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STUDY ON THE PERFORMANCE OF PVA/PVP BLENDS AT DIFFERENT DRYING TEMPERATURE

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Abstract-Million of synthetic polymers are produced worldwide every year. Among the polymers produced, some polymers are non biodegradable due to their stability and they do not readily enter in to the degradation cycle. To solve the problem the biodegradation of plastic has been studied extensively for the past three decades. Various biodegradable materials were prepared to overcome this serious problem. These types of polymers were degraded in the soil, activated sludge, or compost after the service life is over. The present work reports synthesis and characterization of blend using polyvinylalcohol, polyvinylpyrrolidone. Thin films of blends were prepared by using solution cast method. Gluteraldehyde was used as cross linking agent. The films were characterized by using FTIR spectroscopy, XRD, TGA/DTG and SEM. The degradation properties have been studied by using soil degradation.
Keywords: Polyvinylalcohol, polyvinylpyrrolidone, and gluteraldehyde.

INTRODUCTION

The development of polymer based blends/ composites have gained considerable interest to the researchers due to their wide range of application in many field due to their lightweight and water soluble properties [1]. The use of polymers in medical applications covers a broad diversity of fields including implants, prostheses, ophthalmology, dentistry and bone repair. Polymers like polyvinyl alcohol(PVA), polyvinyl pyrrolidone(PVP),polyacrylamide play an important role as a temporary scaffold, a temporary barrier and a drug delivery system. Blending of polymers may result in reducing their basic cost, improving their processing and maximizing their important properties [2]. The increase in properties of the blend depends on the degree of compatibility and miscibility of polymers at the molecular level.

PVA is a semi crystalline, water soluble, non toxic, better films, and fiber forming polymer. Due to their bio compatible, excellent chemical resistance, good mechanical properties and biodegradability, these polymers were used in many fields [3, 4]. PVA hydrogels have been used for various biomedical and pharmaceutical applications. Another polymer PVP is also vinyl polymer which has wide applications in biomedical field because of its properties including adhesion, excellent physiological compatibility, low toxicity and reasonable solubility in water and most organic solvents [5]. When these two polymers are mixed, the interaction between PVA and PVP are expected to take place through inter molecular hydrogen bonding between the hydroxyl group of PVA and carbonyl group of PVP [6].

EXPERIMENTAL:

MATERIAL:

Polyvinylalcohol (mol.wt13000), polyvinylpyrrolidone (mol.wt.40000), and gluteraldehyde were purchased from high purity laboratory chemicals.

FILM PREPARATION

About 10g of PVA was dissolved in 450ml distilled water at 70°C. The solution was stirred using magnetic stirrer for 1 hour. After complete dissolving 5g of PVP with 200ml of distilled water is added. A whitish homogeneous viscous gel was formed. To this solution add 2 drops of gluteraldehyde as crosslinking agent. The whole mixture was stirred for 2 hours. The prepared solution was poured in to a mould and dried at room temperature for one week. The wet film obtained was peeled off from the plates and stored for further analysis. The film obtained is noted as 1PP.The same experiment was conducted by changing the temperature for drying (i.e.) instead of drying at room temperature the film was dried at 70°C for 48 hours. The film obtained was peeled off from the plate and used for further studies. The sample is denoted as 2PP.

FTIR STUDY

FTIR spectroscopy has been widely used by many researchers to study the formation of blends. The FTIR spectra of PVA/ PVP blends were recorded using a Schimadzu FTIR- 470 spectrometer by KBr disc technique. The blended samples were recorded in the range of 600 – 4000cm^{-1}.

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XRD STUDY

The X-ray diffractometre was used to find out the crystallinity of blends prepared. The samples were analysed using KPERT-PRO diffractometre with monochromatized Cu Kα radiation (scan speed of one minute in a 2θ range of 5°- 40° room temperatures).

SEM MICROGRAPH

Areas ranging from approximately 1cm to 5 microns in width can be imaged in a scanning mode using conventional SEM technique. Electron microscopic micrographs of the blend samples were obtained under high resolution using JOEL JSM6390LV SEM equipped with phoenix energy dispersive system. It was used to investigate the morphology and distribution of polymers.

TGA/DTG STUDY

Films were cut in to small pieces and placed in aluminium pans for thermo gravimetric analysis (TGA) on a Perkins Elmer STA 6000 model in Sophisticated Analytical Instrument. The temperature program was a linear ramp of 38° C upto a final temperature of 72° C. A nitrogen pure gas was used during the TGA heating.

