Bio-based Materials China News

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Contents

Headline

Petrochemical PET encounters serious overcapacity. CCM analyzes the PET market on the basis of its production capacity, raw materials and downstream demand in China. As the price of all PET drops and the demand for PET declines, it will be more difficult to develop bio-based PET.

Although the scale of China's bio-based PBS industry ranks front in the world, its development in recent years is far away from expectation, which is closely related to the backwards development of China's bio-based succinic acid. After comparing the production scale and application of succinic acid at home and abroad, CCM believes the development of China's bio-based PBS will be confronted with obstacles.

At present, social problems, such as the lack of petroleum and environmental deterioration, are attracting people's eyes. As a potential product to partly substitute petrochemical plastics, the biodegradable plastics see a strong momentum with the policy support.

Since no applicable standards have been established, China's bio-based materials market is in chaos. This brings drawbacks to its development.

Similar to other bio-based materials, the development of PLA is restricted by raw materials such as LA. However, thanks to the advantages in technology and application, PLA is still positioned as one of the bio-based materials with the strongest development potential.

Governmental policy support is the key to the development of bio-based materials. Due to favorable policies for bio-based materials from the national and local governments, Jilin Province has become the core cluster region for the bio-based material industry in China. At present, the industry cluster scale of bio-based materials is only beginning to be formed. The development of bio-based materials will still rely on policy support over a period of time in the future.

Less and less attention has been paid to the technology of manufacturing bio-based materials. The focus has been gradually shifting to the modification technology for the application of bio-based materials. Using modification technology to produce bio-based products for application in multiple fields has been identified by Chinese bio-based materials enterprises as the ideal strategy for their bio-based materials businesses.

High price of starch is always the main reason for the high cost of raw materials for bio-based materials. To reduce the cost of raw materials for bio-based materials, producing starch with low-priced cellulose is a research focal point in China. Considering the development of the technology of producing bio-based materials with cellulose and the industrialization progress currently, there are no signs that the method of using cellulose to produce bio-based materials will be used in commercial production.

2014 – The operating rate in China's corn starch processing industry began to go up significantly from Sept. However, this can not mitigate the lash of the harvested corn launched on the market on the price of corn starch. The downward trend of the corn starch price has been formed. Considering the prices of corn starch in different areas of China, the corn starch price is expected to see a downward trend in Dec. 2014.

Q1–Q3 2014 – The price of castor oil stayed upward, benefited from many factors like optimized planting structure and reduced planting area of castor, and favorable market of downstream sebacic acid. CCM believes that this trend will continue to the end of 2014.

Editor's Note

In Nov. 2014, the ICTABP6 was held in Anhui Province. Mainly the current situation, development direction and problems of bio-based materials were discussed at the conference. In this issue, CCM also centers the current situation and prospect of PLA, PET and biodegradable plastics in the analysis.

CCM tries to explore the limitation of PLA industry from the perspective of domestic supply and demand, covering the raw material LA. Compared with that of other bio-based materials like PBS and PHA, the production capacity of LA for PLA in China is large. However, CCM finds out that the development of PLA is still restricted by raw materials, regarding the production capacities of industrial and food grade LA and the technology for PLA. Meanwhile, it is believed that PLA is still one of the bio-based materials with the strongest development potential. How do raw materials such as LA restrict the development of PLA? How does PLA continue the strongest development?

Similarly, bio-based PET also shows problems in raw materials. CCM pays specific attention to petrochemical PET, which is regarded as a competitor for bio-based PET. In the light of the raw materials, PTA and MEG, involving their production capacities, apparent consumption, etc., petrochemical PET is proven to encounter serious overcapacity. Meanwhile, fiber, major downstream application for PET, is highlighted. In conclusion, the demand in petrochemical PET market is not that optimistic. Moreover, the continuous price decreases of crude oil in the world is considered, so as to find out the changes brought to the price and market of petrochemical PET and further to analyze the possibility for bio-based PET to enter into the market. What about the current situation of petrochemical PET? What impact will it bring to bio-based PET?

Of course, the bio-based materials market does not wholly stay at a standstill and even depression. CCM collects data from the European associations and concludes that biodegradable plastics maintain a high growth rate and Asia will play a key role in the development of biodegradable plastics.

In addition, CCM grasps the changes in castor oil and domestic technology for bio-based materials.

The above hot topics in China's bio-based materials market will be explored and reported by CCM in detail in this e-journal, *Bio-based Materials China News 1411*. Please pay attention.

The USD/RMB and EUR/RMB exchange rates in this issue are USD1.00=RMB6.1525 and EUR1.00=RMB7.6696 on 3 Nov., 2014, sourced from the *People's Bank of China*. Meanwhile, all the prices in this issue include VAT.

Market Dynamics

Development of bio-based PET severely hindered by overcapacity and declining demand of petrochemical PET

Petrochemical PET encounters serious overcapacity. CCM analyzes the PET market on the basis of its production capacity, raw materials and downstream demand in China. As the price of all PET drops and the demand for PET declines, it will be more difficult to develop bio-based PET.

In the recent three years, both domestic and foreign enterprises have been actively developing bio-based polyethylene terephthalate (PET). More and more manufacturers engage themselves into the production of bio-based PET. The US-based Virent, Inc. produced bio-based p-xylene (PX), which is a raw material for bio-based PET. The US-based Coca-Cola Company produced bio-based PET bottles. The US-based Gevo, Inc. and the US-based Anellotech, Inc. planned the commercial production of bio-based PET. The South Korea-based Honam Petrochemical Corp., the South Korea-based KP Chemical Inc. and the Japan-based Toyota Tausho Corporation cooperated to produce bio-based PET.

There are two reasons for the hot trend of bio-based PET. On one hand, this is the requirement of low carbon and environmental protection. On the other hand, under the global overcapacity of petrochemical PET, enterprises hope to achieve new profit growth through creative non-petrochemical products like bio-based PET. Petrochemical PET has always been regarded as the direct competitor of bio-based PET. Meanwhile, the price of and the demand for bio-based PET are the keys for it to partly replace petrochemical PET. CCM tries to give a comprehensive analysis on how petrochemical PET hinders the price of and the demand for bio-based PET from the perspectives of the upstream and downstream industries and the production capacity of petrochemical PET in China.

As the production capacity of petrochemical PET is enlarged greatly, the overcapacity of petrochemical PET appears, further resulting in the constant price declines of petrochemical PET.

In 2007–2013, the scale of petrochemical PET industry in China expanded rapidly and the production capacity showed an increasing trend. According to statistics from CCM, since 2010, the annual growth of the production capacity had exceeded 2 million t/a. The production capacity in 2012 increased by more than 5 million t/a compared with that in 2011. In 2013, the production capacity of petrochemical PET in China was 43.50 million t/a, with an increase of about 88.70% compared with that of 23.05 million t/a in 2007.

Just in H1 2014, a total of 11 petrochemical PET plants were put into operation in 9 enterprises, including Anyang Chemical Industry Limited Liability Company, Shenghong Group Holdings Limited, Jiangsu Sanfangxiang Group, etc., with an accumulative production capacity of over 2.50 million t/a. What's more, another 2 million t/a will be newly added to petrochemical PET as planned in China in H2 2014. At the end of 2014, the domestic total production capacity of petrochemical PET is estimated to reach about 48 million t/a.

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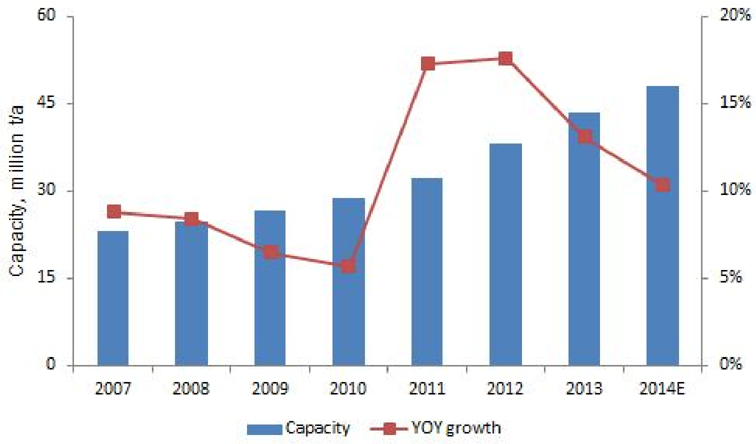
Figure 1: Production capacity of petrochemical PET in China, 2007–2014E



Note: PET stands for polyethylene terephthalate.

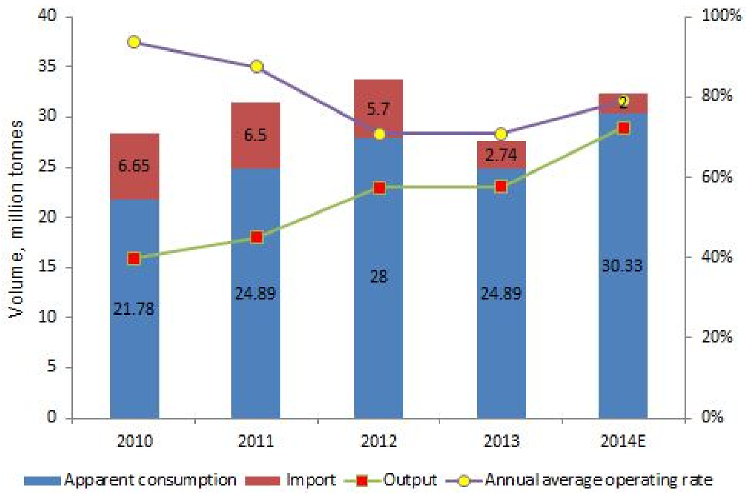
Source: CCM

CCM tries to analyze the overcapacity of petrochemical PET concerning the output, apparent consumption and operating rate of the petrochemical pure terephthalic acid (PTA, the main raw material for petrochemical PET).

Since 2010, the output and the operating rate of PTA had been rising. However, in 2012–2013, they stayed at the same levels or even declined in a short term, because the overcapacity of PET seriously had begun to impact the supply of PTA since 2012. Generally speaking, 0.85 tonne–0.86 tonne of PTA can produce 1 tonne of PET. The apparent consumption of petrochemical PTA in 2013 was 24.89 million tonnes. Theoretically, 29.28 million tonnes of petrochemical PET can be produced based on the aforementioned data. However, the domestic production capacity of petrochemical PET in 2013 was 43.50 million t/a. Superficially, PTA restricted the production of PET. Actually, the domestic production capacity of PTA was hard to release after 2010. In other words, the actual consumption of petrochemical PET was less than the theoretic number of 29.28 million tonnes. Normally, the apparent consumption is larger than actual consumption. However, the serious overcapacity of petrochemical PTA has already appeared. Then how serious the overcapacity of petrochemical PET in China is.

CCM predicts that the operating rate of petrochemical PTA enterprises would partly rise in 2014 because the significant drop of petroleum price could partly reduce the cost of petrochemical PTA. And petrochemical PTA enterprises would take this opportunity to cut the PTA price (even undertake losses) to liquidate inventories. This will partially stimulate the downstream consumption, especially that of petrochemical PET.

Figure 2: Apparent consumption, imports and operating rate of petrochemical PTA in China, 2010–2014E

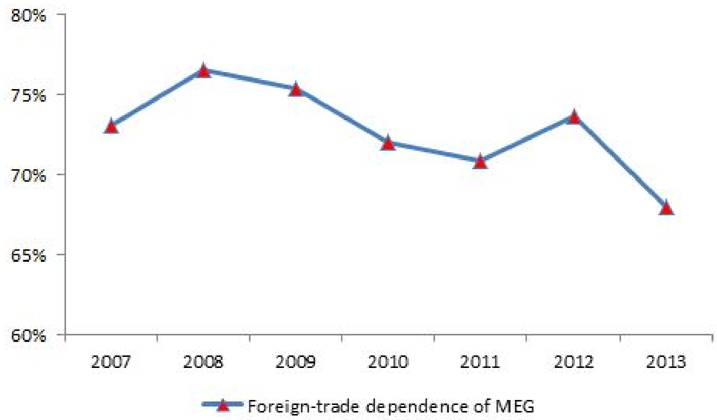


Note: PTA stands for pure terephthalic acid.

