International Journal of Intelligent Information and Management Science
ISSN: 2307-0692, Volume 6, Issue 1, February 2017

Research Status and Prospects of Bioplastics

Guizhi QUAN
Tianjin Agricultural University, Tianjin, 300384, CHINA

Abstract: Although plastic which is made from oil has played an important role in development of economy, at the same time the chemical properties and stability of plastic has led to "White Pollution" which means it is hard to degradation under the natural state. So it's an effective way to develop a new type of non-pollution bi-oplastic for solving environment pollution. This paper expounds the definition, properties, research progress, problem and prospect of bioplastic.

Keywords: Bioplastic; PHBV; Self-destructing plastic; Biomass plastics; PHA

1. Introduction

"White Pollution" is a concept to describe the pollution caused by hard-degradation plastic garbage. Due to the casual discard of kinds of medical, daily and industrial plastic which were hard to degradation made from poly-mer compounds such as polystyrene, polypropylene and PVC, environment is polluted badly. According to the survey, each year there are 140 thousand tons, 190 thou-sand tons plastic bags are wasted in Beijing and Shanghai, accounting for 3%, 7% of the daily garbage . Even in Tianjin, more than 100 thousand tons plastic bags are wasted each year. If these plastic bags were mixed in soil, it will less nutrients and moisture that the crops could have absorbed, and then cut the productivity; if plasticiz-er and additives permeate under the soil, groundwater will be polluted; if plastic bags are burnt with other gar-bage, poisonous gas will leak out in the air and damage human body health; and if these garbage is buried under the ground, it will occupy the land and so on. Every year in China it costs 18.5 million yuan to deal with white pollution which make it a research hotspot to develop a kind of plastic which can be degraded, safe and non-polluted.

2. Definition of Bioplastic and its Feature

Bioplastic is a kind of plastic which directly based on biological materials or fermented by microbial. So far the development of bioplastic is abstracting acrylic acid and polylactic acid from plants because there are lots of starch and protein made up by acrylic acid and polylactic acid. These abstracted chemical materials can be made to bioplastic without polyvinyl chloride, phthalates and oth-er poisonous materials by series of craft, which avoid pollution and damage in large part and it's safe and re-newable.

3. The Research Status of Bioplastic at Home and Abroad

3.1. French

In 1926 Lemoigne from France Pasteur institute found and abstracted polyhydroxybutyrate(PHB) from the huge bacillus cells. PHB, a kind of high polymer storaged in microorganism which grows up in unbalanced condition, widely exists in many prokaryotes in nature.PHB has complete biodegradability, biocompatibility, fine features, such as piezoelectric and optical activity is similar to the chemical synthetic plastic (polypropylene to synthetic rubber) from the physical and chemical properties, can be brushed, pressure film, injection molding, etc, and non-toxic and harmless. PHB has been widely used in the fields of agriculture, food, daily consumer goods, envi-ronmental protection, electronics, optics, biomedicine and so on.

3.2. America

Biologists from Michigan university firstly proposed a tentative plan that "plant" decomposable and self-destruct plastic. Plastic gene were planted into potatoes and corns , potatoes and corns were implanted genetic material which can make PHB, so they can produce biop-lastic without harmful substance under the control. Bio-logical self-destruct plastic is widely used in medical aspect. It can be used to support between bones in an surgery and will decompose carbon dioxide and water gradually with the healing of bones. There is another kind of linear biological self-destruct plastic used to re-place the traditional medical surgical line because it could degrade and be absorbed by human body without taking out after suturing the wound. Besides this kind of plastic could be used to produce medical capsule which

will dissolve slowly and can control the speed the drug permeates into Blood vessels.

American Imperial Chemical Company used Alcaligenes to manufacture biodegradable plastic Polyhydroxybutyrate-hydroxyvaleric acid(PHBV) fermented with sugar and organic acid. The bacteria will store PHBV as energy and when PHBV take 80% of the weight of bacteria, we will break the bacteria with steam and collect the plastic. PBHV is similar with Polypropylene. It's stable even in damp environment after it is abandoned, but it will degrade into carbon dioxide and water when there is microbes around it.

A research team led by Paul J. Dauenhauer from University of Massachusetts Amherst found a new way to manufacture biomass plastic. It will transform glucose to P-xylene which is key material to manufacture biomass plastic through three steps in high temperature bioreactor with molecular sieve as catalyst. It's an important breakthrough because the conversion rate of producing P-xylene with the most of biomass is up to 75% and it's cheaper than other methods. The research results was published in the American chemical society journal ACS catalysis. PET(Polyethylene terephthalate) plastic made from P-xylene could be used to make carbonated beverage bottles, food packaging, synthetic fiber clothing, even car parts and so on.

3.3. Germany

Microbiologists from University of Göttingen in Germany found that plants could generate polyester in the cell after implanted the specific gene of one bacterial and the polyester could be used to made plant-based biochemical plastics. The plastic can degrade into water and carbon dioxide under the effect of bacterial, so this kind of plastic trash can be buried under the ground as fertilizer for plants. And there are many other scientists are trying to add starch material into plastic, so it could be eaten by the bacterial which live on starch and disappear slowly

Besides BioImaging & Optics Platform(BIOP) is planning to build the first factory in Brandenburg, European to produce biomass plastic with potato starch and it can produce 35 thousand tons each year.

3.4. China

Koninklijke DSM N.V. from Netherlands founded a company with 20 million dollar named Tianjin GreenBio Materials Co, Ltd located in Tianjin Economic and Technological Development Zone whose main work is producing Polyhydroxyalkyl(PHA) ester polymers. PHA which exists in prokaryotic cells as carbon source and energy is a kind of degradable plastic synthesized by microorganism. It's a new renewable and wildly useful polymer because it could degrade completely into water and carbon dioxide in ecosystem.