BIO-DEGRADATION PROPERTY

The biodegradation property of films was determined by burying the sample in the soil. In the soil landfill microorganisms show significant degree of biodegradation in short incubation times. The degradation of films was evaluated by measuring the weight loss.

RESULTS AND DISCUSSION

FTIR STUDY

In FTIR spectra of 1PP show the bands at 1200 cm^{-1} due to ether bonds blending of PVA with PVP to form their polymer blends and shifting peak position same and intensity changes the nature of the film. A sharp peak at 1651 cm^{-1} suggests the presence of free C=O group. Increase in intensity of C=O peak compared to PVA membrane confirm the presence of C=O peak compared to PVA membrane confirm the presence of C=O group of PVP in addition of C=O groups of a gluteraldehyde. The peaks at 1486 cm^{-1} to 1444 cm^{-1} were assigned to C=O groups of PVA based membranes. The band obtained at 2923.04 cm^{-1} is attributed due to C-H groups. On increasing the temperature the intensity of the peak has very small changed at 1651 cm^{-1} and all the other bands show same intensity in 2PP.

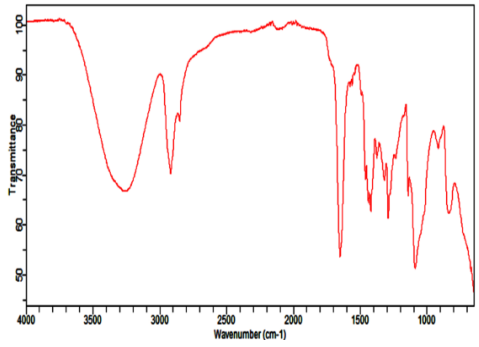

Fig: 1. FTIR spectra of 1PP blend

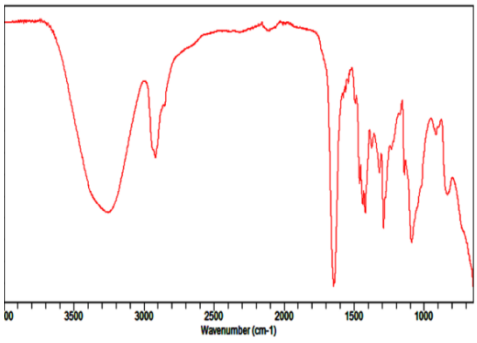

Fig: 2. FTIR spectra of 2PP blend

XRD STUDY

The sample 1PP shows 71.42% crystallinity with crystallinity index 0.599. On increasing the drying temperature (70°C) two broad peaks obtained at 20° and 40°. The sample 2PP shows crystallinity percentage of 56.26 and 59.35. This will be lesser

than 1PP which shows the amorphous nature of PVA/PVP blends and due to the disturbance in the regular patterns of the atoms.

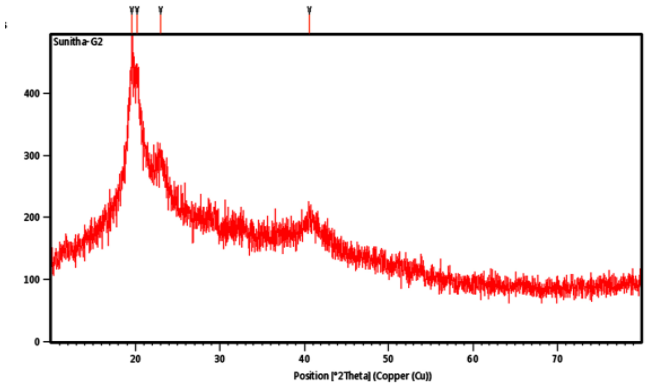

Fig: 3. XRD pattern of 1PP blend

On increasing the temperature blending of polymers results decrease in crystallinity and increase amorphousity. The crystalline index of 2PP is 0.22 and 0.315.

