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Bio Degradable Polymers for Replacement of Plastics

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Abstract: ***One of the most crucial ingredients of municipal waste is plastics. Plastic has been posing a problem of disposal and surrounding pollution difficulties because of their non disposable character. To minimize their surrounding influence and making them to be converted during process of organic waste reusable processes, many materials in a little while back been introduced to enhance the nature of being biodegradable in plastics. In the following review, the speed and scale of mineralization process of a wide range of plastics that are commercially obtained alternative materials were sought out during the process of an anaerobic digestion, composting and soil incubation. The extent of biodegradability was evaluated by critically calculating the scale of carbon mineralized during the process from these materials while incubation under the conditions that imitated those three spaces and by testing of the materials by inspect electron micrographic. The outcome showed that during those 660 days of soil incubation, fundamental mineralization was observed for the material of poly-hydroxyalkanoate plastics; plastics that are starch based and for materials which were made from compost. Moreover, only the plastic based on poly-hydroxyalkanoate-were biodegraded at a speed that is similar to the positive control. Polymers that are synthetic biodegradable have found more resourceful as well as various biomedical and other applications owing to their tailor able plot or improvement. Biodegradable polymers now have been extensively utilized and extensively encouraged the enlargement of biomedical fields due to the tremendous abilities of being biocompatible and biodegradable. The enlargement of the fields of biotechnology and technological improvement of medical field has imposed higher demands of bio-medical materials. Now a day the biodegradable polymers with novel character and specific properties are on high demand.***

Key words: ***Biodegradable Plastics; Natural Fibers; Fiber Composites***

I. INTRODUCTION

In today's scenario, due to the industrialization, the environmental degradation is attracting the people all over the globe to think about the future material that could be more sustainable and eco-friendly in nature. These biodegradable plastics and other bio based polymers when used as composites can replace the petro based polymers in the market up to the large extent.

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Composites are classified as non- biodegradable and biodegradable in nature. Biodegradable can be partially or fully depending upon the type of matrix and reinforcement.
Plastics are extensively used throughout the world on a daily regular course. The plastic literally is a commonly used word for various materials of synthetic or partial synthetic nature. They are used for shellac, cellulose, rubber and asphalt. Bio degradable plastics can begin to decay in the environment. When environment microorganism catabolism and break down formation of biodegradable plastics.[3,4] This result is less harmful to the geographical area as compare to the traditional plastics. Biodegradable plastics should have the require action characteristic in their intended use, but after use should not be unpleasant biodegradation and proper waste management infrastructures should be utilized to environmentally able to exist with constituents.

II. PROGRESSIVE AND ENVIRONMENTAL MICRO-ORGANISM NATURALLY DEGRADABLE POLYMERS RESEARCH

Table 1: Progressive research on bio degradable polymers (2005-2019)

S NO.	Specimen Type	Material Matrix	Method Used	Conclusion	Approached Used
1	Biodegradable polymers	PLA	Epoxy	For any conclusion on dynamic behavior of biodegradable polymers, a precise and higher set of investigations are must.	Experimental
2	Conventional and bio-based plastics	polypropylene (PP),	Standardized laboratory-scale experiments	It confirmed that more than 70% of positive controls (cellulose paper) was biodegraded in all the systems in recyclable manner	Experimental
3	Bio-based polymers	poly(butylenes furandicarboxylate	polycondensation method	Method of two step melt poly-condensation was successfully employed to synthesize a series of multi-block PBF-PEG co-polymers with higher molecular weights	Experimental
4	Degradation	plastic carrier bags	Epoxy	Standard polyethylene showed the least reduction of tensile strength	Experimental
5	Degradation of biodegradable polymers	PLA	NMR analysis	Successful application of polymeric material all in biomedical applications	Analytical
6	Bio degradation	Poly-hydroxyalkanoates	Conventional bio methods	It concluded that shape of the polymer item primarily influence the properties of polymers	Experimental
7	Bio degradation	Polythelyne	polymerization mechanism	It confirmed that cyclic weathering and UV post cross linking conditions caused the gradient stresses in degraded material that caused formation of cracks on surface of polymer	Experimental
8	Bio degradation	Plastics	polymerization mechanism	It concluded that manufacturing alternative polymers that requires less ratio of plasticizers can be made bio degradable by surface modification technique of plasticizers having low leach ability	Analytical
9	Biodegradable polymer	Poly-carbonate.	polymerization mechanism	It showed the comparison of biologically derived and synthetic biodegradable polymers where in the later do not have immunogenicity but can be easily modified chemically to be functional	Analytical
10	Degradation and Stability	PLA	Conventional bio methods	The results from experiment shows that biopolymers can be easily transformed into various products and are easy to disposed also.	Experimental
11	Failure and stability	Metal Matrix Composites	Gray Relation Analysis (GRA) and Scanning Electron Microscopy (SEM)	Most influencing parameter for alteration wear behavior was content of reinforcement of metal while sliding distance has least effect on it.	Experimental
12	Degradation only	Polypropylene matrix	Scanning Electron Microscopy(SEM)	All mechanical properties of wood plastic composite depend on dust of wood.	Experimental
13	Modeling Analysis	Carbon fiber matrix	ANSYS software FE analysis, Scanning Electron Microscopy (SEM)	Mechanical properties of matrix depend on choice of nanostructure and fiber surface treatment gives better performance of matrix	Finite Element Modeling based analysis
14	Modeling and degradation	Sugarcane Fiber reinforced epoxy composite	ANSYS software FE analysis and Scanning Electron Microscopy (SEM)	Average fatigue life of epoxy composite is increased using sugarcane reinforcement	Novel treatment method

