Aerobic gas fermentation for the production of chemicals and fuels

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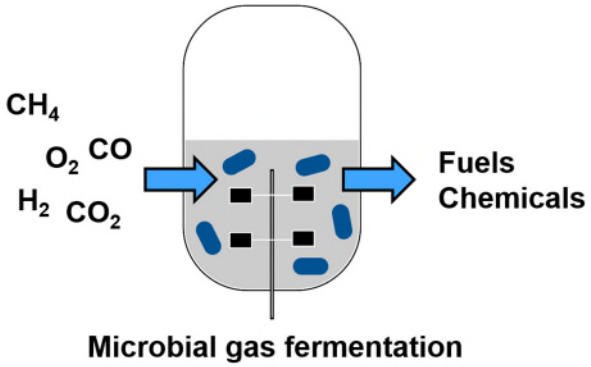

The finite availability of fossil resources and the negative environmental impact of their consumption require the development of sustainable production processes within the framework of the circular bioeconomy. Industrial biotechnology can make an important contribution here in producing chemicals and fuels from biogenic resources or waste streams. Currently, industrial bioprocesses mainly use sugar as a substrate, which is critical for ethical reasons (plate-tank discussion). Therefore, future biotechnological processes should be based on raw materials that are not used as feed or food. Industrial waste gases emit large amounts of greenhouse gases into the atmosphere and contain significant amounts of e.g. CO, CO_2 and H_2 (also called synthesis gas or syngas). The anaerobic use of C1 gases as substrates has become a technology of industrial maturity and first production processes for the microbial conversion of syngas into ethanol have been successfully commercialized by companies such as LanzaTech. This group of bacteria uses the Wood-Ljungdahl pathway to fix CO_2. Although this pathway is the most efficient in terms of ATP and H_2/electron requirements, this group of anaerobic bacteria is considered energy-limited, which makes the efficient production of longer-chain or ATP-intensive molecules difficult. In addition, the strictly anaerobic acetogens react sensitively to oxygen, which must first be depleted in waste gases containing O_2. Waste gases, such as those from the cement industry, contain CO, CO_2 and H_2 as well as O_2 and can be used by so-called carboxydotrophic Knallgasbacteria as a carbon and energy source for biomass formation. The aerobic oxidation of CO provides a higher free energy and thus a higher ATP yield compared to the anaerobic pathway. Therefore, these bacteria are interesting biocatalysts for gas fermentation processes to convert O_2-containing C1 gases directly into more complex products of industrial biotechnology.