Source: CCM

In addition, as another important raw material for petrochemical PET, mono ethylene glycol (MEG) aggravates the destruction of ecological balance in petrochemical PET industrial chain. MEG is mainly from state-owned enterprises or imported from foreign countries. Nevertheless, more than 90% of PET enterprises are private enterprises. Considering the import-oriented feature of MEG and the distribution of MEG supply, more than 70% of MEG relies on imports for a long time. Private enterprises only have 10% of MEG supply. Consequently, domestic petrochemical PET manufacturers have weak bargaining power. In general, severe monopoly of raw materials like MEG results in the serious destruction of ecological balance in petrochemical PET industrial chain, which can not be changed in a short time.

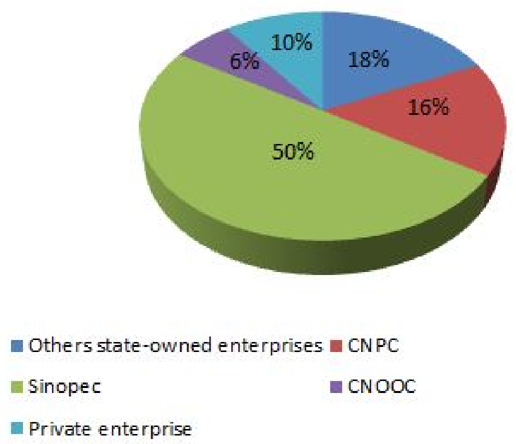
Figure 3: Foreign-trade dependence of petrochemical MEG in China, 2007–2013



Note: MEG stands for mono ethylene glycol.

Source: CCM

Figure 4: Supply distribution of petrochemical MEG in China, 2014



Note: MEG stands for mono ethylene glycol.

Source: CCM

Furthermore, the demand for PET in China is declining. Both petrochemical PET and bio-based PET are mainly used for producing fiber applied in textile and garment. Affected by many factors, such as international economic status, cost and demand, in 2011–2014, the domestic apparel industry saw a sharp decrease in the growth of output. According to statistics from the National Bureau of Statistics of the People's Republic of China, the growth of output of scaled apparel enterprises [Scaled apparel enterprises refer to enterprises with an annual revenue of no less than USD3.25 million (RMB20 million)] decreased from 17.68% at the beginning of 2010 to 1.27% in Dec. 2013. The growth of output of scaled apparel enterprises in 2013 declined by 4.93 percentage points compared with that in 2012, by 6.87 percentage points compared with that in 2011 and by 17.33 percentage points compared with that in 2010, presenting a slow growth. In 2014, from the feedback of the textile industry associations, the apparel industry is not promising, which directly influences the demand for PET.

The imbalance between supply and demand forces the market price of PET to drop continuously. Take Sinopec Yizheng Chemical Fibre Company Limited for example. The average ex-works price of petrochemical PET remained at USD3,007/t (RMB18,500/t) in 2012. In Nov. 2014, the average ex-works price of petrochemical PET stayed at USD1,398/t (RMB8,600/t).

As a potential substitution for petrochemical PET, bio-based PET will encounter obstacles in its development. At present, the biggest problem for bio-based PET is market promotion. And the high price is the largest obstacle for the market promotion. Petrochemical PET is superior in price compared with bio-based PET due to its mature industrialization scale. Currently, the petrochemical PET price is declining continuously. Bio-based PET is extremely disadvantaged regarding the price.

In addition, the demand for PET is not large in the market. Therefore, the demand for bio-based PET will be even smaller. It is more difficult for the market promotion. And this situation can hardly change in a short time. All in all, in terms of petrochemical PET market, bio-based PET seems hard to claim market shares.

Figure 5: Output growth in apparel industry in China, 2010–2013

Source: National Bureau of Statistics & CCM

Backwards development of bio-based succinic acid against development of bio-based PBS in China

Although the scale of China's bio-based PBS industry ranks front in the world, its development in recent years is far away from expectation, which is closely related to the backwards development of China's bio-based succinic acid. After comparing the production scale and application of succinic acid at home and abroad, CCM believes the development of China's bio-based PBS will be confronted with obstacles.

The overall scale of the bio-based polybutylenes succinate (PBS) industry in China is relatively large. However, the development of the bio-based PBS industry is not consistent with the scale. Policies like the two five-year plans supported the development of bio-based PBS in China. At present, the bio-based PBS industry does not develop as expected. In 2010, the total production capacity of bio-based PBS in China reached 50,000 t/a, mainly because many new bio-based PBS projects appeared with the support of favorable policies for new materials when it was the end of the *Eleventh Five-year Plan* and the beginning of the *Twelfth Five-year Plan*. After 2010, the bio-based PBS industry developed rationally in China. Some plants stopped production or even exited the market. The production capacity stayed basically at the level of 2010.

Although the production capacity of bio-based PBS in China has remained at about 50,000 t/a for a long time, it does not indicate a promising prospect for bio-based PBS. The reasons are as follows. On one hand, bio-based PBS is not well accepted in the market. On the other hand, bio-based PBS market is in turmoil interfered by the counterfeit and inferior bio-based PBS produced by some enterprises with petrochemical materials like petrochemical succinic acid. Regarding the global production capacity of bio-based PBS, the production capacity and industrialization scale of China's bio-based PBS industry rank front in the world. In fact, domestic bio-based PBS is greatly restricted by the lagging production and supply of bio-based succinic acid in China. Enterprises with large production capacity of bio-based PBS purchase bio-based succinic acid from overseas enterprises, such as BASF.

Table 1: Production capacity of bio-based PBS in China, 2014

Enterprise	Capacity, t/a	Potential capacity, t/a	Source for raw materials	Remark
Zhejiang Hangzhou Xinfu Pharmaceutical Co., Ltd.	13,000	20,000	Part: BASF's bio-based succinic acid	Launched in 2007, can be expanded to 20,000 t/a
Anqing Hexing Chemical Co., Ltd.	5,000	10,000	Self-produced petrochemical succinic acid and BASF's bio-based succinic acid	To raise production from 2015
Shandong Landian Biological Technology Co., Ltd.	3,000	10,000	N/A	First-phase project under construction and to be finished before 2016. Only a small amount of PBS produced, not sold in the market
Shandong Fuwin New Material Co., Ltd.	20,000	0	/	Suspended
Guangzhou Kingfa Sci & Tech Co., Ltd.	3,000	9,000	BASF's bio-based succinic acid	9,000 t/a PBSA plant in Zhuhai City, Guangdong Province to be completed in 2015
Inner Mongolia Jupu Science and Technology Co., Ltd.	0	10,000	N/A	Launched in Aug. 2014

Note: PBS stands for polybutylenes succinate; PBSA stands for poly(butylene succinate-co-butylene adipate).

Source: CCM

Compared with the overseas status, the production scale of bio-based PBS is not consistent with the development of bio-based succinic acid (the main raw material for bio-based PBS) in China. The development of bio-based succinic acid in China is severely falling behind. At present, the bio-based succinic acid in China is in a state of blank. It did not achieve primary development until 2012. At that time, Shandong Landian Biological Technology Co., Ltd. (Shandong Landian) announced to construct the bio-based succinic acid plant with a production capacity of 500,000 t/a in three phases. This was the first large scale planning production of bio-based succinic acid in China. Currently, the construction for the first phase hasn't be finished so only a small amount of food grade succinic acid is produced in Shandong Landian and the production capacity is merely 300 t/a. Besides, bio-based succinic acid used for chemical purpose hasn't been produced yet. Even though China National Bluestar (Group) Co., Ltd. also planned to produce bio-based succinic acid, it can be predicted that the total production capacity in China in 2015 will not exceed 10,000 t/a.

In fact, before 2010, bio-based succinic acid had not been produced at home and abroad. In Jan. 2010, BioAmber Inc. (BioAmber) constructed the first commercial bio-based succinic acid plant in the world. Glucose derived from wheat was adopted as raw material in the plant. At the beginning, the production capacity was 2,000 t/a. Two factors can account for such a production capacity. On one hand, breakthrough in the fermentation technology for succinic acid was hard to achieve. On the other hand, at that time, bio-based succinic acid can hardly be promoted and profit was also hard to make. This indirectly resulted in the unsatisfactory bio-based succinic acid market.

In the following years, bio-based succinic acid was applied in fields like food additives and welding. What's more, due to the mainstream of low carbon and environmental protection, the market demand for bio-based PBS sharply expanded, bringing about a favorable market trend. After 2012, blowout appeared in overseas bio-based succinic acid enterprises. Although it has developed only for a short time, the total production capacity is estimated to exceed 200,000 t/a in 2015.

There is a gap between the production capacities of bio-based succinic acid enterprises at home and abroad. This directly influences Chinese bio-based PBS enterprises' pricing power. Large-scale bio-based PBS plants in China have to rely on the imports of bio-based succinic acid for development, which is seriously detrimental to the development of bio-based materials in China.

Table 2: Production capacity of bio-based succinic acid in China and globe, 2014

Manufacturer	Investor	Capacity, t/a	Production site	Remark
Shandong Landian Biological Technology Co., Ltd.	Shandong Landian Biological Technology Co., Ltd.	300	Shouguang City, Shandong Province	First phase under construction and to be finished in 2016
Reverdia	Royal DSM & Roquette Frères	10,000	Cassano Spinola, Italy	Put into operation in 2012
Myriant Corporation	Myriant Corporation	13,600	Lake Providence, Louisiana	Put into operation in 2013, and production raised from 2014. Potential capacity: 77,000 t/a
N/A	BASF & Purac	25,000	Barcelona	Supply bio-based succinic acid to the auto bioplastic company established by Faurecia SA and Mitsubishi Chemical Corporation
N/A	BioAmber Inc. & Mitsui Chemicals, Inc.	30,000	Sarnia, Ontario, Canada	Put into operation in 2013 (17,000 t/a) and expanded to 30,000 t/a now
Succinity GmbH	BASF & Corbion-Purac	10,000	N/A	Put into operation in 2013

Source: CCM

Table 3: Planned projects for bio-based succinic acid in China and globe, 2014

Manufacturer	Investor	Planned capacity, t/a	Production site	Remark
N/A	Myriant Corporation & China National Bluestar (Group) Co., Ltd.	50,000	Nanjing	/
N/A	BASF & Purac	50,000	N/A	/
N/A	BioAmber Inc.	65,000	Thailand	Specially supply to a PBS plant newly established in Thailand by PTT MCC Biochem Co., Ltd., which is a joint venture set up by PTT Co., Ltd and Mitsui Chemicals, Inc. The plant was planned to launched in 2014.

Source: CCM

Actually, bio-based succinic acid plays a decisive role in the bargaining power of bio-based PBS. About 0.62 tonne of succinic acid can produce 1 tonne of PBS. The backwards development of bio-based succinic acid will weaken the bargaining power of domestic bio-based PBS. Furthermore, the weak bargaining power will largely restrict the reduction of bio-based PBS cost, which will further influence the market promotion of bio-based PBS and the enthusiasm of investors. Hence, the development of bio-based succinic acid directly impacts the development of bio-based PBS to some extent.

Besides, bio-based succinic acid from foreign countries already imposed obstacles on domestic bio-based succinic acid to enter the market. Actually, overseas bio-based succinic acid manufacturers, such as BioAmber and BASF, have sold their bio-based succinic acid in China and other countries. They have begun to take shares in the bio-based succinic acid market. More importantly, they have planned to take part in the formulation of bio-based succinic acid industry standard in China. This will certainly construct strong barriers to Chinese bio-based succinic acid enterprises who enter the market later and will restrict the development of bio-based succinic acid in China. The pricing power of domestic bio-based PBS will be weakened in the future. And Chinese enterprises can not dominate the market any more.

In addition, bio-based succinic acid is not applied in many fields in China. It is potentially applied in the downstream industry of primary bio-based PBS materials. However, in other countries, enterprises such as BASF, apart from applying in primary bio-based PBS, also apply bio-based succinic acid in the modification and blending of PBS. It is known that, compared with unmodified PBS, modified PBS is resistant to higher temperature with higher intensity and lower cost. Modified PBS can be blended with polypropylene (PP), polystyrene (PS), polycarbonate and bio-based materials, such as polylactic acid (PLA) and polyhydroxyalkanoate (PHA). It can also be used to manufacture non-woven fabrics for automotive interior materials, fiber or padding for construction and consumer goods. Moreover, modified PBS has met the requirement s from the US Food and Drug Administration (FDA) and began to be sold in the market of Europe and America.

