view point, leads to low melt viscosity (easy flow). The pseudo plastic nature of polypropylene enhances this effect at high shear rates (fast filling rates).

Typically melt temperatures for injection molding is between $200^0$C and 250°C.Though they can be as high as $280^0$C, or even $300^0$C, for short periods of time. With Flame Retardant grades it recommended that 220°C is not exceeded.

The melt flow index gives a rough guide to melt flow behavior, but as a result of the pseudo plastic nature of polypropylene (which is strongly dependant on the molecular weight distribution) this should not be taken too literally. Spiral flow mould data is sometimes provided by manufacturers as a practical means of assessing the flow behavior, but this is no substitute for the fundamental melt rheological and thermal data which is now becoming more important. Molding shrinkage of polypropylene is typically around 1%, but prediction of the actual value is difficult due to the strong influence of molding conditions. As a result of the ease of flow of polypropylene materials they are often chosen for large area moldings where it is desirable to operate with minimum clamp forces. However for many current polypropylene moldings, especially where good surface finish is required, it is common practice to use melt temperatures of 250°C combined with high packing pressures (typically about 80 Mpa).

### 1.6 Objective of Study

Blend is nothing but the addition of two or more than two polymers for the improvement properties of individual polymers into desired product. PP and LLDPE are of considerable industrial relevance, especially in the form of a blend. Mechanical properties such as impact strength, tensile strength, crack test and elongation % at the stretching limit as well as processing properties need to be optimized. The blend samples were prepared by a single screw barrel from the melt; the LLDPE content varied from 20 to 40 wt%.

Results from the work show that tensile modulus nearly follows rule of mixture behavior for both systems, although better performance is shown by the PP/LLDPE blends. With regard to impact resistance, the PP/LLDPE blend improved strength.

## II. METHODOLOGY

The study has been conducted in the following two phases:

1. Manufacturing of Blend
2. Analysis of Blend Samples

Over the last decade, the performance and availability of Blends has developed strongly driven by increasing interest in sustainable development, desire to reduce dependence upon finite resources and changing policies and attitudes in Blends and to produce new improved product. The Blends and its manufacturing process available worldwide, major market segments and also the relevant manufacturing companies in India as well as across the globe. Depending on the evolution of synthesis process, different classifications of Blend have been proposed. Blend of different wt % of PP & LLDPE is prepared with the injection molding process and various types of blends prepared and analysis has been carried out.

## III. RESULT & DISCUSSION

### 3.1 Melt Flow Index of Blend

The melt flow index gives a rough guide to melt flow behavior, but as a result of the pseudo plastic nature of polypropylene (which is strongly dependant on the molecular weight distribution) this should not be taken too literally. Spiral flow mould data is sometimes provided by manufacturers as a practical means of assessing the

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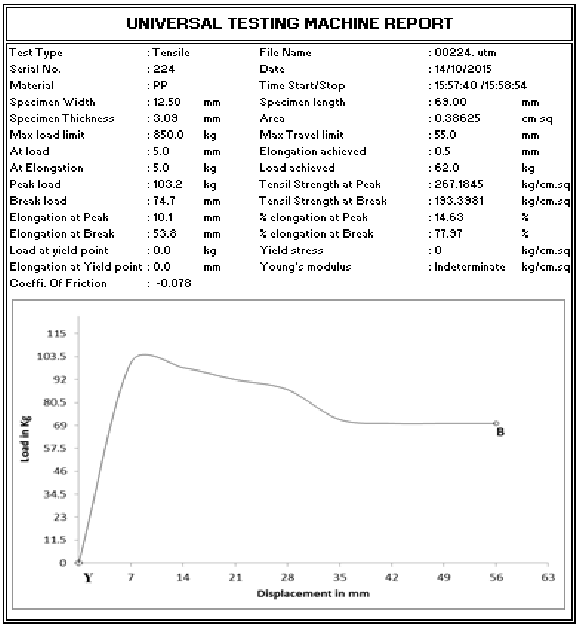
Melt flow index test gives the flow behavior of the material i.e. at specific temperature and load how much amount of material get extrude through the orifice of the melt flow indexer, the unit for the MfI is gm/10min.

| **Sr. No.** | **Composition PP:LLDPE** | **Unit** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|---|
| **1** | 40:60 | gm/10min | 4.1 | 4.1 | 4 | 4.1 | 4 |
| **2** | 80:20 | gm/10min | 4.2 | 4.2 | 4.2 | 4.2 | 4.18 |
| **3** | 50:50 | gm/10min | 3.2 | 3.2 | 3.3 | 3.3 | 3.3 |

