The biogas production into the wastewater treatment plants as an alternative source of energy

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Abstract. The current paper proposes a presentation of the advantages obtained through the construction of intake biogas equipment as a result of sludge organic matter fermentation in the wastewater treatment plants. The second section of the paper contains information about the biogas production in a wastewater treatment plant of 35.000 population equivalents, analysis and determination. The final section of the paper presents the direct proceeding of environment protection by the intake and usage of the biogas, thus avoiding its release into the atmosphere.
Key Words: biogas fermentation, efficiency, energy, plant.

Aims and background. Wastewater treatment plants (WWTP) present an untapped source of renewable energy. Within the millions of gallons of wastewater that pass through these plants in any given day are hundreds of tons of biosolids. When anaerobically digested, those biosolids generate biogas which can be anywhere from 60 to 70 percent methane. Natural gas that is typically purchased from the grid for use on-site is methane. If captured, that biogas can fuel an on-site combined heat and power generation system, thus, creating a renewable energy source (Wong 2011).

The sludge collected in the wastewater treatment process is a permanent source of energy. A sludge treatment plants comes from two wastewater processing steps:

- mechanical stage, after decantation, to obtain primary sludge;
- biological stage, after decantation in secondary sedimentation of activated sludge microorganisms is obtained. Activated sludge collected is divided according to the health of bacteria in the recycled activated sludge and excess sludge for disposal of the system.

Primary sludge after thickening is transported through a pumping station into the fermenter, where it is mixed with excess sludge which has previously been dehydrated.

Fermentation tank (the fermenter) is provided with its own mixer for sludge to determine the sludge inside movement, and to ensure an optimal movement in all directions. Direction of rotation is clockwise and counterclockwise turn (Ceclan & Ceclan 2010).

The heat exchanger is tube in tube type (made from stainless steel), where the hot water flows in the opposite direction of slugde flow. The heated sludge flows in the inner tube and the hot water flows in the outer tube.

The environment is protected by capturing the biogas resulted from fermentation of organic matter contained in sludge treatment plants, in special installations, thus avoiding its emission into the atmosphere. Methane and carbon dioxide are especially particularly dangerous gases, considered as major pollutants.

Experimental. The data used in this study was obtained from a wastewater treatment plant designed for 35,000 population equivalents with an average daily wastewater of 9200 m^3 day^{-1}. The daily amount of primary sludge at the exit of post-thickener is 49 m^3 day^{-1}. The daily amount of excess sludge discharged from the plantis 32 m^3 day^{-1}. The daily amount of crude sludge is 81 m^3 day^{-1}.

Results and Discussion. Sludge stabilization occurs through an anaerobic fermentation inside the fermenter. In order to stimulate fermentation, the sludge inside the fermenter is mixed. The biogas is produced by the stabilization of organic matter contained in the sludge, after fermentation. Biogas consists of methane (CH_4) (65-70%) and carbon dioxide (CO_2) (25-30%).

According to Simionescu (2009), the components of the biogas are:

- CH_4 volume = 60-70%;

- CO_2 volume =30%;
- H_2S volume = 0.3%;
- temperature = 25-30^oC;
- humidity = 100%.

Produced methane contains a significant amount of hydrogen sulfide (H_2S) highly corrosive for energy production plant.

For desulphurization of biogas are used special installations like "tower" to allow through a chemical washing of biogas reducing the hydrogen sulfide content of over 90% efficiency by passing through the three stages of the process.

Drip gas are made of stainless steel type. The drips are equipped with special access (a safety valve and a switch vacuum, including a tube discharge, a set of washing and filling, frost-resistant and designed for maximum gas pressure in the fermentation tank with preliminary pressure capacity reduction and the maximum quantity of gas storage) and all necessary support devices (Ionescu 2010).

The biogas produced in the fermenter is collected through the gas collector and transported to a gasometer. The gasometer is built on an expandable membrane inside a steel skeleton. It is provided with a mechanical indicator on the outer wall of the container to show the volume (m^3) of the gas inside the tank. The membrane tank is equipped with a safety valve to protect it in case of excessive pressure. Another safety valve allows excess gas to be released into the atmosphere when pressure exceeds the pressure tank explosion burner.

The biogas thus generated is used to power a combined plant for heating and electricity. The electricity used to power equipment in the wastewater treatment plant, a well-run process can provide up to 70% of the total energy required. Heat produced by the engine cooling system is used in heat exchangers for ensuring optimum temperature sludge fermentation (37°C).

With measurements conducted in 2014 and 2015 and the first nine months were obtained results, which are presented in Table 1.

Table 1

Performance measurements established by the treatment plant daily for 21 months cumulated

WWTP studied	*[year]*	*2014*	*2015/9 months*
Population connected to sewerage	[population]	31.888	31.903
The amount of treated water	[mc/year]	1704430	1385744
The amount of electricity used in the treatment plant	[Kwh/year]	984,125	730,784
The amount of electricity in the system	[Kwh/year]	777,628	540,009
The amount of electricity produced by biogas	[Kwh/year]	206,497	156,775
The amount of heat produced from biogas (including cogeneration)	[Gj]	1990,46	1700,50
The amount of sludge produced	[To s.u/year]	432,22	207,97
Biogas produced	[nmc]	124107	102454

Biogas collection system will include a burner (burners) to burn off excess gas fermentation. Biogas burner is completely automated and suitable for simultaneous firing of all of the biogas produced by the fermentation tanks.

Automatic gas burner excess will be made of stainless steel, automatic ignition and flame control facility and placed in a antiexplosion construction. Gas flame will be interrelated with the filling level of the meter. They will be provided all the necessary accessories including flame trap, solenoid valve, pressure valve, gate valve and solenoid valve ignition pipe and drainage pipe.

In addition, the burner will be equipped with an indicator/transmitter that will send the operational situation to the burner (gas burning at the moment or not) control panel fermentation system. A switch allows manual or automatic operation.

Fermentation sludge anaerobic digestion is an activity that can greatly benefit by producing electricity and heat, but mostly it is a necessary activity for environmental protection.

Conclusions. The data used in this study was obtained from a wastewater treatment plant for one year and a few months, were the specific wastewater treatment is 1,704,430 m^3 approximately 4,700 m^3 per day and from the data collected were obtained: 124,107 m^3 of biogas that by using a generator conversion occurred; 206,497 kWh and a quantity of heat generated during the engine cooling heat exchangers 1990 Gj. Also ago digested sludge dehydration resulting 432,22 tonnes of dry matter through a proper approach may be turn into a source of income.

Electric current product represents 20.98% of total energy consumption in one year for the entire treatment plant.

Agglomerations with over 35,000 population equivalent, which have in operating wastewater treatment plants can benefit from these advantages presented if they choose to equip wastewater treatment plants with facilities fermentation of sludge generated in the process of wastewater treatment and capture biogas so as was presented.

The advantages are:

- biogas which can be used both to produce electricity and heating boilers to heat water;
- protecting the environment by preventing the spread of fermentation gases in the atmosphere;
- obtaining a stabilized sludge anaerobic fermentation conditions can be more easily to dehydrated and subsequently developed.

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