According to the prediction of BioAmber at the beginning of 2012, the market value of modified PBS and PBS blending materials in the world will be worth USD2 billion in the future. At present, the application of bio-based succinic acid in China is falling behind and bio-based succinic acid is rarely applied in the PBS blending materials. And the domestic market does not have a strong demand for the application of bio-based succinic acid in primary PBS materials.

Analysis on development of biodegradable plastics

At present, social problems, such as the lack of petroleum and environmental deterioration, are attracting people's eyes. As a potential product to partly substitute petrochemical plastics, the biodegradable plastics see a strong momentum with the policy support.

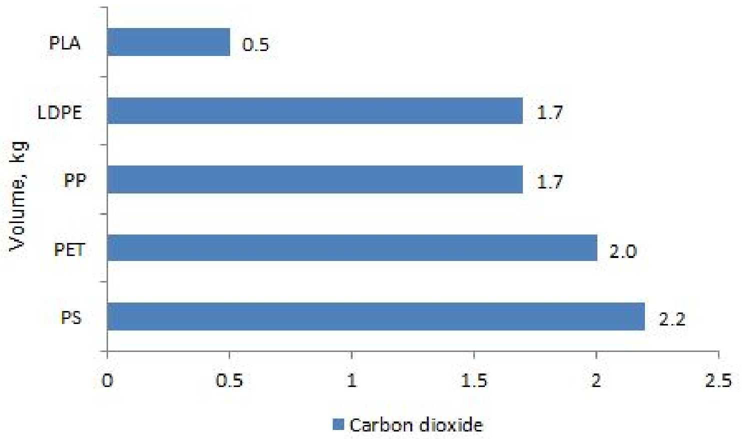
On 3 Nov., 2014, BASF discussed about the investment in biodegradable plastics with Chinese enterprises such as SUPLA (Suqian) New Material Co., Ltd., in Changchun City, Jilin Province. On 24 Nov., 2014, Guangdong Shangjiu Biodegradable Plastics Ltd. and enterprises from Argentina and Turkey jointly invested in producing biodegradable plastics. In fact, many enterprises begin to make preparations for the expanding demand for biodegradable plastics. Since the beginning of 2014, as the most famous biodegradable plastics listed company in China, Guangzhou Kingfa Sci & Tech Co., Ltd. has witnessed a continuous growth in its stock, which indicates that the concept of biodegradable plastics is gradually known and accepted by the public.

Biodegradable plastics are given attention since they can mitigate the consumption of petroleum and the environmental pressure. Raw materials for biodegradable plastics are partially or totally from renewable resources. Normally, biological fermentation is adopted for the synthesis of biodegradable plastics. Compared with chemical synthesis, biological fermentation can effectively reduce the energy consumption, which is significant for the sustainable development. More imminently, the world’s petroleum reserves can be consumed for only 46 years counting the current consumption, according to the world’s petroleum report released by the Union Bank of Switzerland in March 2014. At present, international conflicts are in gestation due to the lack of petroleum, and severe environmental problems like greenhouse effect are caused by the consumption of petroleum. Petrochemical plastics not only largely consume substantial resources of petroleum, but also are regarded as one of the sources for environmental crisis.

Meanwhile, the global output of plastics rose by 3.90%, from 288 million tonnes in 2012 to 299 million tonnes in 2013 (statistics from the European Plastic Manufacturer Association in 2013). Specifically, more than 90% were petrochemical plastics. The growth of the output also meant the increasing consumption of petroleum. Consequently, it was urgent for degradable plastics to partially substitute petrochemical plastics. This was mainly because biodegradable plastics could mitigate environmental crisis like greenhouse effect caused by the consumption of petroleum.

The advantage of biodegradable plastics is highlighted in carbon footprint and cyclic utilization of carbon. Comparing polylactic acid (PLA) with common plastics, such as petrochemical polystyrene (PS), polyethylene terephthalate (PET), polypropylene (PP) and low density polyethylene (LDPE), we can find that 1 kg of PLA discharges approximately 0.50 kg of CO_2 and that 1 kg of LDPE discharges 1.70 kg of CO_2, which is the lowest emission among the aforementioned petrochemical plastics. The carbon emission of biodegradable plastics is obviously advantageous. Regarding the utilization of CO_2, it can not be recycled in petrochemical plastics. Nevertheless, biodegradable plastics, especially bioplastics, are normally produced through the fermentation of starch sugar. And starch sugar is generated through biological methods like photosynthesis of plants, during which a large amount of CO_2 is absorbed. Thus, no more new CO_2 source is generated, helping maintain the balance of carbon in nature.

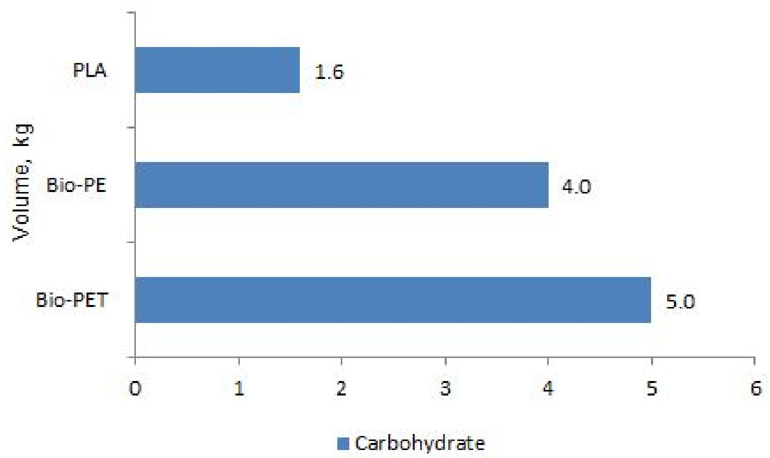
Figure 6: Emissions of carbon dioxide from production of major polymers



Note: 1 kg counted for each polymer. PLA stands for polylactic acid; LDPE stands for low density polyethylene; PP stands for polypropylene; PET stands for polyethylene terephthalate; PS stands for polystyrene.

Source: European Plastic Manufacturer Association & Int. Journal Life Cycle Assessment

Figure 7: Carbohydrate required in production of bio-based polyester

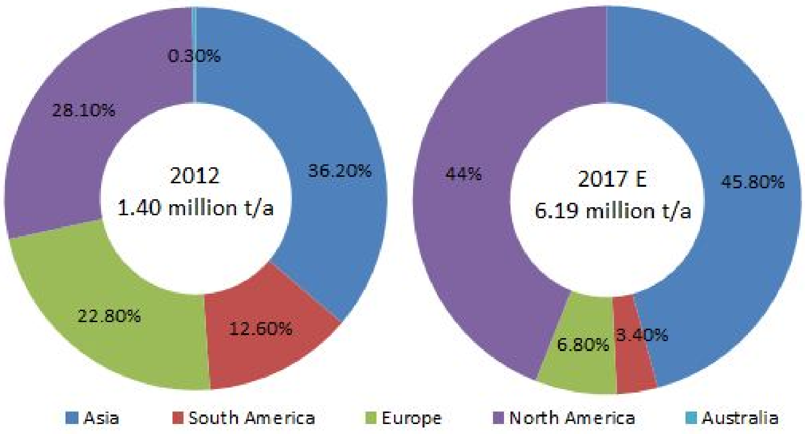


Note: 1 kg counted for each bio-based polyester. PLA stands for polylactic acid; PE stands for polyethylene; PET stands for polyethylene terephthalate.

Source: European Plastic Manufacturer Association & Int. Journal Life Cycle Assessment

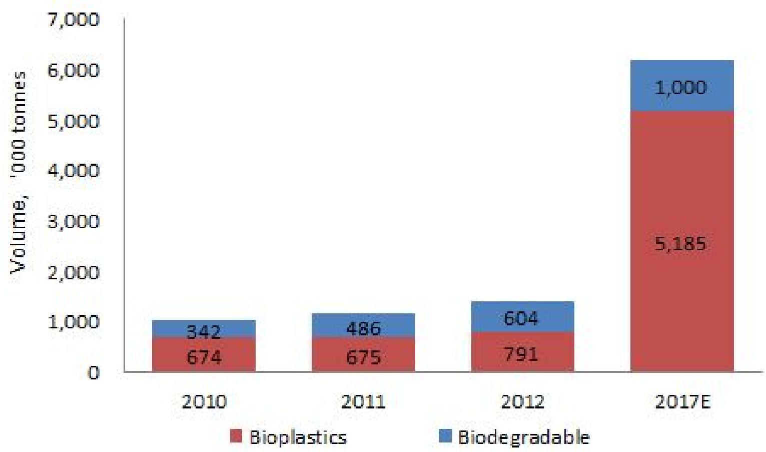
Relying on the unique environmental advantage, the market of biodegradable plastics is expanding gradually. According to statistics from the European Bioplastics Association released at the end of 2013, in 2010–2012, the global production capacity of degradable plastics increased continuously and it was estimated to reach about 6.19 million t/a by 2017. On the basis of the supplementary data from the US-based Research and Markets released recently, in 2013–2018, the compound average growth rate of the synthetic and bioplastics in the world will reach 20.41%. Asia and North America are the fastest growing regions regarding the production capacity and consumption of biodegradable plastics. It is predicted that the production capacity and consumption in Asia and North America will account for more than 80% of the world's and the respective output will exceed 1 million tonnes.

Figure 8: Global production capcaity of degradable plastics by region, 2012 and 2017E



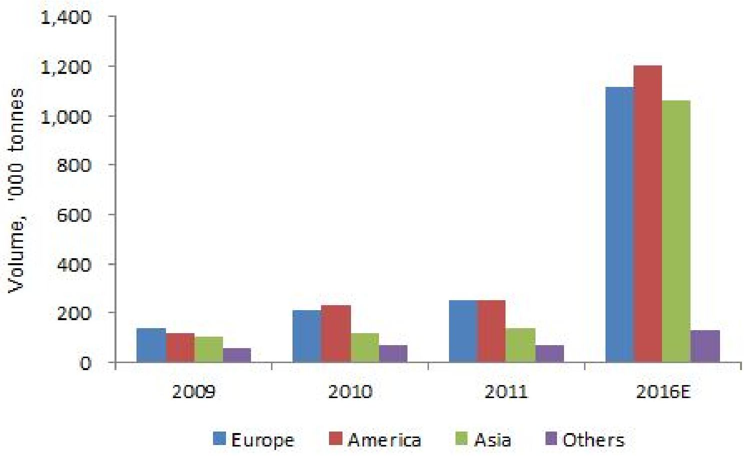
Source: European Bioplastics Association & Institute for Bioplastics & Biocomomposits (December 2013)

Figure 9: Global production capacity of degradable plastics by type, 2010–2017E



Source: European Bioplastics Association & Institute for Bioplastics & Biocoomposits (December 2013)

Figure 10: Global consumption of bioplastics by region, 2009, 2010, 2011 and 2016E



Source: BBC Research (2012)

Under the lack of petroleum and the environmental pressure, biodegradable plastics show a strong momentum. However, biodegradable plastics will not necessarily replace petrochemical plastics. Biodegradable plastics have the unique advantage of environmental protection for certain plastics, such as disposable plastic products, sanitary products and films. After use, these products can decompose through ways like composts. This is the goal for the development of biodegradable plastics promoted by different countries.

Currently, many countries in the world emphasize the application of biodegradable plastics in disposable products, aiming at partially replacing petrochemical plastics with biodegradable plastics. This will certainly further promote the development of biodegradable plastics. At present, petrochemical plastics have monopolized the market and it is hard to break this pattern. What's more, the cost and the price of petrochemical plastics are relatively low thanks to mature technology and large production. The cost and the price are two biggest obstacles to the development of biodegradable plastics. Biodegradable plastics can hardly develop by only depending on environmental consciousness. The good news is that many countries in the world encourage and strongly promote the application of biodegradable plastics through policies, such as tax exemption and subsidies, so as to less rely on non-degradable petrochemical plastics. At present, driven by favorable policies, biodegradable plastics show a strong momentum.