**Table No. ONE**

### 3.2 Tensile Strength Test

The results of tensile tests (stress-strain curves) for the blends of PP: LLDPE were presented in the following Figures. The results show pure polypropylene has higher mechanical properties than the both types of polymer blends components and that related to PP have a rigid shortly methyl group attached to every second carbon atom of the polymer main chain, which restricts rotation of the chain producing a stronger but less flexible material, whereas LLDPE show elastic behavior (soft and weak), so they have lower tensile strength and higher elongation as compared to pure PP, from the other hand these figures show the behavior of both types of blends which are intermediate between their pure polymers. By increasing of weight percentages of PP from 60% to 80% there will be change in the behavior from soft and tough with low percentage of PP to hard and tough with high percentage of PP in the blend. It can also be noted that the blends of ratio 40% LLDPE: 60% PP and 20% LLDPE: 80% PP can withstand maximum load.



UNIVERSAL TESTING MACHINE REPORT

| | | | | | |
|---|---|---|---|---|---|
| Test Type | : Tensile | | File Name | : 00224. utm | |
| Serial No. | : 224 | | Date | : 14/10/2015 | |
| Material | : PP | | Time Start/Stop | : 15:57:40 /15:58:54 | |
| Specimen Width | : 12.50 | mm | Specimen length | : 69.00 | mm |
| Specimen Thickness | : 3.09 | mm | Area | : 0.38625 | cm sq |
| Max load limit | : 850.0 | kg | Max Travel limit | : 55.0 | mm |
| At load | : 5.0 | mm | Elongation achieved | : 0.5 | mm |
| At Elongation | : 5.0 | kg | Load achieved | : 62.0 | kg |
| Peak load | : 103.2 | kg | Tensil Strength at Peak | : 267.1845 | kg/cm.sq |
| Break load | : 74.7 | mm | Tensil Strength at Break | : 193.3981 | kg/cm.sq |
| Elongation at Peak | : 10.1 | mm | % elongation at Peak | : 14.63 | % |
| Elongation at Break | : 53.8 | mm | % elongation at Break | : 77.97 | % |
| Load at yield point | : 0.0 | kg | Yield stress | : 0 | kg/cm.sq |
| Elongation at Yield point | : 0.0 | mm | Young's modulus | : Indeterminate | kg/cm.sq |
| Coeffi. Of Friction | : -0.078 | | | | |

| Sr. No. | Composition | T. S. at peak load(Kg/sq Cm) | T.s. at Break load (Kg/sq Cm) | Elongation at Peak Load (%) | Elongation at BreakLoad (%) |
|---|---|---|---|---|---|
| **1** | 60:40 | 265 | 173 | 13 | 66 |
| **2** | 50:50 | 251 | 13 | 10 | 86 |
| **3** | 80:20 | 267 | 193 | 14 | 77 |

**Table No. TWO**

### 3.3 Impact Test

The impact properties of the polymeric materials are directly related to the overall toughness of the material. Toughness is defined as the ability of the polymer to absorb applied energy. Impact energy is a measure of toughness. The higher the impact energy of material then higher the toughness and vice versa. Impact resistance is the ability of a material to resist breaking under a shock loading or the ability to resist the fracture under stress applied at high speed. The Impact toughness is often the deciding factor in material selection because impact test measures the ability of Polymer to withstand the load imposed upon being struck by an object at high velocity, thus it is a measure of Energy required propagating a crack cross the specimen; therefore the impact properties of these samples are especially important. It is obvious that there are a depression in impact strength these values for LLDPE when mixed with PP, and the depression ratio decreased with increase of weight percentage of PP and that belongs to a rigid shortly methyl group attached to every second carbon atom in the linear molecular chain of PP and this cause PP has relatively low impact strength.

From test results Impact strength of high PP % is lower as compare to LLDPE % increment.

| Sr. No. | Composition PP:LLDPE | Unit | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| **1** | 0:100 | $J/m^2$ | 45 | 46 | 45 | 44.8 | 43.6 |
| **2** | 40:60 | $J/m^2$ | 38. | 37.6 | 37.6 | 37.6 | 37.3 |
| **3** | 100:0 | $J/m^2$ | 25 | 25.2 | 25.7 | 25.6 | 25.3 |
| **4** | 80:20 | $J/m^2$ | 48 | 48.2 | 48.3 | 48.6 | 48.7 |
| **5** | 50:50 | $J/m^2$ | 40.2 | 40.1 | 40.2 | 40.3 | 40.4 |

**Table No. THREE**

## IV. CONCLUSION

The mechanical properties of the blend formedFrom PP & LLDPE were investigated. This study concludes that the blend formation and its result give the improvement in the tensile properties, impact properties&MFI.

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