BIO-BASED PRODUCTION TECHNOLOGY

A sustainable supply of succinic acid

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The need to reduce dependency on fossil fuels, a growing world population and an increased concern for the environment are driving companies to supplement oil-based chemicals with plant-based, sustainable, high-quality chemical building blocks. Reverdia™, a company backed up by DSM + Roquette, produces the sustainable succinic acid Biosuccinium™ with proprietary green technology. It enables customers to produce bio-based, high-quality performance materials while at the same time substantially improving their environmental footprint[1].

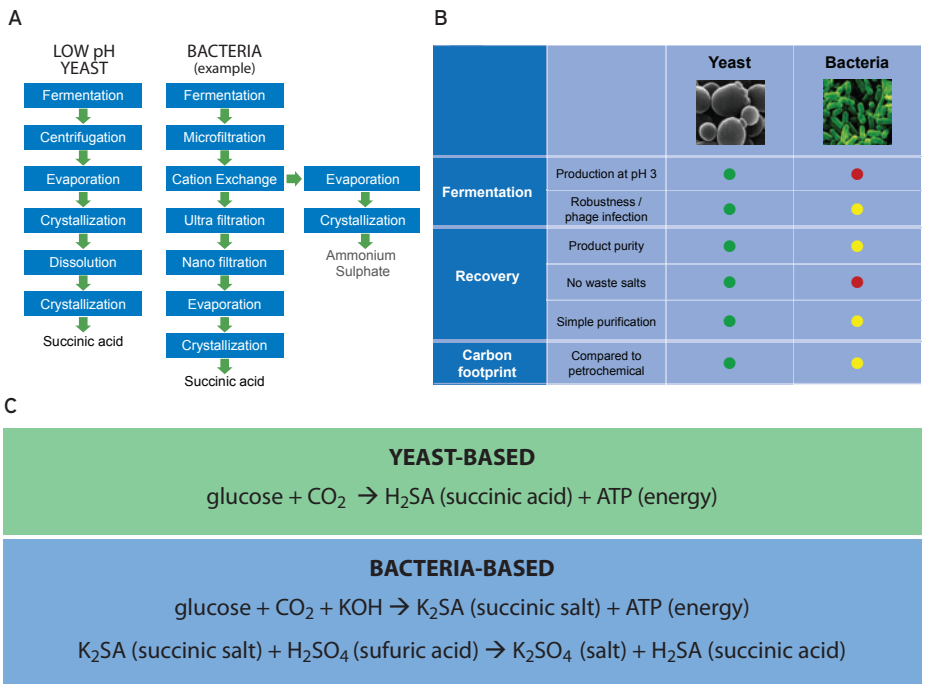

Fig. 1: Comparison of the yeast versus bacteria production processes for succinic acid: low-pH yeast technology requires fewer steps than the bacterial process (A). Additionally, it reveals a beneficial carbon footprint (B), and delivers acid instead of salts (C). With Reverdia's proprietary low-pH (<3) yeast-based fermentation process, the succinic acid is present as H_2SA. In the case of bacteria-based fermentation, since base is added to control the pH, the succinic is present as a salt (K_2SA). This salt has to be transferred into acid – for example, through the addition of H_2SO_4. Alternatively electrodialysis can be used to convert the succinic salt to succinic acid, but this requires significant amounts of energy.

With strong expertise in fermentation, recovery and plant scale-up, Reverdia is the only company currently employing low-pH yeast technology rather than bacteria to produce bio-based succinic acid. The use of this kind of production system provides several advantages for the customer (Fig. 1). The proprietary technology is simple, direct and has several distinct advantages over bacteria-mediated conversion technologies, but one of them in particular stands out: the Reverdia process converts feedstock directly to acid. Bacteria-based processes are indirect, and therefore require extra chemical processing, additional equipment and additional energy to convert intermediate salts into succinic acid (see Figs. 1B, C).

Compared to bacteria-based processes, Reverdia's low-pH yeast process is also much less vulnerable to infection. As a result, production equipment requires less cleaning and handling, which improves both the consistency and quality of the bio-based succinic acid product.

Simple and environmentally-friendly production

Biosuccinium is not only renewable, but also provides an ecologically sensitive way to produce succinic acid. This feature is becoming increasingly important to environmentally-conscious downstream customers. They now want more environmentally-friendly products for ethical reasons, but also in order to help project an eco-friendly brand image as consumers increasingly demand green products. Biosuccinium, for example, can be used as an alternative for petrochemically produced adipic acid in many applications such as production of polyesterpolyols for polyurethanes, coating and composite resins and phthalate-free plasticisers.