Table 4: Part of laws for biodegradable plastics

Country	**Laws for biodegradable plastics**
France	Propose that bio-based materials should account for 40% in disposable non-biodegradable plastic shopping bags
Portugal	Replace disposable plastic shopping bags with biodegradable plastic bags to reduce the consumption of petrochemical plastics
Romania	Levy tax of USD0.31 (EUR0.25) for per non-degradable plastic bag
The UK	Charge for disposable petrochemical plastic bags, and exempt tax for biodegradable plastic bags
China	Jilin Province prohibits using disposable non-degradable plastic bags

Source: CCM

Standards for bio-based materials industry highly required in China

Since no applicable standards have been established, China's bio-based materials market is in chaos. This brings drawbacks to its development.

On 1–3 Nov., 2014, the sixth International Conference on Technology & Application of Biodegradable and Biobased Plastics (ICTABP6) was held in Huangshan City, Anhui Province. At the conference, the Division of Degradable Plastics, China Plastics Processing Industry Association emphasized the slow and disordered development of domestic bio-based materials industry, for which the industry witnessed no practical development in 2010–2013. To a large extent, it can be ascribed to the fact that no industry standards have been established as the guidance. This furthermore directly draws back the promotion supported by governmental policies included in the two five-year plans and the *National High Technology Research and Development Program* ("863"Program).

CCM exchanged ideas with several representatives from bio-based material enterprises. They raised a problem consistently that China has no strict supervision standards for bio-based materials, which results in the big price differences. For instance, the price of polylactic acid (PLA) produced by Zhejiang Hisun Group Co., Ltd. (Hisun) is about USD3,088/t–USD3,413/t (RMB19,000/t–RMB21,000/t), while those from Shenzhen Esun Industrial Co., Ltd. (Esun) and Shanghai Tong-Jie-Liang Biomaterials Co., Ltd. (TONGJIELIANG) are USD4,340/t (RMB26,700/t) and USD4,068/t (RMB25,000/t) respectively. This is mainly because Hisun engages itself in the production and sales of primary-type PLA, while TONGJIELIANG and Esun have some modification in the products which increases the costs. During the market promotion, such price differences are always questioned by customers.

Similarly, that other bio-based materials or products covering polybutylenes succinate (PBS), starch base and polyhydroxyalkanoate (PHA) have not yet been standardized also brings damage to the whole industry. The varied contents in PBS, starch-based and PHA products make it difficult for enterprises to carry out market promotion. Most straightly, customers question about the quality and prices of the products. In addition, some petro-based materials are used in the counterfeit and inferior bio-based products, and they are priced lower than that of completely bio-based products. This draws back the sales of completely bio-based products. Moreover, due to the non-degradable petro-based materials, the counterfeited and inferior products including petro-based materials only can partially decompose, which strongly lashes the customers' confidence in purchasing bio-based products and further misleads the understanding on the degradability of bio-based products. Therefore, a set of industry standards is highly required.

Additionally, not all the bio-based materials launched on the market are made from biomass, and the processed products are not completely degradable. Take PLA for example. It is always blended of PLA, petrochemical polypropylene (PP) and polyethylene (PE) so as to establish the properties. Such a bio- and petro-based blended material, generally, is priced much lower than high-content (over 90%) bio-based materials. So it will somehow hinder the sales of real bio-based materials.

Meanwhile, different soil, climate and sunlight bring about difficulties for the standard formulation. Accordingly, different bio-based materials have different requirements on degradation conditions. For instance, since PHA and polycaprolactone (PCL) are synthesized in bacterium in the nature, they have no requirements on external environment such as composts. Comparatively, PBS and PLA are in need of composts in general. Microorganisms are used for their degradation.

Moreover, the regional differences in China also set obstacles for the standard establishment in bio-based materials industry.

Therefore, there are few applicable standards targeted at bio-based materials in China. Currently, Chinese enterprises intend to export their products to specific countries or regions, so they passively adjust to conform to the standards such as the US Food and Drug Administration, the Biodegradable Products Institute and the EN13432 Biodegradable Test. Currently, the lack of applicable bio-based inspection and supervision standards in China brings great opportunities to many bio-based certification enterprises. Specifically, BASF and Japan BioPlastics Association have initiated the paid inspection and certification for China-made bio-based materials or products.

CCM believes that a set of strict standards for bio-based materials industry is highly required in China. It will facilitate the orderly development of the industry. Although no applicable standards regarding the inspection and supervision are issued currently, the National Center for Quality Supervision and Inspection on Plastic Products has led the comment collection regarding the safety of bio-based products and the test of biodegradability.

PLA boasts strong development potential despite restriction from raw materials

Similar to other bio-based materials, the development of PLA is restricted by raw materials such as LA. However, thanks to the advantages in technology and application, PLA is still positioned as one of the bio-based materials with the strongest development potential.

Polylactic acid (PLA) is one of the bio-based materials with the finest development in China. Commonly, it is believed that the fine development of PLA is closely bound to the complete PLA industrial chain in China. This can be further attributed to the mature application technology to process material into extrusion, injection molding and blown film grade PLA products. However, it is strongly believed that the sufficient production capacity for lactic acid (LA), raw material for PLA, is the key for the development difference between PLA and other bio-based materials such as polybutylene succinate (PBS). This is because other bio-based materials such as PBS also present mature application technologies, and they even show more excellent processing performance than that of PLA; the only difference is that China has insufficient production capacities for raw materials like succinic acid and 1,4-butanediol (BDO).

As a matter of fact, that the development of PLA in China takes the lead among bio-based materials is not because of the difference in raw materials. Instead, the supply of LA cannot satisfy the demand from PLA.

According to statistics, the production capacity of LA in China exceeds 300,000 t/a in 2014. However, CCM found that the output of industrial grade LA is not much, only about 70,000 tonnes. Since the production of PLA requires relatively high concentration LA (over 90% in general), only a few manufacturers, including Henan Jindan Lactic Acid Co., Ltd. and Musashino Chemical (China) Co., Ltd. can produce such kind of LA. Therefore, the production capacity for industrial grade LA is not enough in China. Regarding the current production capacity for PLA (about 30,000 t/a), along with the production capacity under construction by Zhejiang Hisun Group Co., Ltd. (Hisun, 10,000 t/a) and SUPLA (Suqian) New Material Co., Ltd. (10,000 t/a), the supply of industrial grade LA is unable to meet the demand.

Additionally, domestic enterprises highly demand lactide. Currently, domestic enterprises mainly adopt one-step direct polycondensation and two-step lactide ring-open polymerization processes. However, since the one-step process can only synthesize PLA with <5,000 average molecular weight, only Shanghai Tong-Jie-Liang Biomaterials Co., Ltd. (TONGJIELIANG) applies this process to produce PLA. TONGJIELIANG positions the application of PLA products in the disposable sanitary product field. Comparatively, most PLA enterprises, such as Hisun, make use of the two-step process, in which LA is dehydrated and cyclized into lactide, and then lactide is ring-open and polymerized into PLA. Currently, no mature technology is developed for LA to be processed into lactide in China. Moreover, it is hard for the concentration of domestic industrial grade LA to meet the requirements. Thus, the PLA enterprises adopting two-step process mainly import industrial grade lactide from the Netherlands-based Corbion-Purac for the production of PLA.

Table 5: Major LA enterprises in China, 2014

No.	Enterprise	Capacity, t/a	Remark
1	Henan Jindan Lactic Acid Co., Ltd.	120,000	Industrial grade: 35,000 t/a
2	Anhui COFCO & Galactic Acid Co., Ltd.	34,000	Industrial grade: 15,000 t/a
3	Huafu Technology Co., Ltd.	30,000	Industrial grade: 10,000 t/a
4	Ningxia Hypow Bio-technology Co., Ltd.	30,000	Only produce pharmaceutical grade
5	Shandong Fullsail Biotechnology Co., Ltd.	30,000	Put into operation in 2014
6	Xiaogan Kaifeng Bioengineering Co., Ltd.	15,000	Food grade
7	Wuhan Sanjiang Space Gude Bio-tech Co., Ltd.	12,000	Industrial grade: 6,000 t/a
8	Yancheng Haijianuo Biological Engineering Co., Ltd.	12,000	Industrial grade: 3,000 t/a
9	Zhengzhou Tianrun Lactic Acid Co., Ltd.	12,000	Food grade
10	Musashino Chemical (China) Co., Ltd.	10,000	Industrial grade: 3,500 t/a
11	Hunan Anhua Lactic Acid Factory	10,000	Food grade
12	Shanxi Leda Biochemical Co., Ltd.	5,000	Food grade
13	Shanghai Sunshine Biochem Co., Ltd.	3,000	Food grade

Note: LA stands for lactic acid.

Source: CCM

Although the development of PLA is somehow restricted by raw materials, it is still one of the bio-based materials with the best and strongest development potential. This can be mainly ascribed to the technology and application of PLA.

Breakthroughs in technology were made firstly for PLA, largely lowering the technological threshold for the production of PLA. Early in 1990s, the two-step successive process raised by the US-based Cargill Incorporated, and the one-step synthesis process from Japan-based Mitsui Chemicals, Inc. cleared the R&D direction for PLA and laid a better foundation for its technology development.

As part of the patents expired, these two technologies were further open to the public, effectively lowering the technological threshold. The current one-step direct polycondensation and two-step lactide ring-open polymerization processes used in domestic market were also developed from the aforementioned two technologies. Then the afterwards R&D on PLA modification technology also separated PLA from other bio-based materials regarding the development.

The application of PLA perfectly matches the domestic market. Since 2000, China has stressed the development of PLA, primarily intending to ease the white pollution. As the R&D on PLA lasts for a long time, it presents advantages in cost, along with properties highly in accordance with disposable products, such as easy degradation, quick degradation pace and no toxicity. Therefore, most Chinese enterprises still apply PLA in disposable products like film and shopping bags. Thanks to its perfect correspondence with Chinese conditions, PLA is supported by the government. Fine policy support also propels PLA to lead the development among bio-based materials in China.

Crankcase cover made from bio-based PA awarded innovation prize

17 Nov., 2014 – A mass light multifunctional EcoPaxx® crankcase cover made from bio-based materials was awarded the Innovation Prize in authorized by the Society of Plastics Engineers in vehicle field.

The crankcase cover is made from polyamide 410 (PA410), of which 70% of raw materials come from renewable resources. It is developed jointly by the Netherlands-based Koninklijke DSM N.V. and Germany-based KACO New Energy GmbH, and is expected to be used in the new MDB-4TDI diesel engine developed by Volkswagen Group.

Bio-based PA (nylon) captures attention gradually thanks to its excellent performance in special plastics. Currently, a few Chinese enterprises join in the production of bio-based PA.

Table 6: Chinese bio-based PA enterprises, 2014

Enterprise	Product	Capacity, t/a
Shandong Guangyin New Materials Co., Ltd.	PA610, PA612, PA1012, PA1212	PA610: 2,000 PA612: 1,500 PA1012: 1,000 PA1212: 1,000
Shanxi Hoyotek Science and Technology Co., Ltd.	PA11, PA1010, PA6, PA1012	PA11: 1,000 PA1010: 1,000 PA6: under construction PA1012: under construction
Cathay Industrial Biotech Ltd.	PA56	PA56: >=10,000 (project launched in H1 2014 and now under construction)

Note: PA stands for polyamide.

Source: CCM

Bio-based PDO applied in furniture coating field

20 Nov., 2014 – Japan-based Okamura Corporation, jointly with the US-based DuPont Tate & Lyle Bio Products Company, LLC launched the office furniture coated with Susterra® 1,3-propanediol (PDO) powder coatings for the first time.

Susterra® PDO is a bio-based ingredient used in high-performance powder coating that has a biomass mark from the Japan Organic Recycling Association.

Actually, it is a development direction for coating enterprises to utilize bio-based materials to lower the contents of harmful substances such as volatile organic compounds and formaldehyde. Both the European Coating Symposium (May 2009) and the Green Industrial Coating Asia (Sept. 2013) advocated the concept of bio-based coatings.

Currently, France-based Ecoat, Sweden-based Beckers Group and Germany-based Bayer MaterialScience AG take the lead in the bio-based coating sector.

