Properties of pvc abs blends

Introduction

Polymer blending is one of the fastest growing areas of polymer technology. Blending of polymer has become an increasingly important technique because it is an economical, viable and versatile way in which new material can be produced with a wide range of properties by merely using conventional processing equipment such as extruder or internal mixer.

Polyvinyl chloride is most versatile material in plastic family and second largest consumption material in plastic industries compared to polyolefin's. It is characterized by rigidity, hardness, excellent tensile modulus and low cost. However, it has low impact strength and poor thermal stability. Which limit's it's used.

Similarly, Acrylonitrile-Butadiene-Styrene (ABS) is one of most largely used engineering plastics. It has excellent mechanical, thermal, electrical & chemical properties. Followed by inferior properties such as poor weather resistance, highly flammable and merely high cost.

Polyvinyl chloride is largely blended with number of polymers and rubbers. In most cases, to improve properties of PVC and rarely to improve properties of other materials.

One of most inferior properties of PVC is low impact strength. To overcome this problem, it is blended with many rubbery materials. It has been shown that impact strength of PVC increases by blending with rubbery material such as NBR, SBR etc. But, it follows the decrease in tensile strength, rigidity and in most cases thermal stability.

Hence to achieve high impact strength, better thermal properties along with rigidity, PVC is blended with ABS. The blend of PVC and ABS posses their advantage of impact strength, rigidity, chemical resistance, electrical properties and overall low cost.

In ABS, generally the rubbery phase is made of emulsion polymerized polybutadiene, which constitutes the main polymer chain. The glassy phase is made of styrene and acrylonitrile grafted on Polybutadiene. Thus, it combines the impact strength of rubber and tensile strength, heat stability of styrene Acrylonitrile (SAN) Matrix. Thus properties of styrene acrylonitrile (SAN) and polybutadiene are imparted in PVC/ABS blend.

Compatibility of Polyblend of PVC/ABS blends

Compatibility is characteristics, which shows that components of blends are soluble in one another in all proportion. However, compatible blends are susceptible to phase separation at elevated temperature.

While preparing blend, it is necessary to consider compatibility of components of blend with each other, which are used to prepare blends.

In case of PVC/ABS blend, PVC and ABS are used as blend components. ABS is made by emulsion polymerization of SAN grafted by Polybutadiene. Polystyrene and Polybutadiene, have solubility parameter close to PVC. Although, solubility parameter of PS and Polybutadiene are close to PVC, they do not have good compatibility because of their being non-polar nature. While Acrylonitrile imparts good compatibility because of it’s polar nature (as shown in table).

Solubility parameter of components of PVC/ABS blend

Yodouchi and Seto reported that in ABS material, the brittle and glassy component (PS and SAN) improves tensile strength while Polybutadine contribute to toughness. The mechanical properties have been shown to be affected by type of ABS used, due to different Polybutadiene content.

Experimental work:

To prepared PVC/ABS blend work is carried out in three stages

1. Processing/blending
2. Molding
3. Testing

I) Processing/blending

a) Material selection: it is important factor to be considering while preparing blend because it plays an important role in mixing, processing and morphology of blend. commericial grade polymers, which were used in blending of PVC and ABS.

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Since Acrylonitrile- Butadiene-Styrene (ABS) is hygroscopic material, it is dried prior to use.

b) Blending: prior to melt blending, polymers were weighed and dry blended in small household mixture for five minute. Each batch of 2 Kg was prepared. Various blend compositions prepared and temperature of various zones are listed in table as follows.

Each blend composition was then melt blended on single screw extruder having L/D ratio 20: 1 and cut into small pellets. PVC was processed between 100-1350c, while ABS was process between 150-1800c. As percentages of ABS in blend increases, simultaneously processing temperature increase.

II) Molding: compression molding sheets were prepared by placing pellets of blend sandwich in polyethylene terphathalate. (PET) sheets between two previously heated mold halves. Various processing conditions for compression molding process are mention as follows.

III) Testing: Testing of compression-molded sheets is an important part of experimental work, since it shows compatibility, feasibility and enhancement of blends. Generally mechanical and thermal properties are most important for blend. Hence molded sheets with different composition were tested for mechanical and thermal properties.

A) Mechanical properties:

PVC/ABS blend with different composition were tested to determine for mechanical properties such as tensile strength, impact strength and hardness. Tensile elongation and modulus measurement are among the most important indication of strength in material and are most widely specified properties of plastic material, it is carried out on UTM. According to ASTM D 678, dumbbells shaped specimen for tensile test were punched out from 2 mm compression molding sheets. Tensile strength and percentage elongation at break for all compression-molded sheet were determine using R & d electronic computerized tensile testing machine using crosshead speed of 50 mm/min.

Impact strength is another most important property of material. There are various type of impact test specified by ASTM depending on application of product and material. Mostly izod impact test or charpy impact test is specified for injection and compression molded products while for film or sheet falling weight impact test is used. In case of PVC/ABS blend charpy impact test is used to determine impact test.