There is a new biomass plastic developed in Shanghai, it's made from biodegradable polyester through an unique process and catalyst. Through the test of National Plastic Products Quality Supervision and Inspection Center, the degradation rate of this plastic is up to 62.1% in 94 days and it meets the definition of biodegradable plastics defined by national standard. This kind of plastic could be used to produce other supplies if it is mixed with starch or other biological material according to certain percentage. It could be "eaten" by microorganism in the soil after it is abandoned so it's unharmful. It also could be used to make disposable appliances, packing box, agricultural film and so on because it's very stable even though the temperature is over 100℃.

3.5. UK

UK had developed a research project named Combine which mean to develop one bioplastic could be used for very long time. This plastic is hard, light and environmentally friendly and could be used to make car door, hull, infant incubators and other similar products. Rather than thousands of years of half-period of normal plastic, this plastic's half-period is very short because it is the first time that producing structural materials and products with renewable source which means using plants to compound unharmful plastic. The purpose of project Combine is going to develop a new high-performance composite which uses living creatures as raw material with the combination of creation in natural fibers and bioplastics. For now there are only two types of natural plastics which include short fibers made through filled and mat fibers made through compressed, but both of them are not hard enough to be used to make structural component. Natural fiber yarn is always screwed together which makes it difficult to inject viscous thermoplastic resin. In this project, hemp fiber and flax fiber are spun from continuously fiber high performance textiles. After mixing the textiles and self-destructing bio-plastics such as polylactic acid and then put it into vacuum and compress. The last step is surface treatment whose purpose is to strong the combination of fiber and resin. The technique of combination and process is going to be developed and environment degradation in the future, mixed and recyclability are also needed to be considered at the same time.

3.6. Japan

According to the report from Kyodo News Agency in August 18th, 2016, NEC claimed that it had developed a black bioplastic which looks like advanced lacquerware on May 17th. It added material which used to add color and adjust reflection of light into cellulose resin made from trees, grass and some other non-edible plants. This plastic can not only be processed to kinds of shape through being heated to melt, but also be beautiful and easy-designed, so it wouldn't be decorated by spray

painting. NEC is trying to make it widely used in decoration in cars, home appliances and interior.

4. Problems and Prospects

4.1. Problems

Price:The price of bioplastics is much more expensive than normal plastics which hinders its quick spread for now. Some Japanese companies use bioplastics for building their corporate environmental identity. Once the production of bioplastics improves, the cost will go down.

Because it uses crop which human eat, scientists from Japan and America have began to make bioplastics with wasted wood and grass.

There isn't a unified way to mark up bioplastics.

Global warm. Although the degradable bioplastics point out that human will not rely on petroleum to make plastics, it will also produce carbon dioxide and lead to global warm.

Question about safety of genetically modified material. Although manufacturer always use genetically modified organisms such as corn, switchgrass, sugar cane, sweet potatoes to make bioplastics for improving fermentation, it's defective to recycle and re-use the plastics.

4.2. Prospects

Because it can protect environment and resources, bioplastics are very popular at the day which green product is popular with the world. According to the report, the global market of bioplastics will grow rapidly whose growing speed will reach 8%-10% each year under estimated, it will increase from one billion to ten billion dollar from 2007 to 2020. The need of bioplastics will grow while it is used in automobile and IT. Although package is dominating the market for a long time, its market share will go down from 65% to 40% from 2007 to 2025 under estimate. In 2025, the leader of bioplastics market will be Asian whose market share is 32%, Europe's market share will be 31% and America's market share will be 28%. Because of the rapid grow of transgenic plants, Asian will gain the leadership of market. In 2007, the share of bioplastics is 10%-15% in the whole plastics market and it will reach 25%-30% because of the application of creation in automobile, medical and IT with the improvement of performance of bioplastics.

References

[1] Liu Baoquan, Jiang Benguo. The Research of Poly β-Hydroxybutyric Acid (PHB) Journal of Dalian Nationalities University, 2000,1(4):15~20.

[2] Su Tao, Zhou Hezhi, Liang Jingjuan. Degradable plastics polyhydroxyalkanoic acid compounded by microorganism[J]. Industrial Microbiology, 1997,27(3):37~48

[3] Li Hesheng, Zhang Chunyuan, Zhang wei etc. Breeding and Fermentation Conditions of Polyhydroxybutyrate[J]. Petrochemical Technology, 1997,4(4):212~215.

[4] Song Zhaozhen. Biodegradable Plastics Production Technology[J]. Advances in Fine Petrochemicals. 2005,(3):13~20

[5] Zhou Peng. Research Progress of Biodegradable[J]. Shanxi Chemical Industry. 2005,(2):23~27

[6] Li Xing. Research and Development of Biodegradable Plastics in China[J]. Chemical Industry Production and Technology,2004,(1):26~30

[7] Tang Saizhen. Research and Development of Biodegradable Plastics in China[J]. Modern Chemical Industry,2002,(1):2~6

[8] Yi Zuhua, Huang Herong, Chen Dong, etc. Study on poly - β - hydroxybutyric acid produced by Alcaligenes eutropha mutant strain[J]. Bulletin of Microbiology. 1995,22(1),29~31

[9] Chen Guoqiang. Application Status and Development Trend of Biodegradable Plastics[J]. Fine and specialty chemicals,2001,(18):22~26

[10] Qian Bozhang. Application Status and Development Trend of Biodegradable Plastics[J]. Shanghai Chemical Industry,2004,(2):43~46

[11] Zhao Wei, Wang Baiyi, Zhang Xiaohua. Research Status and Prospect of Biosynthesis of Poly - β – hydroxybutyrate. 2006,22(3),129~130