First bio-based smart card project launched in China

28 Oct., 2014 – China's first substrate project for the completely biodegradable polybutylene succinate (PHA) smart card was launched in Xuzhou City, Jiangsu Province, with a total investment of USD17.88 million (RMB110 million). The construction period will last for one year.

Accordingly, the PHA smart card was independently developed by Jiangsu Huaxin New Material Co., Ltd. The enterprise overcame the shortcomings of PHA, such as weak processing stability and low twisting strength. Then, the newly produced material boasts excellent mechanical properties, printability, aging resistance and degradability. It can be widely applied in smart card, high-end stationery and high-end blister packaging.

Currently, the Chinese banks adopt petrochemical polyvinyl chloride (PVC) plastic cards. So, the discards will exert great pressure on the environment. In Sept. this year, the People's Bank of China announced to gradually substitute magnetic card with chip card.

ICIS Asian Polyolefin Conference sees bright prospect for biodegradable plastics in Asia

21 Nov., 2014 – The 2nd ICIS Asian Polyolefin Conference was held in Singapore. Alan Yeap, CEO of New Quantum, stated at the conference that the plastic bags made from traditional petrochemical polyolefin will be labeled with *Harm to Environment*, while biodegradable plastic bags will be welcome as substitutions.

Alan Yeap also predicted that by 2015, the production capacity of biopolymers in Asia would increase from 190,000 t/a in 2010 to 480,000 t/a. Furthermore, the global output of biopolymers will rise from 725,000 tonnes in 2010 to 1.71 million tonnes in 2015.

Meanwhile, Alan Yeap disclosed that the operating rate of biodegradable plastics in Europe now stays at only 50%, due to the low profits. However, Asia is actively involved in the production.

Actually, it is disclosed at the 2014 China International Biobased Technology & Partnering Conference and the 3rd Biobased World Asia held in Shanghai and Singapore respectively that, the output of biodegradable plastics in Asia will go beyond Europe and become one of the most concentrated regions for the production of biodegradable plastics.

Company Dynamics

Sun Australia establish strategic partnership with TIB, CAS

28 Oct., 2014 – Sun Australia (Yantai) Environmental Technology Co., Ltd. (Sun Australia) signed a strategic cooperation agreement with Tianjin Institute of Industrial Biotechnology, Chinese Academy of Sciences (TIB, CAS), to jointly develop bio-based materials.

Accordingly, Sun Australia, a dominant starch-based material manufacturer in China, mainly engages in the production of starch-based materials. Currently, the development of domestic starch-based materials is not optimistic, due to the relatively low economic benefits. This is mainly because the starch-based materials are fermented from high-priced sugar. Though the low-priced raw materials, such as cellulose and lignin can be adopted in laboratory, it is difficult to apply the process in industrial production. Then, the technology is disjointed from production. So the joint efforts made by scientific research institutes and enterprises to establish industry-academia-research platforms will propel the practical production of bio-based materials.

By the way, on 3 Sept., 2014, the National Development and Reform Commission of the People's Republic of China specified to establish industry-academia-research platforms to forward the development of bio-based materials.

Kingfa witnesses surged limit

18 Nov., 2014 – Guangzhou Kingfa Sci & Tech Co., Ltd. (Kingfa, stock code: 600143) opened quotation with a price of USD0.90 (RMB5.56). Then it closed the quotation with a high limit of USD0.99 (RMB6.11), recorded a growth rate of 10.09%.

Kingfa is the largest modified plastic manufacturer in China. In a short term, its performance is driven by both modified plastics and completely degradable plastics.

Currently, Kingfa's degradable plastics including bioplastics enter into harvesting period. In addition to the original 30,000 t/a poly(butylene succinate-co-butylene adipate) (PBSA) production line, Kingfa has been recorded a monthly output of over 5,000 tonnes of PBSA in its Zhuhai plant. Moreover, the second-phase PBSA project (90,000 t/a) is expected to be finished in 2015. Apart from the major application in film, Kingfa planned to utilize it in vehicle and plastic additives.

CCM believes that the gradual rises in Kingfa's stock price can be attributed to the expansion in scale production of bio-based materials and the domestic active subscription of bio-based material stocks.

Figure 11: Kingfa's stock, Sept.–Nov. 2014, RMB per share

Source: Sina Finance

Envonik passes FDA certification for PA1010

14 Nov., 2014 – Germany-based Envonik Industries AG (Envonik) announced to pass the certification of the US Food and Drug Administration for its polyamide 1010 (PA1010). This indicates that PA1010 is accepted by the food packaging field as food contact materials.

PA1010 is a high-quality bio-based PA product, presenting stronger physical and chemical resistance than polylactic acid (PLA), poly butylene succinate (PBS) and polyhydroxyalkanoate (PHA). Also, it is a bio-based material matchable to petro-based materials regarding the properties. Due to its typical position in chemical polymers, the safety of PA products draws wide attention. That PA1010 was granted with the Food Contact Notification will somehow stimulate the development of bio-based PA.

Currently, Shanxi Hoyotek Science and Technology Co., Ltd. and Shandong Guangyin New Materials Co., Ltd., Chinese major bio-based PA enterprises, mainly produce PA1010, PA11 and PA610. Meanwhile, Cathay Industrial Biotech Ltd. and Suzhou HiPro Polymers Co. Ltd. always devote themselves to the PA upstream long carbon chain dicarboxylic. Now they also plan to produce bio-based PA.

Guangdong Shangjiu makes technology investment into overseas bio-based material projects

24 Nov., 2014 – Guangdong Shangjiu Biodegradable Plastic Co., Ltd. (Guangdong Shangjiu) announced to cooperate with Argentina and Turkey respectively through technology investment for the degradable resin granule projects. Now the projects have been launched.

Accordingly, the investments into these two projects were USD36.20 million and USD12.47 million (EUR10 million) respectively. Corn and root and tuber crops such as cassava will be used as raw materials for the production of biodegradable resin granules.

It is noteworthy that there are not many enterprises in China like Guangdong Shangjiu to make technology investment into the biodegradable resin project. As a matter of fact, though domestic enterprises present disadvantaged resin production, they still boast advantages in modification of bio-based materials. Currently, the domestic enterprises give priority to the development of modification technology.

Political Factors

Development of bio-based materials still relying on policy support

Governmental policy support is the key to the development of bio-based materials. Due to favorable policies for bio-based materials from the national and local governments, Jilin Province has become the core cluster region for the bio-based material industry in China. At present, the industry cluster scale of bio-based materials is only beginning to be formed. The development of bio-based materials will still rely on policy support over a period of time in the future.

On 3 Nov., 2014, polylactic acid (PLA) enterprises, such as SUPLA (Suqian) New Material Co., Ltd. (also named YunYou Into (Suqian) Composite Material Co., Ltd., SUPLA) and Zhejiang Hisun Group Co., Ltd. (Hisun), have explored the possibility of investing in PLA with BASF in Changchun City, Jilin Province.

Hisun, SUPLA, BASF and other bio-based material manufacturers have chosen to invest in Jilin mainly because the policies are favorable to bio-based materials in Jilin Province. The *Regulations of Jilin Province on Prohibiting Production, Sale and Provision of Disposable Non-degradable Plastic Shopping Bags and Plastic Tableware* will take effect from 1 Jan., 2015. Jilin will prohibit the production, sales and provision of disposable non-degradable petrochemical plastic shopping bag and petrochemical plastic tableware. This is consistent with the policy issued by the National Development and Reform Commission of the People' s Republic of China (NDRC) on 3 Sept., 2014, which provides large-scale support for bio-based materials.

Enterprises believed that the policy will be the most important factor for bio-based materials to make a breakthrough. Currently, bio-based materials are not well promoted in China. Many entrepreneurs expect bio-based materials to be propelled by the government's support. Meanwhile, they also believed that the complete industry chain of bio-based materials cannot be formed in China without adequate policy support.

At present, the bio-based materials industry is tending to cluster in areas with favorable policies towards bio-based materials. The bio-based material industry has developed the most in Jilin due to the province's favorable policies and because of the superior foundations formed for the industry:

- In 2013, the pilot demonstration of bio-based materials was first carried out;
- In 2012, the Planning for the Development of the High-end Utilization of the Biomass Resources Industry was compiled to advance the high-end development of bio-based materials;
- In 2004, under the leadership of the government, the concept of producing bio-based materials with biomass like corn was put forward.

Currently, numerous bio-based material enterprises have established factories in Jilin. As for Changchun Dacheng Industrial Group Co., Ltd., the trial production plant for producing L-lactic acid with straw sugar and the world's first straw sugar production plant with a production capacity of 50,000 t/a, will be completed and put into operation. The 30,000 t/a PLA project of China National Cereals, Oils and Foodstuffs Corporation is undergoing the approval procedure. The PLA product projects of some enterprises, including Becausewecare Environmental Industry Co., Ltd., have begun construction. Other projects, including the poly butyleneadipate-co-terephthalate (PBAT) modified material project of Shanxi Jinhui Group, the biodegradable material project of Taiwan Green Miracle Technology Co., Ltd., etc., will soon enter into operation.

Meanwhile, Hisun also made an evaluation on the prospect of bioplastics after the prohibition of plastics in Jilin. Hisun believes that the prohibition of plastics in Jilin will boost the consumption of bioplastics. Specifically, the consumption of blown bioplastics will be 30,000 tonnes and the consumption of extrusion bioplastics will be 60,000 tonnes.

In accordance with the regulations on prohibiting plastics in Jilin, bioplastic trays should account for no less than 70% of the total plastic trays and bio-based membranes should account for no less than 30% of the membranes. Take the tray used in meat processing factories for example. At present, the total demand for plastic trays is 400 tonnes. Suppose the substitution rate of bio-based materials is 5%. The market demands 20 tonnes of bio-based trays. The diversified classification of plastic products gives confidence to Hisun. Currently, about 10,000 t/a of newly installed production capacity for bioplastics has began construction in Hisun. Moreover, Hisun is proactively seeking mergers or acquisitions of plastic product companies to meet the demand for bioplastics in Jilin.

SUPLA has also set up a PLA plant with a production capacity of 10,000 t/a, and is promoting the bio-based compost pilot project with BASF in Jilin.

The development of bio-based materials has strong momentum in Jilin. However, bio-based materials are not well accepted in the market and the industry chain of bio-based materials is not complete at present. Therefore, over a period of time in the future, the development of bio-based materials in Jilin will continue to rely on policy support.

In terms of the development of bio-based materials in other areas in China, this kind of policy support and guidance is desperately needed. Measures including the removal of restrictions on imports of raw materials and strengthening restrictions on the application of petrochemical materials are especially urgent and can provide an impetus for the bio-based materials industry. Currently, the price of bio-based materials is too high to be accepted by the market.

Starch is the most common bio-based raw material used in China. Take cassava starch for example. The FOB price of cassava starch from Thailand is steady at USD425/t, while the price of cassava starch produced in China is at USD520/t. The average price of cassava starch imported from Thailand is above USD560/t in China. Based on the comparison between the prices of cassava starch in China and in Thailand, the price of raw materials for bio-based materials used in China is at a high level.

Furthermore, after taxation, the imported cassava starch is more expensive than the domestic starch. Therefore, bio-based material enterprises are restricted by the high price of the raw material. The price of bio-based materials in China has not dropped significantly in recent years due to the high cost of raw materials. Domestic enterprises also hope that the government can promote the imports of raw materials like starch through tax reductions or other ways. In addition, the high price of the raw material directly results in the high price of bio-based materials. Consequently, bio-based materials are not well accepted in the market. Policies which alleviate the factors that keep the prices of bio-based materials high are needed.

Hence, enterprises, represented by Guangzhou Kingfa Sci & Tech Co., Ltd. (Kingfa), Wuhan Huali Environmental Technology Co., Ltd. (Wuhan Huali) and so on, suggested to the NDRC that the government should be stricter in the application of petrochemical plastics and provide further support for bioplastics. Under the government's guidance, Kingfa laid more than 9,333 ha (140,000 mu) ECOPOND® films (made of poly(butylene succinate-co-butylene adipate) – PBSA) in Xinjiang Uygur Autonomous Region in Dec. 2013, with a consumption of over 850 tonnes. In June 2014, Wuhan government also promoted bioplastic products with Wuhan

Huali.