Hardness measures rigidity of material. It is defined as resistance of material to permanent deformation. It was measured by using hardness-measuring instrument. In case of PVC/ABS blend shore durometer was used for hardness testing.

B) Thermal analysis technique: Thermal analysis instrumentation has found wide acceptance in plastic industry for quality control and basic material characterization. Thermal analysis consist of two technique that may be used individually or in combination

1) Differential scanning calorimetry (DSC) : melting behavior of PVC/ABS blends was studied using differential scanning calorimetry(DSC perkim elmer DSC7). The scan rate used was 100c/min. and 20 0c/min. during heating, cooling and reheating cycles. Both the melting endoderm and cooling endoderm were recorded. The DSC for polymer was run on commercially available polymer granules while for blends, pellets prepared by melt blending were used for DSC studies.

2) Thermo gravimetric analysis: Thermo gravimetric analysis is test procedure in which change in weight of specimen is recorded as the specimen is progressively heated. The sample weight is continuously

monitored as temperature is increased at constant rate and component of a polymer that volatilize or decomposed at different temperature are quantitatively measured.

TGA for polymer is carried out on granules while for various blends composition by using pellets. It was carried out on Perkin elmer thermo gravimetric analysis equipment. Plot of % weight Vs temperature as obtained from the TGA testing are as shown in graph on subsequent pages.

RESULT AND INTERPETATION

Various test such as tensile, impact, hardness; DSC and TGA were carried out on PVC/ABS blends. The tests are very important to determine compatibility, efficiency and feasibility of blend. Result of test along with interpretation are described in detail as follows

1) Mechanical properties: it includes tensile strength, impact strength and hardness.

Tensile test: PVC is rigid and brittle polymer and it usually fails by brittle type fracture. The incorporation of rubbery material in PVC decreased yield stress and increased elongation at break. Results of tensile test carried out on different PVC/ABS composition are tabulated as shown in table.

It can be observed from graph and tabulated results that tensile strength and modulus of PVC decrease with increased in percentage addition of ABS. It was found that there is increased in percentage elongation with addition of ABS material

It may be attributed to the fact that due to the rubber content of ABS, tensile strength of PVC/ABS blend decrease and at the same time percentage elongation increase. it may be supported by fact that the final blend contains a grater amount of polystyrene and acrylonitrile in form of matrix polymer. In addition to this composition of matrix to rubber graft in this type of material should have dominant effect in determining the mechanical properties such as impact strength and tensile strength? The amount of SAN in PVC/ABS may be responsible for increased in yield stress. It can be argued that some physical bonding takes palace between two rigid polymer matrixes. In other word, at higher amount of ABS (25- 30%) the chance of an interpenetrating network is favorable resulting in enhancement in yield stress. it is also well know that degree of gelation greatly influence the tensile properties. It is also observed from graph that critical fracture value of PVC/ABS blend is dependent on blend composition.

b) Impact strength: Impact strength values for different PVC/ABS blend composition are tabulated as follows. Incorporation of ABS in PVC result in considerable increased in intact strength of virgin PVC.

It can be seen from impact testing result that with increased in ABS content in blend the impact strength increases. As we go on increasing ABS from 5-25% (by Wt.) Into PVC, impact strength increases from 16. 77 to 36. 77 Kg/Cm. It is found that impact strength of PVC is almost doubled at 20% ABS content in blend.

In ABS, polybutadiene constitute the main polymeric chain to which two polymeric segments viz. polystyrene and Polyacrylonitrile are attached. The

former contribute to toughness of material. Hence depending on percentage of butadiene, ABS is classified as low, medium and high impact material. For this experiment high impact grade ABS is used (Bhansali Polymer)

According to literature, PVC/Abs blend toughness is depend on amount of rubber content in ABS. Since above-mentioned grade has got highest rubber content it was selected for experiment work.

It may be attributed to the fact that numerous crack developed around the rubber particle. Consequently, these rubber particle serve to initiate crazes and thus to absorb energy which enhance impact strength. Hence in order to increased impact strength, the butadiene content in PVC/ABS blend must be higher. Polyblend of PVC and ABS having higher butadiene content shows more ductility

3) Hardness: Hardness of material is related to rigidity. Rigidity is one of the most important properties of material. Addition of rubber particles decreases the rigidity. In this experiment hardness for different composition of PVC/ABS was determined. From tabulated result it has been observed that as we go on increasing Abs content in the blend, hardness of blend decreases. Values of shore hardness for various compositions are as follows

2) Thermal properties thermal characterization techniques have been used to study the glass transition behavior and thermal stability of PVC/ABS blends.

a) Differential scanning calorimetry(DSC) :

In case PVC/ABS blend, DSC is used on various blend composition to determine the glass transition temperature. PVC, a rigid polymer has a transition temperature of 800c. ABS shows two transitions one at -800c corresponding to polybutadine rubber and another at 1040c corresponding to SAN copolymer. It has been reported that impact modifier PVC containing ABS show three distinct transition one at -800c, 800c and 1040c. The lowest transition is attributed to polybutadiene, the intermediate to PVC highest to SAN.