The past work on the production of bio-degradable plastics/composite has been rigorous using various combinations of natural matrix composites, used as main components or fiber reinforcement in the composites. The experiments were observatory, experimental, analytical and mechanical process utilized to draw out various effects on the life and strength of the composites. The latest work done by experimental and modeling process showed that using a natural fiber (sugarcane fiber) that contains hemicelluloses, cellulose and lignin has increases the life of the composite with increase in fatigue strength, weather resistance and water resistance of the composite. Hence an application of natural fibers in epoxy of resin and hardener, that is bio-degradable, can effectively be used for replacing plastics with desired properties. This review paper can be useful for determining various experimental ratios in research works for preparation of bio-degradable plastic which has various future scopes.

III. INTRODUCTION OF PLA

Poly lactic acid or PLA belongs to the category of aliphatic polyesters family that is often made from hydroxyl acids that possesses poly-glycolic acid that is usually considered to be biodegradable. PLA are high modulus polymers having high strength and of thermoplastic in nature that are usually obtained from renewable resources on the earth for their application in various fields like industrial and medical sciences. Due to their biodegradable nature and common process of extraction and utilization of various biodegradable wastes, its uses are increasing every day in all the fields of engineering and science. The need of manufacturing PLA comes as it fulfills the demands like cost friendliness as well as non-petroleum materials. PLA, being a bio-plastic, is a very versatile product as it gets decomposed to non toxic materials when comes in contact with environment. You can predict that if bottle or any product manufactured of PLA is placed in water then it would automatically decomposed within a time period of 2 years maximum, in contrast to other conventional present plastics that usually require hundreds and thousands of years to get completely degraded. Hence, there is a high possibility for PLA being used as an alternate to plastics for it is very useful where biodegradability is highly desired specially for the products having small life period.[4]

A. Classification of Bio Degradable Polymers

Natural fiber reinforced composites are attracting the researchers and end users due to their low cost and improved sustainability which force them to replace the synthetic fiber reinforced composites with natural ones. So there is the need to develop new materials based on renewable resources. So to make completely biodegradable green composites, both matrix and reinforcement should be biodegradable. The classification of natural matrices is given below. From the given classification of matrices, we can say that PLA (Poly Lactic Acid) is the most widely utilized in most of the research and development works now a day. It was firstly discovered by the Carothers after heating up the lactic acid in vacuum in the year 1932. The final outcome possessed a very low molecular weight of the product. PLA being a degradable and versatile product, has replaced fossil fuel based polymers as well as their performance being good as compared to the other polymers that are discovered later.[8] At an early stage of research work in biodegradable polymer, PGA (Poly-glycolic acid) was synthesized firstly followed by PLA (poly-lactic acid) for their use in repair of tissues as implant materials.[11] In further research, the researchers needed a product which have little higher molecular weight that resulted into manufacturing of PLA with high molecular weight by the polymerization of lactide by method of ring opening. In fields of medicine, PLA has been used for internal fixing of fractured bones and drug delivery matrices. [5].In fields of agriculture, PLA has been utilized as growth promoter for crop covers, in plants and textiles etc. Today, PLA has risen as alternative to PVC, HIPS and PET. This novel matrix product has an important role in industries of containers and thermo-formed cups. Due to the awareness and increasing attention towards the development of biodegradable products, the monomers are being manufactured from the various renewable feed stocks which intern bring the PLA as a emerging solution to the plastic industry worldwide.[13] The better methods of processing and improvement in the intrinsic properties of these polymers have increased the interest of commercial sector to make PLA Products. Due to its biodegradable nature and having good properties, PLA has been widely used in different sectors of engineering industries like packaging (films and trays for biscuits, fruit, vegetables, and meat), agricultural (mulching films), furniture, electrical and electronic appliances (CD's, computer keys, casings etc), house ware and other fibers or fabrics (t-shirts, socks, blankets, wipes, hygiene products, diapers) . [10] The reason is not only that PLA is biodegradable but also due to its performance and properties at a reasonable price. So its use is increasing at a very rapid rate. PLA also provide useful in biomedical science for making various internal components of the body like rods in bones, ankle screws.[15]

