Hardware and Software Upgrade of Republic Reference Laboratory of Biogas Transformations

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***Abstract**: This article introducing the reader to the control system of Republic reference laboratory of biogas transformation. This system can be expanded with new modules. The main modules of the system ensure the functioning of bioreactors, sampling and storing data in the database. Other modules then secure login for each user of the system, BI processes etc..*

***Keywords**:biogas, API, emulsions dispenser, controlled agitation*

INTRODUCTION

Nowadays, when electrical energy is produced mainly from non-renewable sources such as nuclear power, coal, brown coal, petroleum, natural gas, etc., it is necessary to find renewable sources. According to the Shell International magazine which published expected changes in energy production between the years 1990-2100, a gradual decline beginning 2030 is envisaged and non-renewable sources will be replaced by the renewable ones such as sunlight, biomass, wind, geothermal energy, biogas, etc. Shell International also predicts a significant increase of these future substitutes for the non-renewable sources and assumes that these sources will supply 50% of the whole world consumption by the year 2050. This makes biogas very interesting and for this reason, it is necessary to conduct research about technology development around it. (Wiessman, 2007)

Each modern process needs to automate their operations. The same applies to biogas production as well and because they are anaerobic processes, all work must be ensured by machines and other equipment. The entire process of transformation of biogas is a microbiological process. For this reason, it is difficult to control this process from the technical point of view. The most preferable data processing for the control system is artificial intelligence. This artificial intelligence will have a knowledge base. It is necessary to store exact data, which will be synchronized using a certain system, into the knowledge base. In this case, it will be a laboratory reactor control system.

OBJECTIVES

The aim of this article is to introduce the reader to the control system of laboratory which is currently still expanding with new modules. The main modules of the system ensure the functioning of bioreactors, sampling and storing data in the database. Other modules then secure login for each user of the system, BI processes, etc. Other objectives are to increase the quantity and the quality of biogas produced.

SOLUTION

API and software of Republic reference laboratory of biogas transformations

When creating the system, the approach of software engineering and system engineering, mainly prototyping and the interactive lifecycle of the system, was used. The interactive lifecycle, modeled and described by associate professor Rábová, was improved using the gates of the lifecycle of the information system according to NASA. The system has to cope with heterogeneous hardware and that is why the fed main control module has additional subsystems which represent various approaches to the individual hardware available and unify the interpretation of individual orders to general API.

API of each module has pre-defined interfaces, which communicate with the main module, the individual modules for managing, storing and retrieving of data. The

disadvantage of API continuous control system is to know the number of the system and subsystem which will be activated.

The entire control and information system of the laboratory is developed in the Control Web 7, which is due to the integration of older modules. Web Control has always been and still is attractively priced and that is why it is used not only in large-scale applications in large companies but also small and embedded applications, and also in schools, science and research. The structure of typical applications has recently changed significantly. The amount of orders which required only a simple operator station with visualization and data collection possible, is gradually decreasing. Requirement of the interface for Web clients is commonplace. Most current systems are connected, often wirelessly, to computer network and the cooperation with a database information system is frequent. Also, the systems often consist of several parts, which have to communicate together. It is becoming more preferable that even a small embedded system is equipped with all communication channels and its software can work with all current standards of data exchange.

Application developed for the Nationwide reference laboratory of biogas transformation provides advanced user management. Defined users in the system are from Viewers who can only observe what is happening in the system to administrators who are not checked by the system and who are allowed any setting.

Emulsions´ dispenser

For the purpose of increasing production and the quality of biogas,it is necessary to create best conditions for the activity of microorganism which produces methan.

The following factors are important as far as the control of the reaction is concerned (Mužík, 2009):

- humidity of the environment – methan bacteria can work and reproduce only in wet enviroment (maximum humidity - 50%)
- temperature of the environment – creation of methan proceeds in a broad range of temperature (4-90 degrees of celsium) For a stable process, we need to ensure stable temperature
- mixing of substrate – „a cake“ should not be created at the top of the substrate
- the PH value – optimal PH value for the growth of methanogen microorganisms is 6,5 -7,5

I have created a dispenser of acid emulsion for controlling the PH value. Capacity – l0.4l. You can see the model of the dispenser in the Fig. 1., most parts of which are created from available construction elements (threated rods, pipe of dispenser, support of moving form of aluminium), other parts (gears of movement, support of movement) will be printed on 3D printer from PLA plastic, which will provide enough resistance and strength.