Certainly, the government is also proactively promoting bio-based materials. In Sept. 2014, the NDRC articulated the policy for increased investment into the construction of bio-based material industry clusters.

Technology

R&D focus of bio-based materials shifts to modification technology for application

Less and less attention has been paid to the technology of manufacturing bio-based materials. The focus has been gradually shifting to the modification technology for the application of bio-based materials. Using modification technology to produce bio-based products for application in multiple fields has been identified by Chinese bio-based materials enterprises as the ideal strategy for their bio-based materials businesses.

On 1–3 Nov., 2014, the sixth International Conference on Technology & Application of Biodegradable and Biobased Plastics (ICTABP6) was held in Huangshan City, Anhui Province. Enterprises and R&D technicians in the bio-based materials field from China and overseas gathered together and probed into the status of the bio-based material industry.

This conference was different because it did not focus on the R&D technology of manufacturing bio-based materials. Instead, the discussion was on the technology of improving the performance of bio-based materials. Specifically, 70% of the discussion was about the modification technology for polylactic acid (PLA) and the application technology for bio-based materials, which covered the study on mixed systems like PLA and polybutylene adipate-co-terephthalate (PBAT), the development of the modification and processing technology for PLA, the study on the modification of PLA, PLA 3D printing, the application of PLA foamed sheets, polyvinyl alcohol (PVA) thermoplastic processing new technology and the application of polybutylenes succinate (PBS).

It can be seen that most of the above technologies are within the scope of PLA, which conforms to the current situation that PLA has the most advanced development among all bio-based materials in China. Meanwhile, the modification technology for bio-based materials including PLA, PVA, PBS, etc. was the focus of the discussion during the conference. This was mainly because the development of bio-based materials is expected to be propelled by the focus on the development of the application of bio-based materials in China.

As a whole, bio-based materials have not developed strongly in China. Most enterprises indirectly promote the development of bio-based materials through the application of bio-based materials. At present, there are approximately 260 enterprises engaging in bio-based materials. Specifically, about 55 enterprises are bio-based material manufacturers.

Enterprises enter and leave the bio-based materials market too frequently. The main reason for this is that bio-based materials are unable to gain a foothold into the market. Enterprises decide to exit the market because they are unable to achieve meaningful revenue after investing a great sum of money, or their revenue is even insufficient to pay the related expenses.

As for the enterprises still in the market, apart from the bio-based manufacturers, the rest are focusing on the modification and processing of bio-based materials. Since the R&D of bio-based materials requires advanced technologies, small businesses rarely have enough funds or the personnel to enter the market. These small businesses usually buy raw materials from large enterprises, such as Zhejiang Hisun Group Co., Ltd. (Hisun), Nanyang Zhongju Tianguan Low Carbon Technology Co., Ltd.

(Nanyang Zhongju Tianguan) and TianAn Biologic Materials Co., Ltd. (TianAn) for modification and processing. Then the modified or processed products are applied in areas with higher requirements which need the superior performance of bio-based materials, including cups with resistance to high temperature, fiber and engineering plastics. There is strong momentum and potential regarding these applications.

According to Weng Yunxuan, the secretary general of the Division of Degradable Plastics, China Plastics Processing Industry Association, most bio-based material manufacturers in China have not achieved significant economic benefits mainly because bio-based materials are not well known to the public. In order to change this situation, manufacturers have gradually changed their approach in order to propel the development of bio-based materials and have shifted their attention to the reprocessing of bio-based materials. Enterprises have shifted from simply manufacturing and selling bio-based materials to processing and manufacturing bio-based products independently. Some enterprises are producing bio-based products and are buying bio-based materials, rather than manufacturing bio-based materials. For example, Shenzhen Esun Industrial Co., Ltd. (Esun) invested a large amount of money in manufacturing PLA early in its history in 2002. As of 2006, no great changes in the demand for PLA had appeared in the market. So, Esun transformed its main business to 3D printing with modified PLA. Esun no longer focused on the manufacturing of PLA and most of its PLA materials were bought from NatureWorks LLC.

Actually, except for Esun, several PLA master batch manufacturers have had problems in the sales volume of materials. Currently, the application of modified bio-based materials is well accepted by the market. For example, the sales volume of PLA materials in Shanghai Tong-Jie-Liang Biomaterials Co., Ltd. (TONGJIELIANG) was not satisfactory since the performance of its PLA materials was not good enough. However, after TONGJIELIANG applied its modified PLA in feminine hygiene products, its products began to be sold in supermarkets in many places including Shanghai.

Meanwhile, as China's largest PLA manufacturer, Hisun was dedicated to the manufacturing of PLA master batch over the years. Without great breakthroughs in the PLA production rate through fermentation and the PLA output, Hisun has begun to sell its PLA modified materials and PLA products in Jilin Province since Sept. 2014. At the same time, Hisun decided to regard the modification technology for PLA as the focus of its R&D, and to supply plastic manufacturers in Taizhou City, Jilin City and other cities with PLA modified plastics especially for toys and baby bottles.

Furthermore, PLA manufacturers, such as SUPLA (Suqian) New Material Co., Ltd. (also named YunYou Into (Suqian) Composite Material Co., Ltd., SUPLA) have applied modified PLA modified materials in touch-screen computers. This is because they have focused on the modification technology in the development of PLA for a long time and have been dedicated to applying modified PLA in high-end electronics. The plan of expanding the production for PLA is on the agenda thanks to the positive social repercussions.

Other bio-based material manufacturers, such as Shenzhen Ecomann Bio-technology Co., Ltd. (Shenzhen Ecomann) and Wuhan Huali Environmental Technology Co., Ltd. (Wuhan Huali), tend to sell modified polyhydroxyalkanoate (PHA) and starch-based products, in order to provide more practical products.

According to the analysis from CCM, if domestic bio-based material enterprises are to raise the rate of capacity utilization for the existing bio-based materials, they must adopt the strategy of diversified application with the help of modification technology. At present, concerning the prices or specific performance, bio-based materials are not qualified to compete with petrochemical materials. It seems infeasible to concentrate on the commercial operation of bio-based materials.

Take PBS manufacturers for example. According to the table below, major domestic manufacturers including Anqing Hexing Chemical Co., Ltd. (Anqing Hexing), Zhejiang Hangzhou Xinfu Pharmaceutical Co., Ltd.(Xinfu), Shandong Fuwin New Material Co., Ltd. (Shandong Fuwin) have made the biggest contribution to the production capacity in China in 2014 (Shandong Landian Biological Technology Co., Ltd. contributed the new production capacity). So far, Shandong Fuwin has given up manufacturing PBS. However, Anqing Hexing and Xinfu use their 10,000 t/a plants to conduct small-scale manufacturing. These enterprises optimize their modification technology respectively so as to apply PBS in tableware and film products. The production volume will gradually rise. They no longer spend large amounts of money on the R&D of the productivity of PBS or on high production capacities. Also, companies including Hengan International Group Company Limited are successfully selling their PBS products, such as disposable packaging and tableware made of modified PBS.

CCM believes that enterprises are building bio-based materials production facilities because of the desire for environmentally friendly products. However, this has not translated to the demand for bio-based materials. The existing production capacity for bio-based materials in China is not being fully utilized. Enterprises should seek for breakthroughs in downstream applications.

Mainstream bio-based materials are largely inappropriate for downstream product manufacturers due to their defect in the source property (from biomass). However, after modification, the bio-based products can be applied in different areas and are receiving good responses from the market. In the future, enterprises related to bio-based materials should develop modification technology to satisfy the everyday use of bio-based materials. With improvements to the modification technology, the application of bio-based materials will no longer be limited to fields like plastic products, packaging. Instead, the application scope can be expanded to other fields, such as fiber, nylon and special engineering plastics, which is the new development focus.

The modification technology for bio-based materials has been refined gradually in China. For instance, Zhejiang Nanyi Biological Science and Technology Co., Ltd. emphasized on producing a transverse cracking film. Compared with other longitudinal cracking bio-based films, the transverse cracking film is superior in wrapping soil and heat retention, which is more practical. Currently, some enterprises related to bio-based materials are transforming and depend on modification and processing technology to produce products with high value added.

At present, China's production rate of bio-based materials through fermentation and the strains for fermentation is below many other countries. However, China's modification technology for bio-based materials is at the same level as other major producing countries. The application of bio-based materials in different fields can almost be accomplished in China. Chinese enterprises need to adopt the strategy of differential modification technology for bio-based materials to compete in the domestic market.

Table 7: Major PLA manufacturers in China, 2014

PLA manufacturer	Capacity, t/a	Output, tonne (E)	Major applications
Zhejiang Hisun Group Co., Ltd.	5,000	4,000	Fiber, tray and film
Nantong Jiuding Biological Engineering Co., Ltd.	3,000	2,000	Fiber and disposal plastics
SUPLA (Suqian) New Material Co., Ltd.	3,000	2,200	PC enclosure and electronic parts
Shanghai Tong-Jie-Liang Biomaterials Co., Ltd.	1,500	1,000	Non-woven fabrics
Shenzhen Esun Industrial Co., Ltd.	3,000	1,800	3D printing

Note: PLA stands for polylactic acid. The output is estimated.

Source: CCM

Table 8: Major PBS manufacturers in China, 2014

PBS manufacturer	Capacity, t/a	Output, tonne (E)	Major applications
Anqing Hexing Chemical Co., Ltd.	5,000	3,000	Tableware
Shandong Fuwin New Material Co., Ltd.	20,000	//	
Shandong Landian Biological Technology Co., Ltd.	20,000	3,000	Trial production
Zhejiang Hangzhou Xinfu Pharmaceutical Co., Ltd.	13,000	4,000	Film
Guangzhou Kingfa Sci & Tech Co., Ltd. (PBSA)	10,000	5,800	Film and plastics

Note: PBS stands for polybutylenes succinate. The output is estimated. Shandong Fuwin New Material Co., Ltd. has suspended production.

Source: CCM

Producing bio-based materials with cellulose still far away from industrialization

High price of starch is always the main reason for the high cost of raw materials for bio-based materials. To reduce the cost of raw materials for bio-based materials, producing starch with low-priced cellulose is a research focal point in China. Considering the development of the technology of producing bio-based materials with cellulose and the industrialization progress currently, there are no signs that the method of using cellulose to produce bio-based materials will be used in commercial production.

Starch is the first choice for raw materials for producing bio-based materials through fermentation. The price of starch is closely related to the cost of bio-based materials. Take polylactic acid (PLA) materials for example. PLA has the most advanced development among all the bio-based materials produced through fermentation in China. Based on the technology in China, generally 1.60 kg of starch can produce 1 kg of lactic acid through fermentation, while 1.30 kg of lactic acid can transform into 1 kg of PLA. In other words, theoretically, 2.08 kg of starch can produce 1 kg of PLA. Suppose the price of starch drops by USD1/kg. The cost of PLA would reduce by USD2.08/kg. Therefore, the cost of producing PLA can be largely reduced especially when the output reaches 5,000 tonnes or even >=10,000 tonnes.

Also, China is abound with waste straw resources (straw is rich in cellulose). Both cellulose and starch can hydrolyze into glucose. Starch consists of glucose. Considering the above factors, producing low-priced starch with cellulose to reduce the cost of bio-based raw materials is a focal point for research. Many domestic enterprises even stated frankly that they have acquired technologies for the industrialization of producing starch with cellulose. So far, domestic or global enterprises are still mainly dependent on corn and cassava to produce starch so as to produce bio-based materials. Is it feasible to produce starch with cellulose or to achieve the industrialization of producing bio-based materials with cellulose?

Using cellulose to produce starch in order to produce bio-based materials is theoretically possible. The application of this technology in the industry still has a long way to go because of the unsatisfactory economic benefits. Although both cellulose and starch can hydrolyze into glucose, they are not isomers.

There are two problems that will inhibit the industrialization of producing sugar with cellulose. The first problem is removing lignin and retaining cellulose from the extractive of straw. The other problem is how to apply it in industrialization economically.

First of all, the cellulose advocated in China all come from waste, such as straw. Besides abundant cellulose, a large amount of lignin exists in the extractive of straw. Currently, it is technically difficult to only retain cellulose without lignin. Only few methods are available in this procedure in China. Purifying cellulose means a large expense. Not purifying cellulose will impact the purity in the subsequent procedure.