Life-cycle assessment (LCA), a technique that identifies the energy, material, and waste flows of product production and their impact on the environment, is becoming the standard for comprehensive ecological assessments. LCA was

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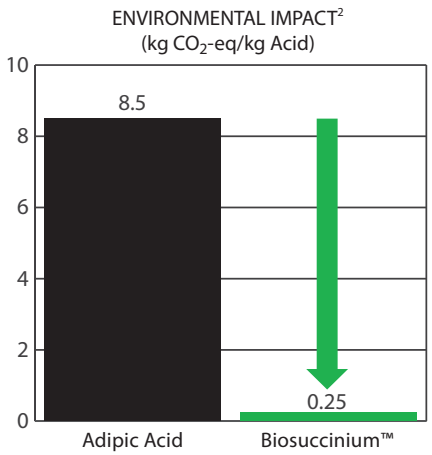

Fig. 2: LCA Comparison of Biosuccinium™ vs. petrochemical adipic acid. The LCA was calculated cradle-to-gate for both substances. The Biosuccinium™ cradle-to-gate study was performed by CE Consult and validated by Patel and Roes of the Copernicus Institute in the Netherlands. The adipic acid data is derived from the public domain and internal validation for a best-in-class plant with excellent control over NO_x emissions.

used to compare the carbon footprint of Biosuccinium production to fossil fuel-based adipic acid production. The Reverdia process showed an ~8 kg CO_2/kg acid advantage over petrochemical technologies (Fig. 2). This reduction in CO_2 emissions translates into a greatly reduced environmental impact for products made with Biosuccinium.

Providing a chemical intermediate that is also of the highest quality and purity is essential for applications where color and other criteria are important. Reverdia produces succinic acid of excellent quality and purity, largely due to its proprietary low-pH yeast-based production process, which greatly reduces impurities and undesired by-products.

Succinic acid made with bacteria technology suffers from several production challenges that negatively impact purity and quality. These processes can also produce mono-acids, which may cause unwanted polymerisation. In addition, it can cause the formation of nitrogen-containing compounds, which creates unwanted discoloration that is difficult to remove.

The low-pH process technology is based on proven technology for other compounds such as citric acid, itaconic acid and lactic acid.

Unique proprietary technology

Biosuccinium is protected by a robust patent portfolio surrounding its low-pH fermentation process. It is currently being successfully produced in a 300 metric tonne capacity demonstration plant in Lestrem (France). This facility is used for process validation and optimisation, as well as to provide tonne-scale quantities of Bioscuccinium to customers for internal testing and application development.

In the second half of 2012, Reverdia will be opening a commercial-scale bio-based succinic acid facility at Roquette's large biorefinery site in Italy's Cassano Spinola municipality. This novel plant, which will have an annual capacity of around 10kt, is backward-integrated with the biorefinery-producing C-source. The site will employ the co-generation of steam and electricity and on-site waste water treatment. Its proximity to Genoa's harbour also ensures efficient global logistics (Fig. 3).

Driving market growth

The development of Biosuccinium succinic acid will provide impetus to an entire range of more renewable, sustainable bio-based products. While current markets for succinic acid include pharmaceuticals, food, coatings and pigments, Reverdia believes that the production of a high-quality, bio-based succinic acid like Biosuccinium will help drive the emergence of new applications. Possible markets include those for the production of bio-based polyurethanes, polybutylene succinate (PBS), plasticisers, composite and coating resins, and 1,4 butanediol, which is used in products as diverse as packaging, footwear, elastane clothing, shopping bags, mulch films, and automotive interiors. When it comes to markets for products such as PBS, Biosuccinium is positioned not only as a direct, cost-competitive substitute for petrochemical-based succinic acid, but also as a competitive alternative for petrochemical adipic acid.

Market growth will receive a big leg up from the marketing and application experience of Reverdia's parent companies, DSM + Roquette. DSM produces petrochemical succinic acid, and is a major user of petrochemical adipic acid. Roquette is the world leader in polyols, and produces isosorbide from sorbitol – a unique bio-based building block that is employed in a variety of material applications.

In its production of Biosuccinium with pioneering yeast-based technology, Reverdia is creating sustainable business opportunities for customers who want to produce high-quality performance materials that are also bio-based and better for the environment.

Fig. 3: Set to open in the second half 2012, the Reverdia™ plant for the production of Biosuccinium™ is still under construction at the Roquette biorefinery site in Cassano Spinola (Italy).

References

1. The joint venture Reverdia is subject to regulatory approvals and notifications. Biosuccinium and Reverdia are joint trademarks of DSM N.V. and Roquette Frères.

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