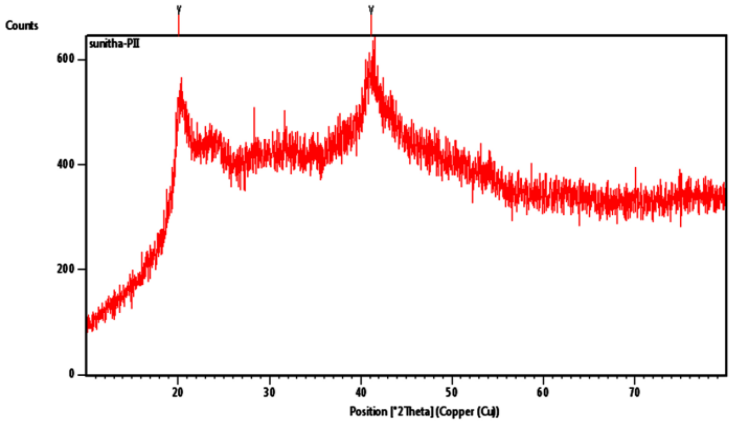

Fig: 4. XRD pattern of 2PP blend

SCANNING ELECTRON MICROSCOPY

Scanning electron microscopy is a well known electron beam technique in which electron scattering is used to image the topography of the sample surface under investigation. The surface morphological of 1PP, 2PP blends were observed using SEM image. The SEM image of 1PP shows most of the particles are equally distributed and also some irregular appearance due to agglomeration.

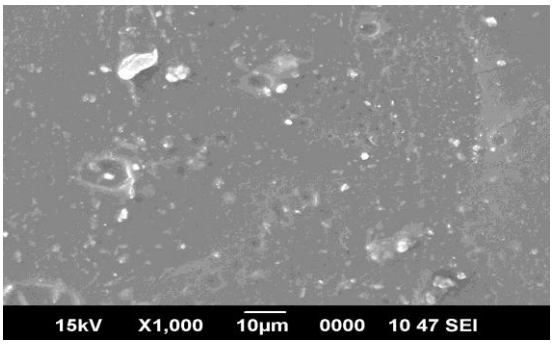

Fig: 5. SEM micrograph of 1PP blend

On increasing the temperature at (70°C) 2PP shows clear distribution on the surface of PVA which is closely related to the amorphous nature of the blends. This was supported by XRD. On comparing these two polymers 1PP and 2PP, 2PP shows good results due to the blending nature of two polymers (PVP and PVA).

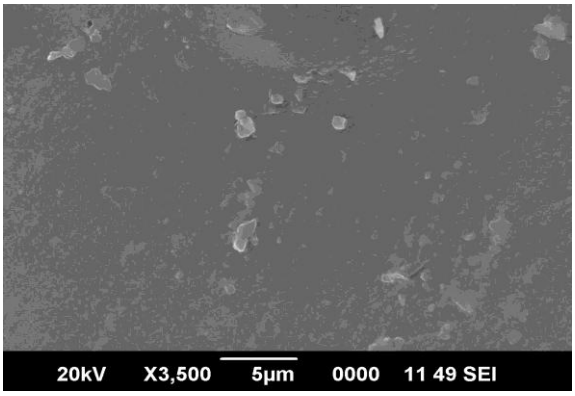

Fig: 6. SEM micrograph of 2PP blend

TGA/DTG study

Table 1: Percentage weight loss of PVA/PVP blends

Percentage weight loss at various temperature							Residue
Sample code	100° C	200° C	300° C	400° C	500° C	600° C	
1PP	0.266%	7.82%	11.36%	61.93%	95.37%	96.73%	3.27%
2PP	1.97%	6.13%	15.19%	48.60%	79.45%	88.25%	11.75%

Table 1 shows the percentage weight loss of PVA/PVP blends. In thermo gravimetric analysis the 1PP sample shows a initial weight loss about (7.82%) upto 200°C is due to the evaporation of loosely bound water, CO_2, N_2O molecules[8]. In DTG curve two endothermic peaks are observed at 320°C (sharp) and 430°C (sharp) demonstrating the combustion of organic residuals in the matrix. At 320° C the DTG curve corresponds to the decomposition of PVA and at 430°C it corresponds to the decomposition temperature of PVP. Above this temperature no weight loss is observed which indicates the completion of the decomposition process of PVA and PVP. The first stage of thermal degradation takes place at 200–400°C (weight loss upto 61.93%) may be caused by decomposition of the polymeric structure.

