Microbiology Research Group

Development of biorefinery technology -Utilizing microbiological functions-

1. Introduction

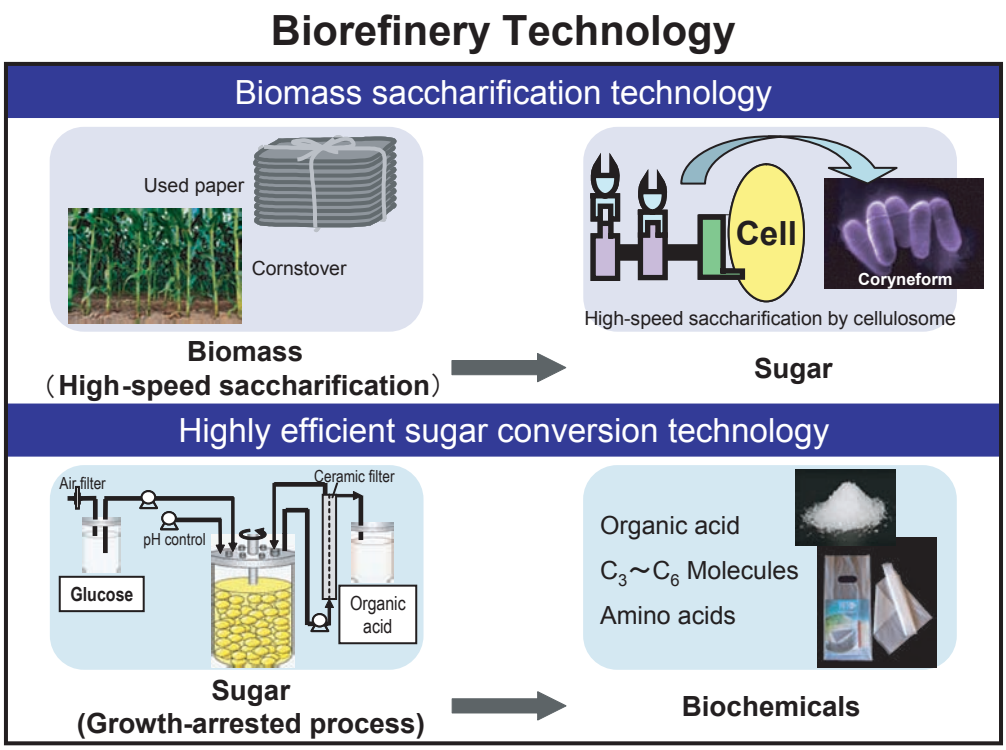
Two years after Kyoto treaty had come into force, there is a need for further act against the climate change. The crude oil price recorded the highest last summer resulting in the sharp increase in the prices of petroleum-based fuels and chemicals, and this phenomenon had significant effect on our society. Despite the lowered crude oil price (<$60) this year, there is no future in the industry which consumes large amount of resources, hence there is a growing expectation on corporations as well as on society to switch to using renewable resources. The Prime Minister Abe had instructed to increase the bioethanol usage last November and there is a plan to supply 10% of nation's petrol consumption with bioethanol. As bioethanol is renewable and carbon neutral, there is no theoretical increase in CO_2 resulting from any bioethanol usage. The assignment for all the nations including developing countries is to develop an economic way to incorporate biomass cultivation, biofuels and biochemicals into the sustainable society.

2. Biomass utilizing technology –world trend

In the USA, the government has been actively supporting the development of technology based on biomass resource usage. Unlike in the oil crisis time, there is a new concept of "biorefinery" in addition to the search for the alternative to fossil fuel and the companies are actively involved in the technological development. This is due to the expectation on the newly formed market with novel technological foundation. Moreover, there is a national strategy to become independent of the foreign supply of transportation fuel by producing bioethanol. In the state of the union speech this year, the president Bush announced his plan to supply 35×103 million gallon of renewable and alternative fuels, which is five times that proposed by existing plan, by 2017. This amount is 15% of the predicted gasoline consumption in 2017 and includes butanol and hydrogen in addition to ethanol. The EU is also aiming to introduce biofuels in their action plan and intends to supply 5.75% of transportation fuel with biofuels (mainly biodiesel fuel, BDF) by the end of 2010. In the case of biorefinery, there are constructive research and developments including use of cellulosic biomass. However, in order to achieve the practical application, it is necessary to establish bioprocess, by which the biomass is efficiently converted, hence each nation is competing in the technological development.

3. Technological development of biorefinery (in RITE)

As a consignment of NEDO, "Biorefinery research and development" project started in Japan last year. In RITE Microbiology Research Group, research has been carried out with "growth-arrested bioprocess", which is a novel and highly efficient technology, as a core technology. We are aiming to produce C3-C6 organic acids and amino acids from soft-biomass such as cornstover and used paper (http://www.nedo.go.jp/). Unlike the conventional bioprocesses of which production processes are dependent on the microbial growth, "growth-arrested bioprocess" utilizes artificially growth arrested microorganisms as catalyst to produce chemicals. By this method, the problem of low productivity (STY: Space Time Yield) associated with conventional processes has been solved and, by the continuous reaction, the productivity similar to the chemical process was made possible. With the post-genome technology, which analyzes all the gene, protein expression and function in the cell using the genome information, corynebacteria with improved production ability have been devel-



oped. The establishment of the "growth-arrested bioprocess" is predicted to be a key to the application of "biorefinery" in Japan.

4. Cooperation with industries

In the Microbiology Research Group, we have been conducting a collaborative R&D with industries using "growth-arrested bioprocess" as a core technology. As discussed above, bioethanol produced from biomass has been in the center of attention as a basis of energy security and transportation fuel which is effective in tackling the global warming. Owing to this fact, there is a heated research competition mainly in the U.S.A. to reduce the cost of production process. In our group, we have established the technology to produce alcoholic fuels from cellulose contained in soft-biomass not suitable for human consumption, such as cornstover and rice straw, and have moved forward to achieving the practical application. In our process, it is possible to significantly reduce the effect of fermentation inhibitors and we are carrying out R&D along with the car manufacturing company (Honda) for the practical application.

5. Future development

There is a heated competition among the nations to achieve the early practical application of biorefinery using the post-genome technology. Therefore we will devote ourselves to achieving practical application of our novel "growth-arrested bioprocess". Moreover, to accomplish the practical application of organic acid production, including succinate, we have started developing the continuous production system with the industry. We are also carrying out the primary R&D for biomass-derived hydrogen production in collaboration with electronics companies. In order to implement our bioprocess to produce wider variety of chemicals and energy, we are planning to collaborate with industries in R&D in the future.