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SYNERGIC CONSIDERATION OF COMPETITIVENESS AND ECOLOGY IN BIOGAS PRODUCTION AND USE

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ABSTRACT

A biotechnological investment producing biogas from the by-products of sugar industry was put in operation at the Kaposvár Sugar Factory of Hungarian Sugar Ltd in 2007. The project essentially contributed to the survival of the Kaposvár Sugar Factory, as the only one Hungarian plant, in the worsening contention in producing beet sugar. In addition, the favourable environmental effects of the investment support the long-term sustainable and successful activity of the factory. The investment involved the building of two extremely large fermentors of 12000 m³ useful volume, with the connected feeding and mechanical equipment, as well as gas system. Depending on the dry matter content, the biogas plant is able to receive 800-1000 t raw material daily. Based on the pilot studies, the biogas production of 110.000 m³ / day was supposed with 55-60% methane content. This amount replaces 60-65.000 m³ natural gas in heating of the evaporators of the sugar factory. The test operation of the biogas plant in 2007 has been followed by the normal operation since 2008 September. The obtained results exceeded the expectations, regarding both the quantity and the quality of the produced biogas. Daily production reached the value of 140.000 m³ with an average methane content of 53%. The methane equivalent of 76-77.000 m³ covered more than 50% of the factory's energy demand.
Keywords: biogas production, sugar industry, anaerobic digestion, competitiveness, sustainability

INTRODUCTION

A biotechnological investment, producing biogas from the by-products of sugar industry was put in operation at the Kaposvár Sugar Factory of Hungarian Sugar Ltd in 2007. The biogas plant has made numerous favourable effects on the competitiveness of the Kaposvár Sugar Factory. The project essentially contributed to the survival of the Kaposvár Sugar Factory, as the only one Hungarian plant, in the worsening contention in producing beet sugar. In addition, the favourable environmental effects of the investment support the long-term sustainable and successful activity of the factory. The biogas equipment produces energy from the degradation of sugar beet fibers which is a renewable vegetal energy source. This way of energy production and use doesn't pollute the environment. The sugar beet plant fixates carbon dioxide from the air via its physiological processes and builds it up in organic matters consisting of mainly carbohydrates and cellulose.

Fundamentals of biogas production

Biogas consists of methane and carbon dioxide mostly. Reproduction of microbes and biogas formation is a slow process also in the nature. It spontaneously appears

where organic matter is presented in high concentration, while oxygen is excluded. Anaerobic digestion consists of a series of microbiological processes that convert organic compounds to methane, carbon dioxide and new bacterial cells (*Labat and Garcia*, 1986; *Hutnan et al*, 2001a; *Hutnan et al*, 2001b; *Gerardi*, 2003). This procedure is commonly considered to be a three-stage process. The first stage of the process involves the hydrolysis of solids. The hydrolysis results in the production of simple, soluble organic compounds (volatile acids and alcohols). Acetogenesis, the second stage of the process, involves the conversion of the volatile acids and alcohols to small substrates, such as acetic acid, or acetate and hydrogen that can be used by methanogen bacteria. Methanogenesis, the third stage of the process, involves the production of methane and carbon dioxide.

BACKGROUND AND MOTIVATION

Pressed sugar beet slice is traditionally used for animal nutrition, however, the demand for this by-product has dramatically decreased in the past years. The high transportation cost compared with the value of the product is one of the reasons. The transport cost already exceeds the value of the product for highway transport longer than 40 km. In addition, sugar production has been accumulated, which resulted in oversupply, while the steadily increasing transportation charges also effect the market unfavourably. Costumers are very limited in such economic conditions. The storage or the alternative utilization of the accumulated byproduct (like ensilage, application on croplands to recover nutrients, etc.) are expensive procedures, consequently they are not sustainable in long term. Moreover, there is a risk that the given byproduct would be classified as waste, if it were not used for biogas production or utilized in some other way in the future.