B. Biodegradable Polymers Based on Classification and Sources

Biodegradable polymers are usually arranged in four different categories based upon their manufacturing and the sources of origin. Polymers of biomass origin are very useful such as the agriculture polymers. The classification of agriculture resources polymers are as follows [22]

- Polysaccharides based PLA that is starch from potato, wheat, etc, products having lignin and cellulose such as wood, straws, and other products as pectin and gums. PLA based on proteins and lipids from animals namely casein, gelatin or collagen, whey, etc, and based on plants having soya and gluten.
- Polymers that are obtained from microbial production, such as poly-hydroxyalkanoates (PHA) and poly (hydroxyl-butyrate) (PHB). The other example is poly (hydroxyl-butyrate co-hydroxy-valerate abbreviated as (PHBv).
- An another classification is polymers that are chemically manufactured using monomers that are obtained from agricultural-resources such as poly lactic acid also called PLA.

❖ Other class is of the monomers of polymers and that are both produced from fossil resources synthesized chemically such as poly-caprolactone (PCL), poly-esteramides (PEA), or organic carbon co-polyesters for example PBSA and PBAT or aromatic co-polyesters.

IV. RESULT & DISCUSSION

After a rigorous study on the research work done on bio degradable polymers, we can suggest for the following result under consideration –

- Both analytical and experimental researches have been done on polymers and its degradability but still there are not satisfactory outcomes to replace plastics effectively.
- PLA can be a good polymer that can be used for the synthesis of bio degradable substance to replace the plastics.
- The polymers prepared by using natural resin and naturally occurring gum care analyzed using software modeling as well as experimentally.
- The polymers that are reinforced with natural fibers in a fixed ratio was seen to give best results as far mechanical properties of polymers are concerned
- Some past work also suggested that the mechanical properties of polymers also depend on nano-structures of the matrix that are present in it.
- There is a vast scope of research work in the field of natural polymers and there are many areas of this regard which are untouched.

V. CONCLUSION

There are different ways for the production of poly lactic acid. It may be deduced that synthesis of higher molecular weight poly lactic acid having high yield may be achieved by taking in account the process of sequential melt-solid-poly-condensation catalyzed by water tolerant catalyst. PLA properties are not different when they are obtained by various routes. Also the study of different characteristics of PLA reflects that they can be a useful polymer for application in wide variety of fields like electrical, biomedical and packaging, and many more. Among these various uses, the biomedical utilizations stand on top wherein it has been utilized to a greater extent while applications to other fields are still in the initial stage. PLA being a polymer which is biodegradable and biocompatible, PLA can be used as preventive product for our environment without causing pollution. This review paper concludes that with the current technology obtainable for melt and for solid state poly-condensation of Lactic Acid, the finalization of catalyst, various synthetic methods, the results of operating variable on the molecular weight of the product outcome, and different properties of Poly Lactic Acids such as their physical, thermo-physical, mechanical properties, electrical properties as well as behavior of degrading and the dependence of these demands on its molecular weight, the synthesis of biodegradable polymer can be effectively prepared. The kinetics and process elaborated in the various manufacturing methods and in degradation procedure of the polymer can also be examined. Finally, this review opens a wide range of possibilities of manufacture of such a polymer that can completely and efficiently replace the use of harmful plastic from the environment.

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