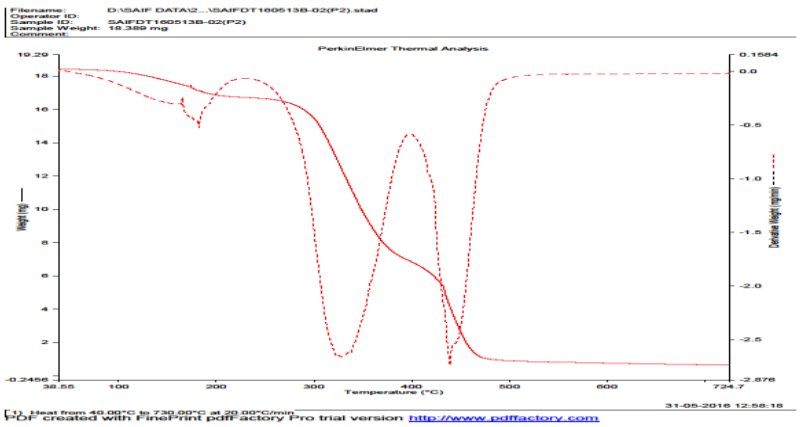

Fig: 7. TGA/DTG of 1PP blends

Similarly in sample 2PP the initial weight loss is 1.97% at 100°C due to the evaporation of water molecule in the sample. The first degradation takes place (weight loss upto 15.19%) at 300°C is due to decomposition of polymer backbone. At above 400°C second degradation takes place due to the existence of a chemical degradation process resulting due to PVP. DTG also shows sharp endothermic peaks at 452°C. On increasing the temperature a small peak obtained at 608°C and upto this the sample 2PP is thermally stable. Finally it gives 11.75% residue. The T_{max} value obtained at 410°C which is higher than the sample 1PP which shows the thermal stability of 2PP compared with 1PP. On comparing 1PP and 2PP, the 2PP shows higher stability may be due to even distribution of particles and their drying temperature.

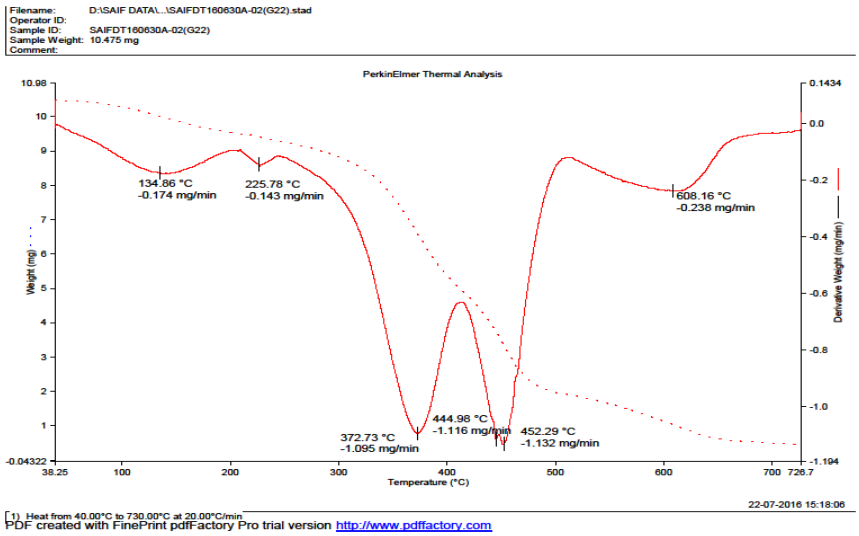

Fig: 8.TGA/DTG of 2PP blends

SOIL DEGRADATION

The PVA/PVP blends (1PP, 2PP) were exposed to soil for 120 days under prevailing environmental conditions. After 120 days of exposure in soil films eventually diminished in size and appeared hard and fragile. Film deterioration was also accompanied by loss in their total weight after soil exposure. The weight loss may be due to adhering of soil and debris partial to the film surface [9, 10].

In 1PP and 2PP blend films the percentage of degradation is 66.66% and 73.68% with weight loss of 40mg and 85mg were recorded. On comparing 1PP and 2PP with this polymer film there is increase in degradation percentage for films prepared above the room temperature may be due to the addition of PVP.

Table 2:Percentage degradation of PVA/PVP blends

Sample code	Initial weight	Final weight	Weight loss	Percentage of degradation (%)
1PPA	120mg	40mg	80mg	66.66%
2PPA	95mg	25mg	70mg	73.68%

CONCLUSION

The present work reports synthesis and characterization of blend using PVA, PVP. The prepared PVA/PVP blend has good properties due to the water soluble property and hydrogen bond interaction among PVA, PVP. The FTIR spectra of polymers give the same peaks even though they are prepared at different temperature. At 1651 cm^{-1} the intensity of peak increased due to the addition of PVP in PVA matrix. The XRD spectra shows two peaks one crystalline and other amorphous indicate the semi crystalline nature of the films. The SEM image of PVA /PVP blends at different temperature shows a clear distribution of particles inside the matrix. In TGA and DTG studies we know that high thermal stability of 2PP compared with 1PP polymer may due to even distribution of particles and their drying temperature. From soil degradation study us clearly that there is increase in degradation percentage due to the addition of PVP.

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