The energy demand of sugar production was traditionally provided by natural gas at the Kaposvár Sugar Factory. The rising cost of natural gas results in a disadvantage compared with those sugar factories which are still able to cover their energy demand from cheaper fossil resources (like coal or coke). Regarding the production costs, the complete or partial replacement of natural gas with a cheaper energy source could increase the competitiveness of Kaposvár Sugar Factory substantially.

However, the consumption of the fossil fuels is essentially limited by the available carbon-dioxide quota of the factory. From the energetic point of views, the factory can only realize its ambitions either by increasing the carbon-dioxide quota, or by producing the required energy from alternative raw materials (e.g. biomass), which are not included in the group of quota regulated energy resources.

RESULTS AND DISCUSSION

The raw materials of biogas formation are the by-products of the sugar production of organic content. The basic by-product is the pressed sugar beet slice, with a daily amount of 1800-2000 t during the campaign. The other byproducts come from the beet cleaning, like beet debris, beet fragments, but some other organic vegetal residues and weeds can also be utilized for fermentation in smaller amounts of 200 t / day.

The investment involved the building of two extremely large fermentors of 12000 m^3 useful volume, with the connected feeding and mechanical equipment, as well as gas system. Depending on the dry matter content, the biogas plant is able to receive 800-1000 t raw material daily. Based on the pilot studies, the biogas production of 110.000 m3 / day was supposed to have 55-60% methane content. This amount replaces for 60-65.000 m^3 natural gas in heating of the evaporators of the sugar factory.

The economic importance of the project is the significant decrease of the more and more expensive natural gas consumption. Biogas, generated from cheap byproduct, covers the 55-60% of the total energy requirement of the factory. Since no sugar producing enterprise in Europe has any similar equipment, the Kaposvár Sugar Factory could obtain a major competitive advantage from this innovation.

Replacement of fossil energy resources

The biogas equipment produces energy form the degradation of sugar beet fibers, which is a renewable vegetal energy resource. This way of energy production doesn't cause environmental pollution. The sugar beet plant fixates carbon dioxide from the air, during the physiological processes. It building up in the organic matter of carbohydrates and cellulose. During the fermentation, a series of bacterial events turns the organic matter into biogas. Therefore the process is a recycle, which, in contrast to fossil fuel utilization, doesn't pollute the environment with additional carbon-dioxide emission. This type of energy production and use is sustainable in the long term. It decreases the air pollution and the emission of greenhouse gases, preserving the present environmental conditions for the forthcoming generations.

Assuming a normal duration of campaign, the investment produces 15 million m^3 of biogas, which is equal to the energy of 330 TJ. This value is the double of the complete Hungarian biogas capacity and takes 0.6% of the total bioenergy production of our country. Except for the wood burning based bioenergy production (that is not long-term sustainable), this project provides the 6.5% of the national bioenergy production. In case of biogas production also, over the campaign period the volume could be tripled (assuming the year long operation). Consequently, the total potential of the investment can be 1 PJ, which takes 2% of the recent overall national bioenergy production.

The investment is in complete accordance with the most important targets of the National Environmental Program, regarding both the priorities of the air protection, and the increased production and use of renewable energy sources. In addition, it considerably helps to accomplish the environmental commitments that Hungary assumed. (Accordingly our country will produce 165 PJ from renewable energy, consisting of 10 PJ from biogas by 2013.) Besides this, it promotes the realization of 6% decrease in CO_2 emission until 2010, which was committed in Kyoto Protocol and moderates the dependence of Hungary from external energy sources.

CONCLUSIONS AND RECOMMENDATIONS

The test operation of the biogas plant in 2007 has been followed by the normal operation since 2008 September. The obtained results exceeded the expectations,

regarding both the quantity and the quality of the produced biogas. Daily production reached the value of 140.000 m^3 with an average methane content of 53%. The methane equivalent of 76-77.000 m^3 covered more than 50% of the factory energy demand.

Future possibilities, use of other substrates

The biogas fermentors can operate over the campaign period by minor mechanical modifications and improvements. The plant would be able to use other organic by-products and wastes originating from the South Transdanubian region (agricultural, dairy and meat industrial wastes, etc.). Accordingly, the materials which are currently handled or rendered harmless on high cost, could be processed in an environmental friendly way.

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