Moreover, in the step of cellulose hydrolyzing into glucose, generally in China, endoglycosidase, cxenzyme and exonuclease, C1 enzyme are used to help cellulose decompose into cellobiose, and cellobiose will transform into glucose with the help of glucosaccharase. Under the ideal reaction conditions set up in labs, the transformation rate from cellulose to glucose is only 1/3. However, during industrial experiments in China, some enterprises including Shenzhen Ecomann Bio-technology Co., Ltd. carried out experiments on producing glucose through this enzymolysis approach and faced many uncontrollable factors. The enzyme activity, by-products and other factors made the productivity of glucose drop significantly. The transformation rate of glucose is much lower than 1/3.

Furthermore, the selection of enzyme basically depends on the genes from bacteria, soil fungi and potatoes. And *Escherichia coli* (usually used as experimental model) is genetically modified with the genes to get the required enzyme. It costs about USD1 million to transform 200 kg of cellulose raw materials into 20 kg of starch. The cost is expensive, and often prohibitive for the the use of this method within this industry. Therefore, domestic enterprises turn to another method. This method involves destroying the cellulose' interior structures like hydrogen bond by setting extreme conditions such as high temperature and high pressure. The interior structure is then reconstructed to get the isomer of starch. In the industrial experiments in China, this technology can rarely reached its goal. The isomer of starch can be difficult to attain, as expected. Also, the cost for industrialization is very high due to the rigorous reaction conditions required. Therefore, this technology and method is uneconomical and has been shelved.

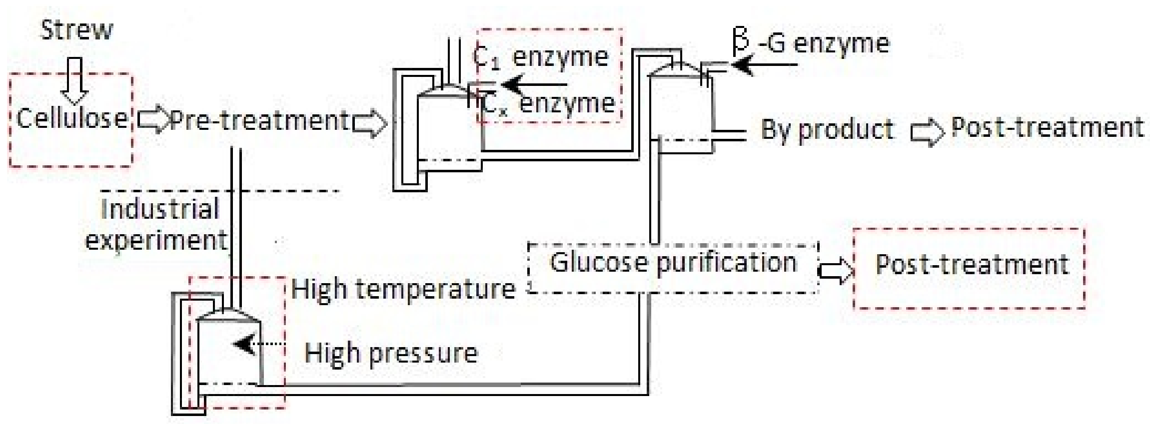
It can be seen that the industrialization of producing starch with cellulose in China is very difficult and expensive, especially regarding the two aforementioned steps, let alone producing bio-based materials with starch from cellulose. The cost of producing bio-based materials with this method is much higher than the cost of producing bio-based materials directly with corn starch. Therefore, the value generated from the industrialization of producing starch with cellulose cannot be achieved at present. However, considering the large amount of straw requiring disposal (burning straw has caused major environment issues like haze) and the urgent demand for reducing the cost of bio-based materials, domestic enterprises have not deviated from their pursuits for the industrialization of producing bio-based materials with cellulose and the reduction in the cost of bio-based materials.

In order to realize the economic value of the industrialization of producing starch with cellulose, domestic enterprises are still seeking for technological breakthroughs to lower the cost for bio-based raw materials. In the bio-based annual conference in Nov. 2014, Professor Zhang Jun from the Institute of Chemistry, Chinese Academy of Sciences (ICCAS) put forward the new technology that produces cellulose ester though the homogeneous functionalization reaction of cellulose in ionic liquid. In this technology, ionic liquid promotes the homogeneous functionalization reaction of cellulose as a medium. Derivatives are generated through the reaction, such as cellulose ester and cellulose graft copolymer, which have homogeneous structure and good performance. Enterprises are a step closer to producing bio-based materials with cellulose thanks to this new technology. Currently, this technology has not been largely adopted in the industry. However, the ICCAS has tried it out at a small scale in some enterprises.

Besides, there is another way to produce bio-based materials with cellulose in China. This involves selecting suitable polarity plasticizer to destroy the coacervation of macromoleculein the cellulose of straw. Subsequently, this macromolecule with hydrogen bondin cellulose can flow under certain conditions. This produces thermoplastic bio-based materials. At present, it is not feasible to use this technology for industrialization.

In general, all the problems, regarding the purification, enzyme, conditions of industrial experiment, economic benefits, etc., have not been effectively solved for the industrialization of cellulose. The technology for the industrialization of producing bio-based materials with cellulose in China is not mature yet, and there are no signs that there is a solid foundation for industrialization to occur.

Figure 12: Production process of starch with cellulose



Source: CCM

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China makes breakthrough in straw enzymolysis to produce bio-based ethanol and butanol

31 Oct., 2014 – The Institute of Process Engineering, Chinese Academy of Sciences (IPE, CAS) officially released its ≥ 10,000 t/a project concerning the industrialized technology for alcohols from straw enzymolysis and fermentation.

Accordingly, the IPE, CAS made breakthroughs in the following aspects:

1. The high-efficiency and clean selective resolution and refining technology was invented, based on the structure characteristics of straw.

2. The industrial fermented strain which can synchronously produce xylose and glucose was cultivated through continuous dynamic domestication.

3. New process was developed and it runs stably in the 400 m^3 fermentation facility. Accordingly, it first goes through the solid-phase enhancement and depolymerization by enzymolysis, and then enters into synchronous saccharification and fermentation.

4. The industrialized refining technology for straw was developed, through which different straw-based products can be produced, such as ethanol, butanol and completely lignin thermoplastic materials. It was highlighted for its complete utilization of straw.

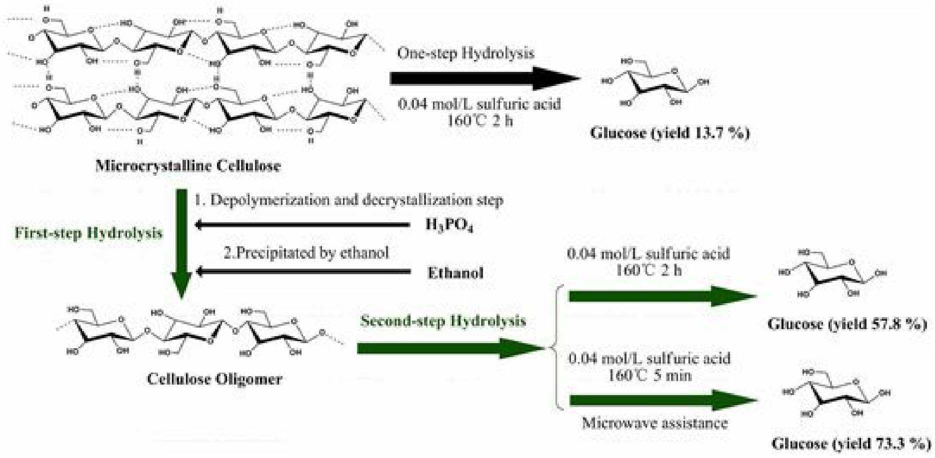
CNITECH, CAS makes progress in cellulose chemical transformation technology

11 Nov., 2014 – Ningbo Institute of Industrial Technology, Chinese Academy of Sciences (CNITECH, CAS) announced to make progress in cellulose chemical transformation technology.

Through chemical or biological hydrolysis, the cellulose will be transformed into glucose and further processed into chemical products like ethyl alcohol and levulinic acid. Mainly two steps, decrystallization and stable hydrolysis are adopted to make the high-efficiency and high-transformation hydrolysis from cellulose to glucose.

According to the study, the yield of glucose from two-step hydrolysis is three times higher than that from one step, as the crystalline texture of cellulose is broken effectively. Then the use of microwave irradiation further weakens the hydrolysis conditions, and enables the yield of glucose to reach 73.30% within five minutes at the temperature of 160℃ (Glucose accounts for 95.80% in the reductive sugar). However, this technology has not yet been applied in industrial production.

Figure 13: Designed process of two-step hydrolysis from cellulose to glucose



Source: Ningbo Institute of Industrial Technology, Chinese Academy of Sciences

Market Data Analysis

Harvested corn launched on market forms downward trend in corn starch price in China

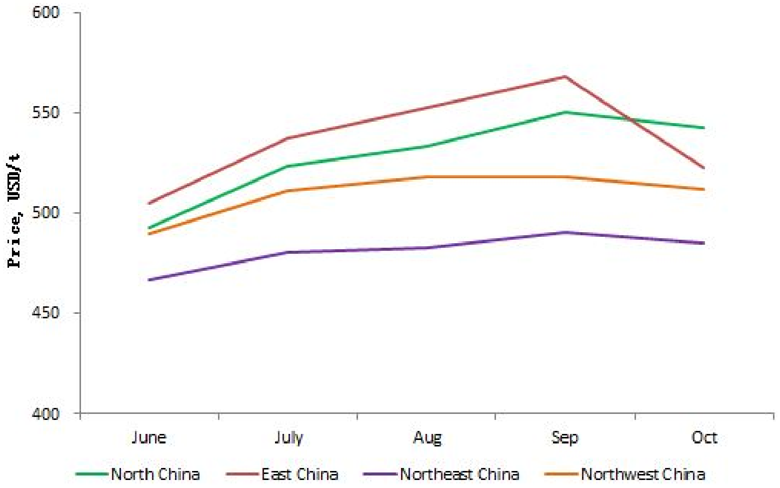
2014 – The operating rate in China's corn starch processing industry began to go up significantly from Sept. However, this can not mitigate the lash of the harvested corn launched on the market on the price of corn starch. The downward trend of the corn starch price has been formed. Considering the prices of corn starch in different areas of China, the corn starch price is expected to see a downward trend in Dec. 2014.

In 2014, the harvested corn started to be launched on the market in Sept. Then the price of corn starch had dropped for the first time since May 2014. This downward trend had appeared nationwide. Specifically, the price of corn starch in East China was the most sensitive and was the first to go down in mid-Sept. As of Oct., the decrease reached USD45/t (RMB277/t). This was mainly because the planting area of early corn in East China was larger than that in any other areas. Therefore, the harvested corn launched on the market influenced the ex-work price of corn starch in East China the most obviously.

In addition, the corn starch prices in Northeast China, North China and Northwest China also declined in Sept. 2014 but the decline was not significant. As of Oct., the largest decline of the corn starch price in North China was only USD7.80/t (RMB48/t). There were two main reasons. On one hand, the corn in Northeast China, North China and Northwest China had not been mature yet. On the other hand, as the main corn supplier for China, the US slowed down the reaping progress due to lots of rain in the central and western US. Therefore, the imports from the US was drawn back. In this way, the corn price in China did not decline significantly.

However, it can be clearly seen that the harvested corn launched on the market lashed the corn starch price. The downward trend of the corn starch price has been formed in East China, North China, Northwest China and Northeast China.

Figure 14: Price of corn starch in China (by region), June–Oct. 2014



Note: North China: Henan and Hebei provinces East China: Shandong Province Northeast China: Liaoning, Heilongjiang and Jilin provinces Northweat China: Shaanxi and Shanxi provinces

Source: CCM

The increasing operating rate in the domestic starch processing industry did not mitigate the downward trend of the corn starch price. According to the operating rate in the corn starch processing industry in 2014, there were apparent signs that corn starch market recovered in China in Sept. 2014. Generally speaking, 80% of cost for corn starch would come from corn. The corn price would drop as the harvested corn was launched on the market. In this way, the corn starch processing industry would pick up.

