Sewage sludge process integrated and environmentally friendly thermal heat recovery with green electricity production, extracting phosphorus compounds

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The device is a unique facility in the world adequate to the eco-friendly thermal disposal and heat recovery of sewage sludge and wastes, in integrated process, producing green electricity and recovering useful materials (e.g. recovery of phosphorous compounds). Thanks to the several, innovative solutions its comparison is also complicated with the other existing technologies as it operates based on a completely new methodology - that is the disposal of sewage sludge as an increasing problem and environmental risk. With an individual PE (population equivalent) of 50-250 thousand (1.5-5 MW) there is no other device that - meanwhile meeting the requirements - is able to incinerate the waste and can be installed freely at the waste collection or production site.

Sewage sludge disposal, High moisture content waste disposal, ORC, Phosphorus recovery, RDF, Waste disposal, Utilization of thermal treatment, Decontamination with energy profits, Energy from waste

As an individual, in collaboration with several universities, we created a sewage plant incinerator in Eger, which creates "electricity and fertilizer raw materials from shit." In addition, this equipment has patented plasma system, which can dispose all kinds of hazardous chemicals without releasing harmful substances to the environment (no emissions) and it can generate clean drinking pure water from contaminated water (i.e. leechate).

'Ish is burning!

Perfect burning!

'This is the future!' – Herr Untersteller, Minister, Baden-Württemberg

Scientific background, be expanded

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Our water, air, our fields are continually contaminated. This should be stopped only with the power of fire. A fire (thermal disposal) technology, which can produce energy in a closed system, furthermore it can create disinfected vital raw materials for agriculture! These products, produced in an environmentally engineered system can stop polluting our environment, besides ensuring sustainable development. We have to deal waste with the same intensity, as the treatment of residues, as we are producing them. Environmental products are useless if there is no control, if they focus on the sale of the products; because in that way the customer (user) gets an advanced technology through which - generally - government cost grow, but in fact there is no impact on the environment. Just an organized, technologically thought out system with a material balance proved systems can help to reduce the environmental risks. The main task of the Danube Region Strategy is to moderate Romanian-Hungarian environmental risks. Set up a pollution sample strategy for the environment in the Danube Region. With the work of our engineers, we could join our strategy for the environment in the Danube Region.

II. BIOFIVE® Waste Recovery Plant, Eger

Sewage sludge is an organic waste that poses certain risks and can be harmful to both humans and animals. It contains pathogens (bacteria, mold), poisonous inorganic materials, pharmaceutical waste, and other residual waste materials, as well as heavy metals such as: Hg, Pb, Cd, Co, etc. A variety of problematic and hazardous materials can enter and accumulate within soil through the use of sewage sludge. Through agricultural spreading of sewage sludge these unnaturally enriched pollutants enter the natural cycle and harm the living environment. If the residual materials are available in a relative concentrated form, more efficient disposal strategies can be considered, such as the incineration and elimination of drastically mass-reduced residual waste.

II.1. Eger incinerator as an environment-industrial product, technology

Decontamination of sewage sludge is a very real problem for the Danube Region Strategy. This potential opportunity could have an effect on the following ecological and economic aspects:

- Decontamination prevents the hazardous materials in sewage sludge from contaminating drinking water through agricultural spreading and also prevents the absorption of these harmful substances into food and feed.
- The energy created can be applied and used for various inner and outer processes, for example low-emission and energy efficient drying of sewage sludge, that is, the amount of waste decreases.

The project brings together scientists from Hungary and Baden-Württemberg with a common goal of winning support for medium-sized businesses and affordable technologies of the future, and introducing and distributing these technologies to markets in Europe and the Danube Region. The created value of using regional thermal recovery of BIOFIVE - ENTECCO processes will remain in the regional towns/villages.