It is observed from the plot of heat content Vs temperature, the lower value of Tg of rubber (-800c) could not be determined because of lack of cooling facility in the instruments.

The glass transition (Tg) of various composition of blend is shown in table. PVC/ABS may not be compatible. Miscibility of the modifier as ABS in PVC is not always desirable to achieve useful mechanical properties.

2) Thermo gravimetric analysis (TGA): TGA has been quite useful in determining the thermal stability of PVC/ABS blend. Primary thermo gram of PVC, ABS and PVC/ABS blend (for 10 % and 20 %)were shown in graph. For PVC two-step decomposition was observed. Major volatilization started at around 2500c and above 3500c. Complete dehydochlorination of PVC took place and HCl is predominant product of degradation. Incase of ABS, volatilization started at around 3000c with sharp loss of weight. The loss of weight was about 90% at 4000c and complete loss of material took place at 5000c

from the graph it may be stated that as ABS content in PVC increase the stability of blend also increase. For virgin PVC at 4000c there was 58 % loss of weight, whereas for blend composition (90%PVc- 10 % Abs) it was 52% and for composition (80%PVC- 20 % ABS)it was around 48 %.

The increased thermal stability of PVC can be attributed to the incorporation of ABS terpolymer. ABS is composed of polystyrene, PAN and polybutadine. It may be stated that PS stabilized PVC to greater extent. In PS, chain scission takes palace because of depolymersation. Due to this effect, Cl radical from PVC reacts with styrene resulting in unavailability of Cl radical for further dehydrochlorination, which results in degradation of PVC. Thus increasing thermal stability of PVC.

It may be stated that whenever the losses of Cl radical to other phase occur, dehydrochlorination requires reinitiating. Hence increase in decomposition temperature result into increase in thermal stability of blend.

CONCLUSION:

From the results of various tests carried out on PVC/ABS blend following conclusion may be carried out:

Incorporation of ABS into PVC results into tremendous increase in impact strength of PVC.

PVC/ABS blend posses properties like tensile strength, rigidity and flame ret ardency of PVC and impact strength and thermal stability of ABS

TGA analysis shows that incorporation of ABS into PVC improves its thermal stability to greater extent.

DSC analysis of blend shows the compatibility of blend. It also shows that as we go on increasing percentage of ABS into PVC, results into shift of glass transition temperature of blend towards ABS . It may indicate increase in thermal stability of PVC.

5) Incorporation of the ABS into PVC result in decrease in hardness and increase in impact strength, which may gives ductility to blend.

Since blend possess excellent mechanical and thermal properties along with flame retardancy, it is used in electrical application such as electrical switches, plug and knobs. Also useful for automotive application such as automobile panels and clutches and other parts, where thermal stability along with weather resistance is desired.

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ABSTRACT

Polymers and alloys represent a commercially important and emerging class of such multicomponent polymer system . The physical blending and alloying of different polymers is more cost effective way of modifying properties of material than chemical modification. The main properties improvement through polymer blending includes impact resistance, heat deflection temperature (HDT), flame retardancy and processing in addition to cost dilution. These properties are dependent on morphology of moulded or extruded part

The requirement of special application polymer becomes very sharply defined with development in polymer technology . so, it becomes necessary to manufacture each major polymer in wide range of different grade which are made to offer optimum properties for particular processing and application development . Many different method are used to prepare the tailor-made polymer compounds for such purposes like blending , copolymerisation, and chemical modification . Blending is most effective method compare with the other methods.

The present work deals with preparing PVC /ABS blend. The work aims at enhancing the mechanical properties of PVC by addition of ABS and improvement in flame retardency, rigidity and cost effectiveness of ABS by addition of PVC.

The above project will be carried out in three stages:

1) Material selection: It is one of the important factors to be considered while preparing blend because it plays an important role in mixing, processing and morphology of blend.

ABS material of HI-40 and HI-40K grades (manufactured by Bhansali polymers Ltd. Mumbai) are selected for the above project work because of its excellent mechanical and thermal properties.

Depending on ABS grade, PVC material (compounded) of proper grade is selected, which is suitable for processing.

2) Blending: PVC compound and ABS resin (both in powder form) are mixed in mixer in various proportion and pelletised on single screw extruder. The pellets are further compression moulded into sheets.

3) Testing: The standard specimen are cut from the compression moulded sheets. The following tests will be carried out as per respective ASTM standards.

Tensile testing to find out the properties like elongation, Yield strength

Charpy Impact test to determine the impact strength in the direction of orientation and perpendicular to orientation

Duracol hardness test to check the surface hardness

Flammability test