Biological hydrogen production as a new source of energy for waste water treatment plants

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Due to the aeration of activated sludge tanks and numerous pumps, waste water treatment is a very energy consuming task. Today it is very common to produce some of the required energy on the waste water treatment plant itself. For this purpose, the sludge is treated anaerobically, producing bio gas consisting mostly from methane (CH4) and carbon dioxide (CO2). The bio gas is then burned in a block heat and power plant. The energy is used to power the aeration and the heat is used to heat the administration buildings and the digestion towers. The system has an electric efficiency ranging from 25 to 40 %. If the entire heat can be used, the total efficiency increases to up to 90 %.

For some years, operators try to increase the energy production, by not only treating their own sludge, but to acquire and treat co-ferments from industry and farming. Especially in summer this leads to a surplus in heat that can not be used, reducing the efficiency of the whole process. Another disadvantage of this treatment is the long residence time of approximately 21 day, requiring large and consequently expensive digestion towers. That is why a new approach to produce hydrogen instead of methane is pursued at the department of waste and waste water management at the University of Duisburg-Essen. Hydrogen can be transformed to electricity using fuel cells with an efficiency of 65 %.

Figure 1 shows the four steps of anaerobic digestion. Biological hydrogen production is similar to the methane production, with the exception, that methanogenic bacteria are eliminated and therefore the fourth step is inhibited. At the University of Duisburg-Essen, lab scale tests are carried out, continuously producing hydrogen from glucoses under mesophilic conditions. The residence time reduces from several weeks to a single day. The liquid digestate, consisting mainly of organic acids, can be further processed in a methane stage, or serve as a proton donator in a denitrification.

This paper will show the current state of research, regarding the continuous lab tests and research regarding batch tests to estimate the suitability of different substances for the biological hydrogen production.

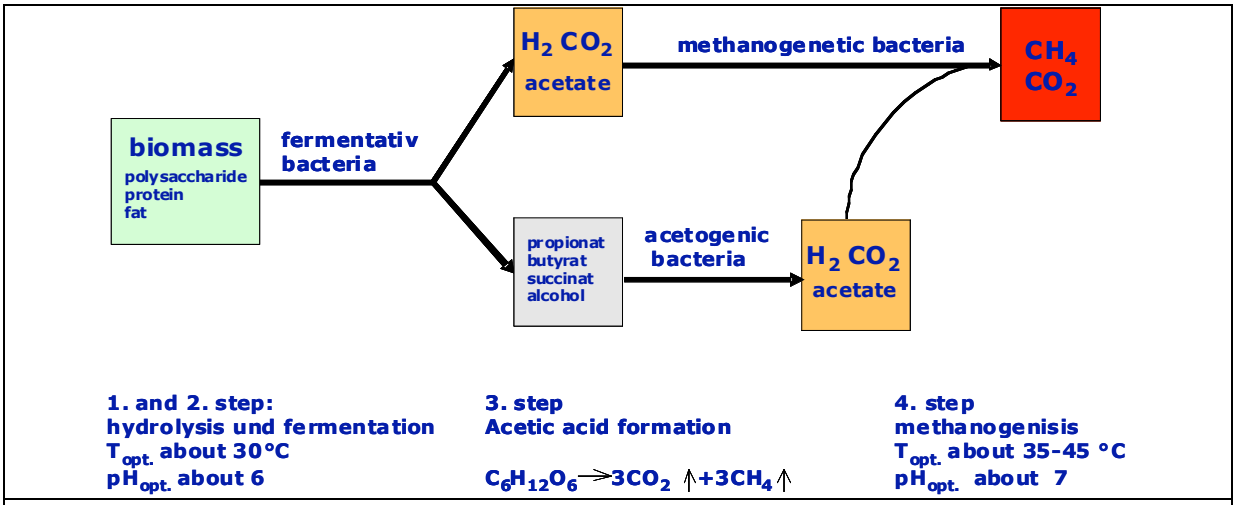

Figure 1: Four steps of anaerobic digestion