

Is the biogas industry right to be sceptical of enzymes?

# Controversial enzymes

**E**nzyme application in biogas plants – there is hardly any other topic in the biogas industry being discussed as controversially. Farmers, plant operators and consultants are rightly sceptical of the new miracle cures, advertised almost every single day, as their efficacy in the biogas process cannot usually be confirmed.

There are inconsistent reports on the use of enzymes in practice: Some biogas plant operators see desired effects such as an improvement of the viscosity in the fermenter, while others cannot observe any effects at all.

The North Rhine-Westphalian Chamber of Agriculture therefore carried out a product screening of enzyme products promoted for application in biogas digesters. For only a few products tested, an improved substrate conversion and thus stirability of the fermenter contents was shown. About half of the products tested showed little effect in the laboratory tests contracted by the Chamber of Agriculture.

Added enzymes are

supposed to supplement the enzymes formed by the microorganisms in the biogas plant and thus improve, or more exactly, accelerate substrate degradation to methane and carbon dioxide. Enzymes have long been used in numerous industrial and agricultural processes. As biocatalysts, they accelerate these processes and thus contribute to economic efficiency and environmental friendliness. Therefore, the question arises: Why is the use of enzymes assessed so controversially in biogas production?

## The enzyme activity profile is key

Enzyme preparations must be adapted to the specific application. Particular attention must be paid to the so-called enzyme activity profile. It must fit with the substrates used and match the environmental conditions in a biogas fermenter, the most relevant factors being pH value and temperature. Biogas plant operators are often offered enzyme products from other technical applications, which are not

necessarily appropriate. The activity profile of these enzymes usually shows limited suitability for biogas fermentation. Consequently, their effects are insufficient and sometimes their activity is hardly even measurable. Reasons for this are a lack of substrate specificity, limited stability or adaptation to the pH conditions in the fermenter.

## New enzyme generation

The company Biopract ABT focused their research on these problems and developed a second-generation enzyme product. Considerable increases in biogas production were demonstrated in lab experiments. The enzyme product was shown to improve the digestion of the plant cell walls and thus make the substrate digestible for the biogas bacteria. In particular, the gas yield increased when animal wastes, such as cow dung and fibrous substrates, were part of the substrate mix. Furthermore, dead microorganisms, which often make up a considerable proportion of

the fermentation residue, were broken down.

## Field test

What works in the laboratory, however, does not necessarily work in the field. Therefore, the developer of the novel enzyme additive and the North Rhine-Westphalian Chamber of Agriculture (Germany) carried out a field study on a one-megawatt biogas plant in the Lower Rhine area. To this end, the plant received intensive technical and scientific support over a period of six months. The substrate mix of energy crops, dung and liquid manure was kept constant during this period. Before starting the enzyme application, all relevant biochemical and technical parameters of the plant were recorded for more than 70 days, conforming to the hydraulic retention time of the substrates in this case. An exact measurement of both gas and electricity production over the entire experimental period proved to be important.

Following the initial observation period the application of the new product called “UltraPract P2” was started. The product features a specifically adapted enzyme preparation and includes the newly developed enzymatic AC (acceleration) factor. Following an initial concentration for twelve days to reach the enzyme target level the plant was supplemented at standard dosage for another 52 days. As before, the energy yield and the daily substrate quantities were recorded in the test phase. In addition, dry matter and organic mass of each individual substrate were determined on a weekly basis. Furthermore,



1,000 kW biogas plant in Salizzole, Italy successfully applying UltraPract P2 since Autumn 2017. Image credit: Biopract



**700 kW biogas plant in Schoepping, Germany successfully applying UltraPract P2 since Spring 2017; achieved a net increase in plant efficiency of 15%. Image credit: Mathias Haack**

all substrate types were precisely characterised with the proximate feed analysis during both the reference and application periods.

