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A Review On Mechanical Properties And Applications Of Chlorinated Polyethylene

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FarshidIranmanesh, FariborzIranmanesh, BehzadMahjour Shafiei: A Review On Mechanical Properties And Applications Of Chlorinated Polyethylene

ABSTRACT

In this article the mechanical propertiesof chlorinated polyethylene was reviewed. The mechanical properties of CPE such as impact strength, breaking elongation, tensile strength was studied and resultsshowed chlorinated polyethylene can improvethe applications of polymers like,polyvinyl chloride (PVC),styrene acrylonitrile (SAN),andpolypropylene (PP).

Key words: Mechanical properties of CPE, impact strength, CPE blends.

Introduction

Chlorinated polyethylene is odorless nontoxic and white or pale yellow powder with excellent resistanceto weathering or age ozone chemicalsand good resistance to oil or flame.Chlorinated polyethylene(CPE)offers excellent flexibility and resistance to ignition,chemicals,heat,low temperatures and weathering at a low overall system cost.

Chlorinated polyethylene (CPE) can be used as a base polymer or as an additive to polyvinyl chloride (PVC), styrene acrylonitrile (SAN), and polypropylene (PP) for a wide range of applications spanning both thermoplastic and thermoset chemistries.

2. Applications of CPE:

2.1.Applications of CPE in blend with polyvinyl chloride (PVC):

There are 2 important kinds of PVC:

1. Rigid PVC which is used in fabrication of pipes and plastic plates.
2. Flexible PVC,which is composed from polymer with addition of plasticizers.This type of PVC used in fabrication of films,coating purposes and production of industrial leathers.[1]

So, PVC is one of the most important commercial plastics to its wide applications and low cost.PVC stillpossess many problems such as low thermal stability and brittleness.[2]

PVC without any additives,at room temperature,is a rather rigid material.It is often used in place ofglass.But if it is heated above the temperature of 87 Ca changeoccurs,PVC becomes flexible and rubbery.[3]

When compared with PE and PP,unmodified PVCis more rigid,strong,and more solvent sensitive.

PVC is largely used in fabrication of rigid pipes and frames of windows and doors.PVC competes rubber in many applications because of its excellent properties like:[1]

1.High electrical insulation.
2.High resistance for abrasion.
3.Low diffusion for humidity.
4.Good flexibility within range of temperature.

Liling Zhou, Xin Wang and others[4] studied the influence of CPE and ABS copolymer on the mechanical properties of PVC. i.e…. PVC/CPE and PVC/ABS hybrids were examined. The experimental results showed that toughness of the hybrids could be modified greatly by the introduction of the CPE or ABS. The impact strength of PVC/CPE and PVC/ABS hybrids increased with the content of 2-nd phase.

CPE exhibited a better toughening effect than ABS.

CPE thermoplastic resins are widely used as impact modifiers in PVC extrusion and injection molding applications. Especially effective in products such as window profiles, pipe, and siding, CPE provides excellent corner welt strength and high surface gloss. These resins offer high impact efficiency and perform well at low temperatures, giving very good weather resistance for all climate conditions.

2.1.1 Materials:

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Polyvinyl chloride (PVC)with an average polymerization degree of 1000,produced by QiluPetrochemi etrochemicalCorp,china.Chlorinated polyethylene (CPE) with 35% weight content of chloride, produced by weifang Chemical factory,china.

2.1.2. Experimental:

The mechanical properties of PVC/CPE blends change with the amount of CPE,as it shown in figure 1, 2 and, 3.It could be seen that the tensile strength decreased persistently,while the breaking elongation Increased and the impact strength various in “S” type curve when the amount of CPE is increased.

