High Sensitivity Calorimetry on Aceton-Butanol-Ethanol (ABE) Fermentation

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Since chemical and biological processes generate or consume heat, calorimetry is a universal method to investigate and control such processes. While aerobic processes are frequently monitored by their oxygen consumptions, require anaerobic processes other methods. For exploring the analytical potential of calorimetry in anaerobe biotechnology, we investigated the activities of *Clostridum acetobutylicum* with a calorimeter. *Clostridum acetobutylicum* transforms carbohydrates first into butyrate and acetate and later into ethanol, acetone, and butanol. Butanol is a promising alternative fuel additive. Challenges were the measurement of the small amounts of generated heat that were in the range of 10 to 100mW/l. Furthermore, each fermentation process took typically 3 to 6 days to completion and required an instrument with the corresponding stability.

The reaction Chemisens calorimeter nowadays made from Syrris Ltd has been equipped with an especially developed high sensitivity reactor for biotechnological applications. The sensor has a sensitivity of 1mW/l and is therefore unique for reactor types with volumes of 100 to 200ml. The reactor has a temperature range from -20 to 150°C and can withstand pressures up to 10bar. The reactor can be equipped with various automated dosing and sampling lines for liquids and gases as well with additional sensor such as pH, pressure or more sophisticated ones, like IR or particle size sensors. Beyond heat measurements, we will present simultaneously measured data of pH, gas production and of the chemical compositions of gas and liquid.

The measuring principle of the Chemisens calorimeter is unique and offers a number of significant advantages over conventional calorimeters: (1) Due to its design, it does not require any additional calibration after an initial one that is already performed in the factory. (2) Consequently, changes in experimental conditions such as changes in pressure, liquid level, stirring rate or viscosity do not require any calibration procedures. (3) Even the high sensitivity reactor has an extremely stable baseline with almost no shifts. This allows a reliable quantitative evaluation of the heat production curves. (4) The measured heat data do not require any post experimental correction and can potentially be used as control process parameter.

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