After 140 experimental days with 162 samples, more than 400 analyses and the assessment of all data from the plant's operating journal including the electricity and heat statement, a summary was drawn up. The use of the new enzyme UltraPract P2 increased the energy yield per tonne of organic dry substance from 1,349 to 1,494 kilowatt hours. This corresponded to a net increase in plant efficiency of 11%, which was equivalent to a saving of 6 tonnes of corn silage per day

at constant plant output.

The economic evaluation is similarly positive. Due to the savings of corn silage, daily substrate costs were reduced by around €250 from €1,848.59 to €1,606.22. Related to 1m<sup>3</sup> of biogas, costs were reduced by €0.02 from €0.147 to €0.127. This results in an annual savings potential of around €90,700. In addition, substrate savings also reduce the amount of fermentation residue by about 1,700m<sup>3</sup> year. Multiplied by the disposal costs of €8, this results in a further savings potential of €13,600. In biogas plants, which have to export their fermentation residues, the savings can be

even higher. In the example calculation shown, this would result in total annual savings of €104,000.

Of course, the costs for the enzyme product must be set against this: The application of UltraPract P2 would amount to €35,340 per year, including feeding into the fermenter via a metering pump. The net result: annual savings of €104,000 minus annual costs of €35,340 corresponds to an extra gain of almost €70,000 per year – or €189 per day.

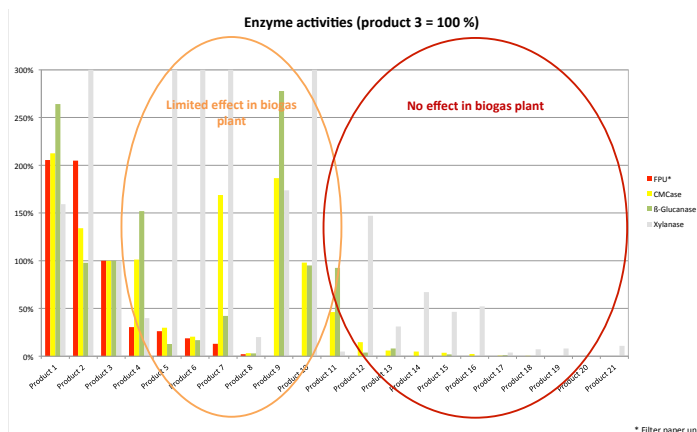
study supervisors developed a calculation tool. It takes into account a large variety of substrates as well as different constructions and operating modes of biogas plants. Today, the North-Rhine-Westphalian Chamber of Agriculture is aware of numerous biogas plant operators who apply the new enzyme concept. The feedback is positive without exception and in some cases benefits measured even exceed the calculated values. ●

**Calculation tool developed**

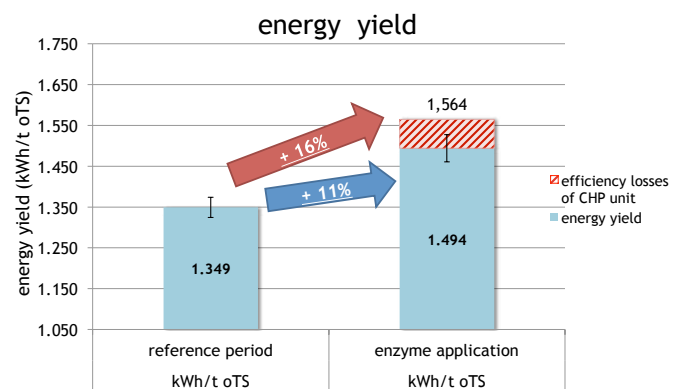
In order to be able to calculate the optimisation potential on a plant-specific basis, the

**For more information:**

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**Chart 1:** Results of commercial enzyme product screening conducted by the North Rhine-Westphalian Chamber of Agriculture. The potential efficacy of the preparations was assessed in laboratory tests.



**Chart 2:** In the 1 MW biogas plant chosen for the field study, the tested enzyme product increased the gas yield significantly. Total power output as well as the electrical power yield minus deduction of the CHP unit efficiency losses were calculated.