In Sept. 2014, the corn starch processing industry was going upward. From the launch of the harvested corn on the market in Sept. to the mid-Nov., the growth of the operating rate in the corn starch processing industry was 18% accumulatively. This growth rate was higher than that of 11.70% in the same period of 2012 and also higher than that of 13.40% in the same period of 2013. It was the first significant growth in 2014. However, the peaks of the operating rate in the corn starch processing industry in the same period of 2012 and 2013 were 64.50% and 58.30% respectively. In the first ten days of Nov. 2014, the operating rate was just 53%. The peak of the operating rate in the corn starch processing industry has been declining in the recent three years, indicating that the domestic corn starch processing industry did not develop strongly in 2012–2014 in general.

Meanwhile, compared with the operating rate in the corn starch processing industry in 2012 and 2013, the operating rate went up seasonally every year as the harvested corn was launched on the market. Therefore, the growth of the operating rate in the corn starch processing industry in 2014 did not mean that the corn starch market began to recover. In fact, the corn starch processing enterprises were not active to launch production. Large starch processing enterprises, such as Henan Julong Bio-engineering Co., Ltd., Changchun Dacheng Industrial Group Co., Ltd. and Changzhi Jinze Biological Engineering Co., Ltd. stopped production one by one. There was no sign that they would restart the production in a short time.

Both the lash of the launch of harvested corn on the market and the depressed corn starch processing industry resulted in the unsatisfactory corn starch market. As the new year is approaching, corn starch enterprises will be more eager to cater the market and to recover funds by down-regulating the price. It is predicted that the corn price will still go down in Dec. 2014.

Figure 15: Operating rate in corn starch processing industry, Jan. 2012–Nov. 2014

Source: CCM

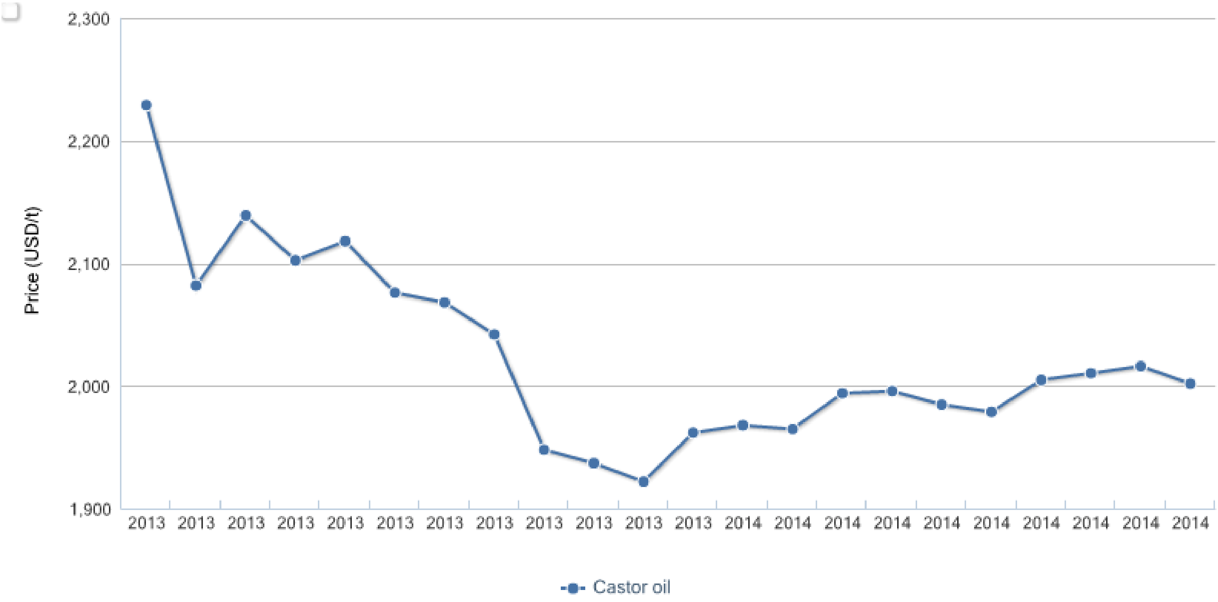
China's castor oil market tends to recover from 2014

Q1–Q3 2014 – The price of castor oil stayed upward, benefited from many factors like optimized planting structure and reduced planting area of castor, and favorable market of downstream sebacic acid. CCM believes that this trend will continue to the end of 2014.

In 2013, the ex-works price of castor oil kept a downward trend in general, dropping from USD2,229/t in Jan. 2013 to USD1,962/t in Dec. 2013, with a decline of USD267/t. In Nov. 2013, the ex-works price of castor oil reached the lowest level at USD1,922/t in recent three years. Coming into 2014, as of the end of Oct., the ex-works price of castor oil had remained rising, from USD1,968/t at the beginning of 2014 to USD2,001.88/t at the end of Oct. 2014, with an increase of USD33.88/t.

Although the price of castor oil does not rise significantly in 2014, a strong upward momentum can be seen based on the general price changes from Jan. to Oct. 2014. This has been the first rise in the price of castor oil for such a long time since H2 2012. The rise also suspends the declining trend of castor oil price since 2013. CCM believes that the castor oil market begins to pick up.

Figure 16: Ex-works price of castor oil in China, Jan. 2013–Oct. 2014



Source: CCM

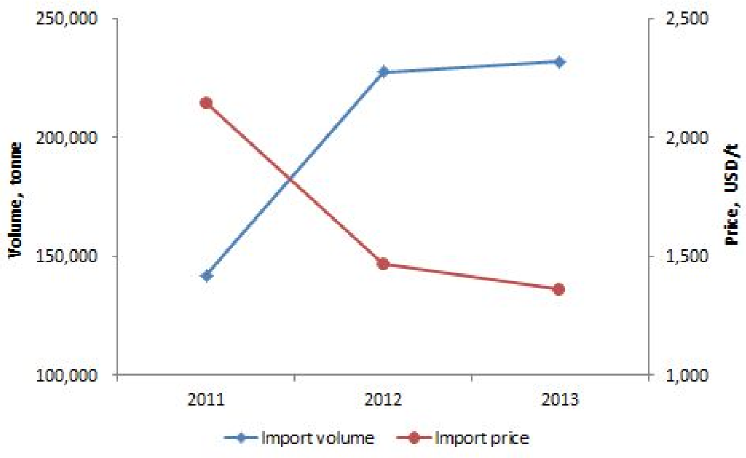
The price of castor oil is mainly determined by the price of castor bean (raw material), imports of castor oil and downstream products.

The oil production rate of castor bean is around 50%. Generally 2.55 kg of castor beans can produce 1 kg of castor oil. The price of castor bean plays a decisive part in the price of castor oil. In 2001–2010, the price of castor bean went up from USD0.33/kg (RMB2/kg) to over USD0.98/kg (RMB6/kg), since the demand for castor oil exceeded the supply for a long time. Subsequently, castor bean was widely planted by Chinese farmers. Statistics has it that, in 2001–2011, the planting area of castor bean in China expanded from 13,333 ha–20,000 ha (200,000 mu–300,000 mu) to 200,000 ha (3 million mu).

In China, common castor seeds are used in about 80% of castor production. The average oil yield is only 3 t/ha–4.5 t/ha, which is far less than that of 45 t/ha from the high-quality hybrid castor seeds. Therefore, the demand for castor oil had not been satisfied even though the output of castor oil grew with the expanding planting area of castor. The average price of castor oil in 2011 even reached as high as USD3,331/t, which strengthened the farmers' confidence in planting castor. In 2011–2013, the planting area of castor was expanded largely. Specifically, hybrid castor seeds were largely planted in areas including Inner Mongolia Autonomous Region, Xinjiang Uygur Autonomous Region, Shandong Province, Northeast China, etc., resulting in the declines of castor oil price in H2 2011. In the following 2012 and 2013, the price of castor oil was even sliding continuously. The price of castor oil reached the bottom at USD1,922/t in Nov. 2013.

A large import volume of low-priced castor oil aggravated the downward trend of the domestic castor oil price in H2 2011. According to statistics, the import volume of castor oil reached 142,000 tonnes in 2011, and it reached 227,000 tonnes in 2012, presenting a YoY increase of 85,000 tonnes. What's more, in 2011–2013, the average annul price of imported castor oil dropped by 36.50% and meanwhile, the import volume was enlarging. The large increase of imported castor oil lashed the domestic castor oil market. The price of castor oil kept declining from H2 2012 to the end of 2013.

Figure 17: Imports of castor oil in China in 2011–2013



Source: CCM

However, statistics has it that, from Jan. to Sept. 2014, the import volume of castor oil was 150,000 tonnes, presenting a reduction of 40,000 tonnes compared with that of 190,000 tonnes in the same period of 2013. This had been the first time for the large decline of import volume of castor oil since the beginning of importing castor oil in China in 2001. It also mitigated the lash from the low-priced imported castor oil onto the domestic castor oil price in 2014. The domestic castor oil shows a strong upward momentum in 2014.

Certainly, the main reason for the strong upward momentum of castor oil is the recovery of domestic castor oil market.

Concerning the upstream, the enlarged planting area of castor in recent years enabled the supply increase of castor oil. Furthermore, the hybrid castor seeds planted in areas including Inner Mongolia, Xinjiang, Shandong, etc. satisfied the domestic demand for castor oil to some extent. After the downward trend of the castor oil price in 2012 and 2013, the price of castor bean dropped from the high price of USD1.38/kg (RMB8.50/kg) to USD1.14/kg (RMB7/kg), resulting in a shrink of the planting area of castor. The supply and demand was comparatively consistent.

Regarding the downstream, as a main purpose of castor oil, sebacic acid sees a stable market in 2014. The price and demand grow and the current price stays between USD3,982/t (RMB24,500/t) and USD4,144/t (RMB25,500/t). The proportion of domestic hybrid castor seeds that have a high oil production rate rises and the consumption of castor oil in domestic sebacic acid manufacturers increases, giving an impetus to the domestic castor oil market.

In addition, as the planting structure of castor is optimized in China (more hybrid varieties with high oil production rates and less common varieties with low oil production rates), the operating rate of the castor oil deep processing industry sets free gradually from the lack of high-quality raw materials and recovers. In 2014, the castor oil market is expected to develop well in general.

Price Update

Table 9: Average ex-works price of major raw materials of bio-based materials in China, July–Nov. 2014, USD/t

NO.	Product	Nov. 2014	Oct. 2014	Sept. 2014	Aug. 2014	July 2014
1	Castor oil	1,980	2,019	2,009	2,013	2,005
2	Sweet potato	301	342	419	634	685
3	Sugarcane	409	388	414	405	393
4	Corn	373	374	409	394	376
5	Wheat	407	408	404	406	410
6	Dry cassava	310	310	331	380	374
7	Fresh cassava	97	94	99	92	93
8	Molasses	149	150	149	149	150
9	Bagasse	76	73	72	83	86
10	Corn cob	81	77	75	70	63
11	Wheat straw	51	46	48	51	55
12	Cornstover	52	48	48	49	48

Source: CCM

Table 10: Average ex-works prices of major bio-based materials in China, Aug.–Nov. 2014, USD/t

NO.	Product	Nov. 2014	Oct. 2014	Sept. 2014	Aug. 2014	Remark
1	Bio-polyamides	6,989	7,155	7,215	7,133	PA610
2	PHA (Polyhydroxyalkanoates)	4,225	4,065	4,180	4,210	Films
3	PBS (Polybutylene succinate)	4,762	4,715	4,701	4,860	Extrusion grade and injection molding
4	PPC (Propylene carbonate)	2,812	2,780	2,756	2,850	Injection molding
5	PTT (Polytrimethylene terephthalate)	5,063	5,024	5,206	5,187	Fiber
6	PLA (Polylactic acid)	3,657	3,463	3,407	3,242	Injection molding
7	PVA (Polyvinyl alcohol)	2,275	2,195	2,180	2,231	Flocculent
8	Starch-based material	3,982	3,862	3,865	3,890	Injection molding
9	LDA (Long-chain dicarboxylic acid)	6,258	6,342	6,270	6,322	Twelve-carbon chain dibasic acid

Source: CCM

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