Customised Enzymes

On-site Enzyme Production to Obtain Bio-based Chemicals and Polymers from Straw

The production of bio-based chemicals and polymers from renewable raw materials is destined to be a major future issue. That is why PFI has long been active of the area of white biotechnology and has undertaken various research projects for the development of digestion processes and fermentation technologies which utilise agricultural waste materials for the production of bio-based products. However, the high cost of cellulose-cleaving enzymes constitutes a major obstacle to the industrial-scale production and application of these raw materials. In order to significantly reduce these costs, PFI plans to participate in a collaborative project with goal of setting up on-site enzyme production.

Agricultural residues as well as by-products and joint products have enormous potential as sources of raw materials for sustainable production of biochemicals and bio-based plastics. Some 50m tonnes of straw are produced annually in Germany alone. Even though a sizeable proportion of this straw must be returned to the land for humus regeneration, there remains a significant amount of at least 15m tonnes for the production of bio-based chemicals and polymers.

Use of crop straw for generation of raw materials requires development of appropriate digestion technologies to make the sugars it contains available for fermentation. One highly promising pre-treatment method is hydrothermal digestion by thermal pressure hydrolysis (TPH) followed by enzymatic hydrolysis. The TPH process could be implemented in various projects at PFI and optimised, thus enabling practically complete hydrolysis of the hemicellulose fraction to monosaccharides.

Enzymatic hydrolysis of the cellulose fraction, however, remains critical. Although TPH pre-treatment significantly enhances the effectiveness of enzymatic hydrolysis, the enzyme cost level is still too high for economic processing: Extensive enzymatic hydrolysis of 1 tonne of straw (after thermal pre-treatment) currently requires expenditure of at least € 400 on enzymes. These high costs explain the market absence of biopolymers and bio-based chemicals required for most applications.

A research project has therefore been initiated to develop on-site enzyme production in order to reduce enzyme costs. To this end, part of the straw treated by TPH is used for production of the cellulolytic enzymes required for breakdown of the remaining TPH-treated straw. This yields a glucose-enriched fermentable hydrolysate suitable for the biotechnological production of various target products.

A project proposal was submitted to the German government's Agency for Renewable Resources (FNR) (Fachagentur für Nachwachsende Rohstoffe) and has already been classified as eligible for funding. The project is anticipated to start in the autumn of 2014.

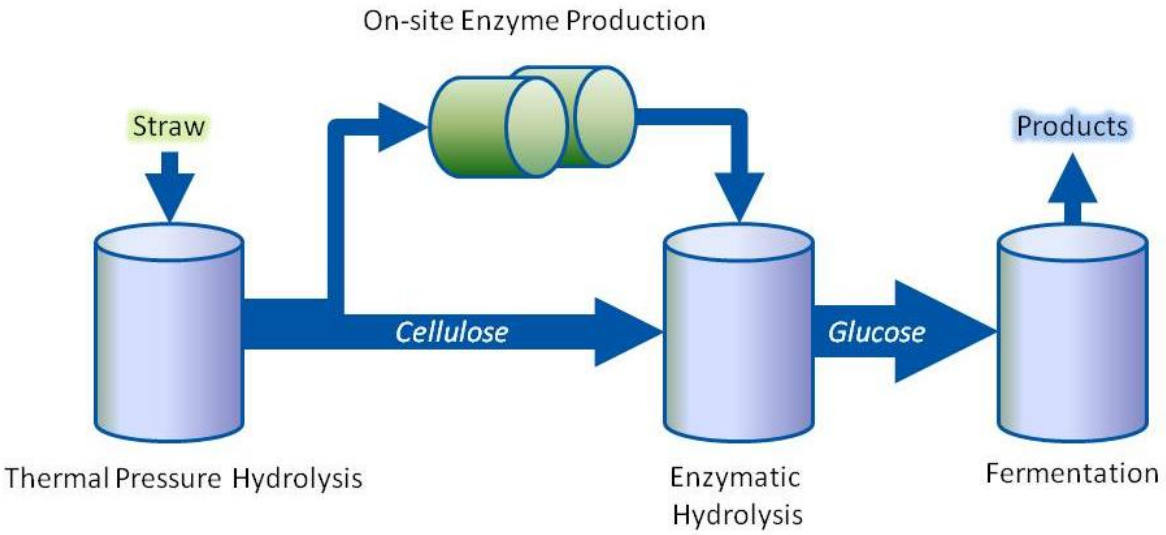

Fig. 1: Process schematic

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