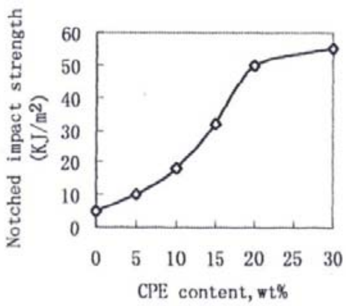

Fig. 1: Notched impact strength versus composition

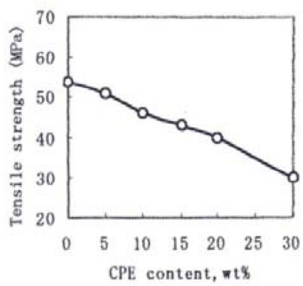

Fig. 2: Tensile strength versus composition

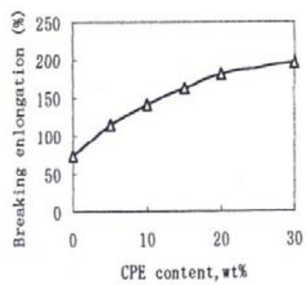

Fig. 3: elongation at break versus composition

Table I: properties of Base Resins

Materials	Mw	Other Characteristics	Source
SAN1	60000	AN content,35%	Hyosung BASF
SAN2	80000	AN content,35%	Hyosung BASF
SAN3	102000	AN content,24%	LUCKY
CPE		Cl content,36%	DOW

(The effect of CPE content on the mechanical properties of PVC/CPE (100/variable)):

This result is a typical character in the behavior of toughening plastics with elastomer. Ductility of PVC/CPE blends only increase slightly as a small amount of CPE is added,and a mutation region of brittle-ductile transition is formed when 10-20 phr CPE is added into 100 phr PVC (impact strength increased rapidly with CPE amount). After that,the impact strength does not increase obviously but the tensile strength decrease greatly as the CPE amount is increased further.[5-14]

2.2.Applications of CPE in blend with styrene acrylonitrile (SAN):

Styrene acrylonitrile resin is a copolymer plastic consist of styrene and acrylonitrile.It is widely used in place of polystyrene owning to its greater thermal resistance.Like polystyrene itself,it is optically transparent and brittle in mechanical behavior.

2.2.1.Materials:

2.2.2.Experimental:

Impact strength of the blends as a function of CPE content is shown in figure 4. The impact strength of the blends increase with CPE content,with the effect more pronounced as the molecular weight of SAN increase.

Three types of SAN having different molecular weight and different AN (acrylonitrile) content were used. A brittle-tough transition in the impact strength is observed at a composition of about 40 wt % CPE (SAN 1 and SAN2) and about 30 wt % CPE (SAN3).

Below 30 or 40 wt % CPE,a gradual increase in impact strength is observed with increasing CPE content, but the effect is small compared with the transition.

Figures 6 and 5 show the tensile strength and he elongation at break of the blends as a function of CPE content. The tensile strength decrease almost linearly with CPE content,indicative of good dispersion of CPE in SAN without the inclusion of SAN in CPE domains. The elongation at break is increased with with CPE content.SAN2 and SAN3 blends give slightly more improvement in this property than SAN1. [15-22]

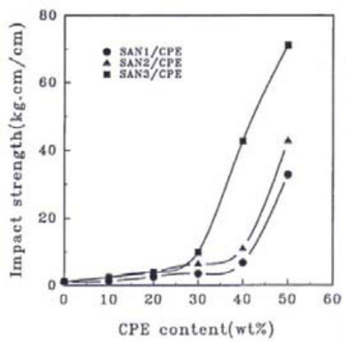

Fig. 4: Notched Izod impact strength versus composition

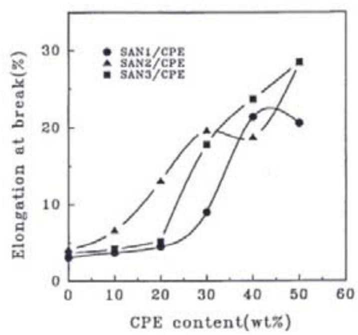

Fig. 5: Elongation at break versus composition

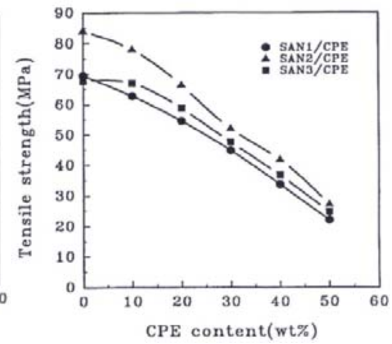

Fig. 6: Tensile strength versus composition

2.3.Applications of CPE in blend with PP(polypropylene):

Chlorinated polyethylene (CPE) is tried as an impact modifier for polypropylene (PP). The mechanical properties of PP/CPE blends have been investigated.CPE is found to be an efficient impact modifier when its concentration is above 30% of the blends.