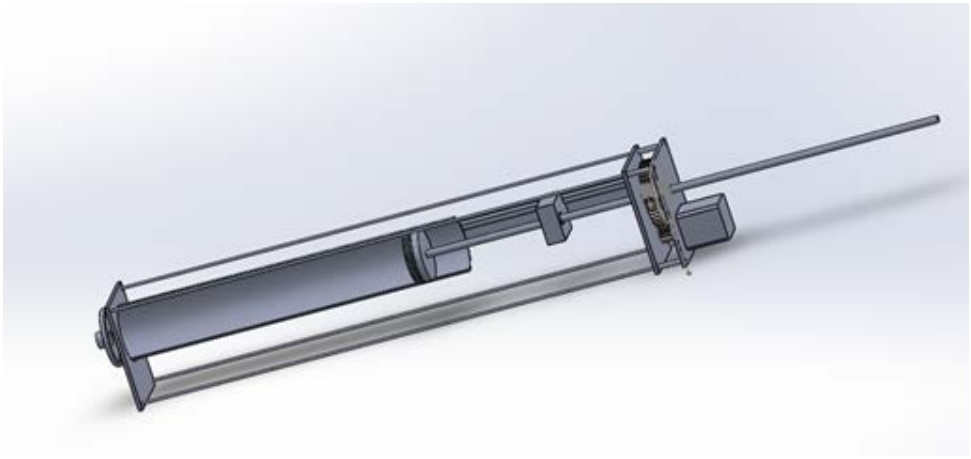

Fig. 1 Model of the dispenser

The whole device will be powered by a motor from microcon company, model SX17-0905 with flange NEMA 17 and static moment 0,6 Nm. This motor will be in assignment ratio 12:36 to the rod which will be connected to the head of the dispenser.

The driver DVR8825 (a 4- layer part) will be used for the controlling of the motor. This driver of the motor can control one bipolar motor up to 2,2A of output current and maximum power 45V. With the use of this driver, we can define direction and size of the step. There are 6 possibilities: Full step, half step, ¼ step, 1/8 step, 1/16 step and 1/32 step. Thanks to the potentiometer of the driver, we can define maximum power for the motor. Setup of power is very important – if the power was lower than required, the step motor may lose steps and power. This driver can be driven by 3.3V and also 5V.

Controlled agitation for small biogas plants

The following text applies to the management and engineering design of the mixing mechanism for small biogas plants, which are placed on Mendel university in Brno, in Republic reference of biogas transformations. The current small experimental reactors are only heated, but unmixed. This fact reduces the accuracy the performed experiments. Mixing is performed for the following reasons (Pokorná, 2015):

1. Maintaining a homogeneous environment
2. To ensure good contact anaerobic biomass with our substrate, to avoid local overload.
3. Maintaining the same temperature in the whole reactor volume.
4. Acts againts floating layer and formation of sediments on the bottom of the reactor.

For control was selected one desk computer Raspberry Pi, which allows us to connect and manage other hardware. Its advantage is low price against classical personal computer. The operating system of the device running on linux distribution Debian, which allows us again to save costs, because we can use GPL licens. (Raspberry, 2015)

It will alsi be used Arduino. Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. This environment is programmed on Java technologies – it means open-source and multiplatform based.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, MaxMSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment. Connection between Raspberry and Arduino will be realize via USB port.(Arduino, 2015)

RESULTS AND DISCUSSIONS

The final information system combined with the control system is very beneficial because in its core, it combines working with users and the control of particular components. The risk of this entire system is a strict adherence to the separation of the roles of the information and control systems.

The final solution will enable to deliver acid to bioreactor in an emulsion form and therefore, the control reaction will be run in the final phase, in which methan is produced (methanogenic phase). As a consequence, the production of methan itself and the quality of final biogas should be increased.

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