

«Waste4Butanol&Biogas» Project

Bio-based Products and Sustainable Energy from Bread and Dough Residues

Combined material and energetic utilisation of waste from food production and the agricultural sector has long been a major research topic at PFI Biotechnology. By embarking on a new research project entitled “Development of Processes for Combined Material and Energetic Utilisation from Residual and Waste Materials from the Food Industry for Production of Biobutanol and Biogas” (abbreviated as “Waste4Butanol&Biogas”) we can further augment our expertise in the important area of bioeconomics. Our objective is to develop an energy-optimised and waste-based process for production of butanol, a long-chain alcohol with a variety of applications in the chemical industry, and which can also serve as a high-quality biofuel.

Background – Biobutanol in the Chemical Industry and as a Biofuel

Recent years have seen a considerable upsurge in demand for platform chemical and fuels from renewable resources and organic wastes. Today up to 15 % of German chemicals production is already biobased and the German Chemical Industry Association (Verband der Chemischen Industrie eV, VCI) expects a 50 % increase by 2030. One of the highly promising products on the rapidly expanding market for biobased chemicals is butanol. This alcohol has numerous applications, e.g. in the cosmetics industry as a solvent, in hydraulic fluids, cleaning agent formulations, pharmaceuticals, as an intermediate in the production of butyl acrylate and methacrylic acid, and as an extraction agent. Moreover, butanol has many advantages over ethanol as a biofuel, for example lower volatility and higher energy content; it is also less hygroscopic and completely miscible with petrol.

Approach: Utilisation of Reject Products from the Frozen Pizza and Baked Goods Industry

The initial starting point of this project was to develop an ABE fermentation technology which utilises rejects from the baked goods and frozen pizza industry as starting substrate. ABE stands for the products acetone, butanol, and ethanol which can be produced simultaneously by certain *Clostridium* strains (for example, *Clostridium beijerinckii* and *Clostridium acetobutylicum*). The waste streams considered here as feedstock for fermentation have enormous potential. Returns to bakeries alone (unsold bread, bread rolls, and other baked goods) have been variously predicted to amount to over 500,000 tonnes per year just in Germany; a total of more than three million tonnes can be safely assumed for the whole of Europe. In addition, considerable amounts of residual dough are collected as production surpluses during the production of baked goods and particularly of frozen pizza.

Key issues faced in the planned process development for utilisation of these starch- and fat-rich waste materials are adaptation of natural butanogenic strains to high product concentrations, immobilisation of the microorganisms on the reactor packing to facilitate continuous production in a trickle-bed process and in-situ product isolation by stripping*. A further innovation is that the process should not require any external energy input. The butanol fermentation proceeds solely with the carbohydrate fraction of the waste streams. Fats, proteins, and the cell mass produced remain behind. These energy-rich residual substances will subsequently be used to produce biogas by anaerobic fermentation. The biogas serves as fuel for supplying thermal and electrical energy. Figure 1 shows a simplified scheme of the planned process development.

Glossary

***Stripping:** Method of isolation and purification of (volatile) final products of a fermentation process. The volatile substances are transferred with the aid of a countercurrent flow of carrier gas from a liquid into the gas phase.

****Stillage:** Fermentation residue after removal of alcohol by distillation in a still (or by other methods such as stripping).

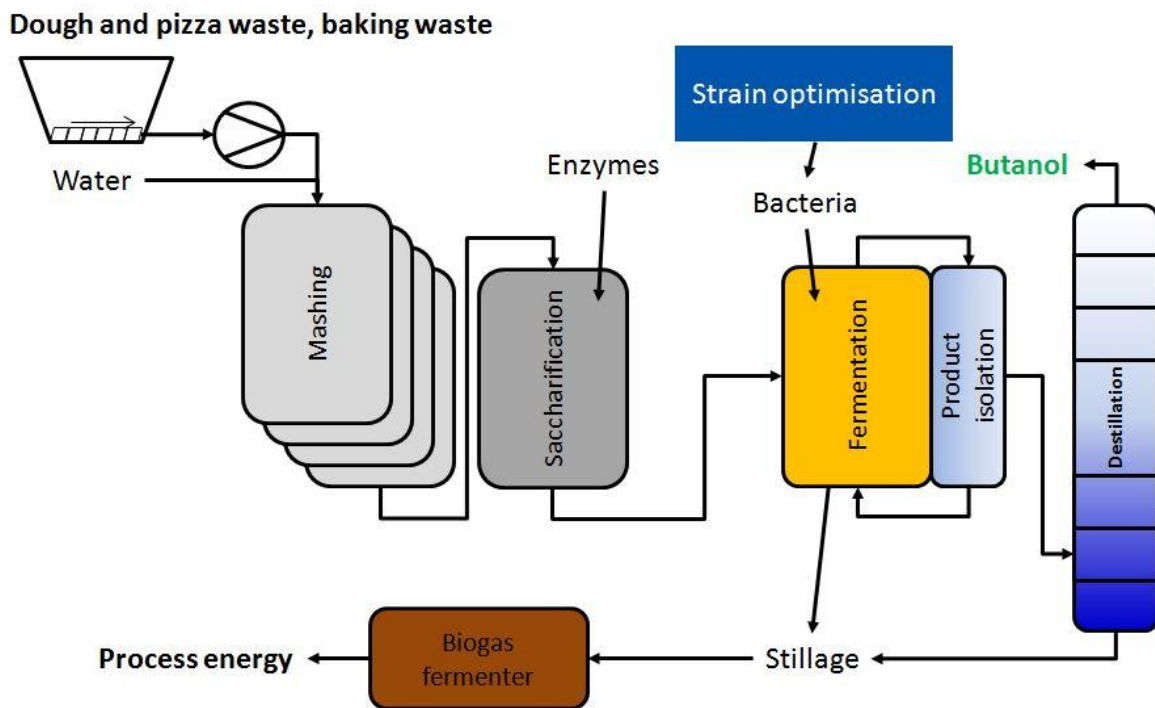


Fig. 1: Schematic representation of process comprising fermentation, product isolation, and biogas production (Stillage, see glossary)**

Research Funded by INNO-KOM – New Funding Programme for Private, Non-profit Research Institutions

Waste4Butanol&Biogas is the first research project that PFI will conduct within the framework of the new INNO-KOM Programme. This programme aims to promote research and development in structurally weak regions of Germany. Support is provided for industry-oriented non-profit research institutions, such as PFI, which transfer their fundamental R&D results to the companies operating in the corresponding regions. Whereas the preceding INNO-KOM-Ost programme was limited to the new federal states in eastern Germany, the current funding programme has been extended to include structurally weak regions throughout Germany. For PFI the programme offers further opportunities to conduct innovative industry-oriented research projects, which will be of particular benefit to the many SMEs in the region.

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The project outlined in this report started in October 2017 and has a duration of two and a half years. It is funded by the Federal German Ministry of Economics and Energy via the INNO-KOM Programme under the reference number 49VF170019. Responsibility for the content of this publication rests with the author.

Gefördert durch:



Bundesministerium
für Wirtschaft
und Energie

INNO-KOM



EuroNorm

aufgrund eines Beschlusses
des Deutschen Bundestages