Among polyolefins,polypropylene (PP) play a very important role by virtue of its attractive properties such as high melting temperature,low density,high chemical inertness etc.In addition,cost places PP in an advantageous position in comparison to most other plastic materials,engineering plastics in the partic- ular.

However low impact strength of PP is a serious shortcoming.Elastomersare efficiently used as impact modifiers.But the low heat resistance of the modifying elastomers limits the use of impact modified blends in demanding applications.

Chlorinated polyethylene (CPE) which has better heat resistance than common elastomers is tried as an impact modifier for PP.

2.3.1.Materials:

Table II: Properties of materials

Materials	Density	Other characteristics	Source
PP	0.907 g/cc	Melt index (230/50), 30g/10min	Hoechst HG
CPE	1.2 g/cc	Cl content, 41%	Hoechst AG

2.3.2.Experimental:

Figure 7 shows the stress-strain curves of various PP/CPE blend at a fairly high strain rate of 500 mm/min.PP shows very little toughness at this strain rate. With addition of CPE toughness increases moderately upto about 30% CPE content and thereafter increases sharply.A widely different stress strain behavior is observed PP and PP rich blends at low strain rates.These blends show fairly large elongation at break as shown in figure 8. This is obviously due to the semicrystalline nature of PP whose deformation depends strongly on the strain rate and temperature.Such semicrystalline polymers exhibit a critical strain rate above which crazing dominates and below which shear yielding is dominate.[30]

The behavior of CPE and CPE rich blend is more or less similar at both high and low strain rates.

Figure 9shows variation of hardness and impact hardness strength of PP/CPE blends with CPE content.

As expected,hardness progressively decreases with CPE content while impact strength steadily increases.

The improvement in impact strength becomes more pronounced after a CPE content 30% as observed from the tensile tests. of polypropylene can be improved by addition of chlorinated polyethylene.[23-27]

Conclusion:

It can be seen that PVC/CPE,SAN/CPE and,PP/CPE blend can improve mechanical properties of PVC, SAN,PP.

CPE will give excellent mechanical properties to PVC when 10-20 phr CPE is added into 100 phr PVC. Mechanical properties of SAN increased with molecular weight at a constant AN content. The impact strength of the blends increases with CPE content. The better mechanical properties of SAN1/CPE, SAN2/CPE, SAN3/CPE blends attributed to the superior mechanical properties of SAN2 and the better compatibility of SAN3 with CPE.

The toughness of polypropylene can be improved by addition of chlorinated polyethylene About 30% CPE is required for substantial improvement in toughness. PP/CPE blends exhibit a pseudoplastic behavior.

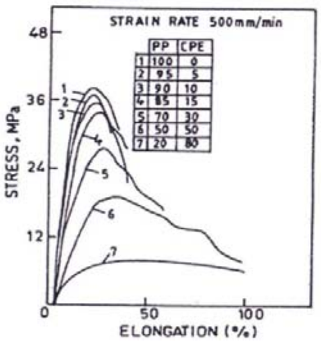

Fig. 7: Stress-strain curves of PP/CPE blends at a strain rate of 500 mm/min

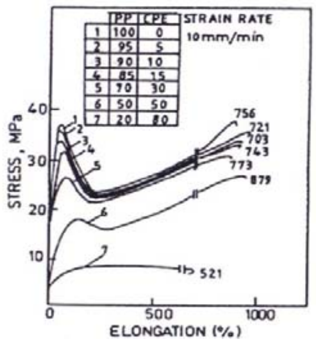

Fig. 8: Stress-strain curves of PP/CPE blends at a strain rate of 10 mm/min

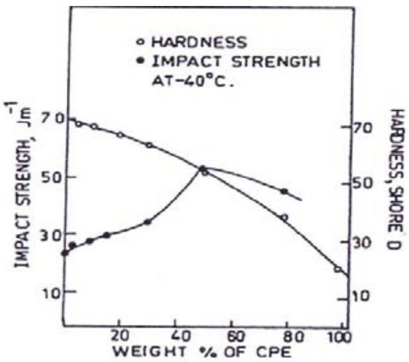

Fig. 9: Variation of impact strength with CPE content for PP/CPE blends

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