The utilization of thermal treatment in sewage treatment plants does not require the instillation of further decontamination equipment. The plant in Eger serves as a model for similar sewage sludge incineration plants in the Danube region. The energy consumed to dry the sludge would no longer be required because transport of the sludge would no longer be required, thus the transport of the CO2 load of the sludge within the incineration plants or cement factories is unnecessary considering the sludge is dried and burned on site.

The incineration equipment is modularly-constructed and is able to accommodate the size and composition of the proposed waste; in addition to wet, dry or fermented sewage sludge, wood chips (non-contaminated biomass) or municipal solid waste chips, also known as substitute fuel source (municipal shredded waste, SRF stabilizers) can also be used.

The equipment is endowed with many new innovations (L.1.1.2) and the process is both innovative and involves direct profit (surplus revenue as well as energy and cost savings) for the following reasons:

- no waste preparation is required
- waste is not transported to a disposal site, rather the disposal equipment is installed at the waste’s place of origin (we connect and integrate the equipment onto the existing technology) and with this we eliminate the
need to transport the waste multiple times and reduce the environmental risk because of this; the production of energy from disposal does not consume any kind of fossil fuel energy; the remnants of the incinerated matter contain some valuable and useful materials which are extracted and recovered; after this, the mass, less than 5% of the original mass of the waste, which can be not be used for anything, is landfilled. (All the ash produced in current incinerators is landfilled.)

Current status

The prototype of the equipment is finished and is ready for operation. Tests have shown that it meets the current guidelines for waste incineration. For the National Water Directorate, we prepared and finalized the text, „A strategic review of the contractual framework for sewage sludge utilization and disposal project development concepts” in which the following determinations concerning the incineration of sewage sludge are made:

„There are 10 companies that hold D10 permits (waste incineration on land) and are licensed to incinerate the sewage sludge originating in the settlements of the EWC 18 08 05: while 9 companies are licensed to use waste for the purpose of heating energy (R1 is primary or combustion as a fuel or other means to generate energy). Of these companies, the mono-incineration of sewage sludge occurs at the Eger Water Treatment Plant with the 2-2.4 MW BIOMORV incinerator (1t/h), that had a 19 t trial run in 2013 and received its waste management permit at the beginning of 2014. In 2012, 1,337 t of sewage sludge was incinerated in Sajóbábony’s hazardous waste incinerator. The remaining incineration plants do not accept municipal sewage sludge.”

II.2 Description of the incinerator and utilization of Eger (3.)

The burner-disarming system built in technology with energetic exploitation is working excellent proved by accredited measurements on our site HU-3300 Eger, Kölyuk út 9841 hrsz. with its unique positive energy balance in Europe and its emission value under the specification of the law. The heat capacity of the mobile boiler burning dry, wet or fermented sewage sludge on the spot integrated in technology is 1.6-2 MW which is sufficient for about 40-150,000 people. The development is promoted by the market leader BIOFIVE® biomass boiler patents, the VK-300 dangerous burner in hospitals made by German, Austrian optional equipments and technologies. The equipment is suitable for thermic exploitation of non eligible communal waste mince (so called RDF final product) which improves profitability significantly. Beside Europe introduction our aim is export of technology as well. The standardized production is planned in Far East.

According stipulated specification we dose wet, dry or fermented sewage sludge and chopped wood to the container burner space with conveyor strip in every 5-10 minutes through a double hopper – out of touch with human hands. In the special stair grate primer firebox the sludge burns with 800-850 C°, its optimal temperature is ensured by a 400 kW-os pellet burner and 200 C° preheated primer burning air. The stack gas stays in the post burner during 2.5-3.1 seconds. The 850-950 C° temperature is controlled by 3 pellet burners which helps heating up as well. The frequency exchanging blower of about 3,500 m3/h volume stream and 12 kPa draft sucked the stack gas through the system and got to the atmosphere. The heat energy is recovered from stack gas with heat exchangers (2 stack gas-thermo-oil, 2 stack gas-water, stack gas-air) which is used for drying sewage sludge, optional electric current development, and pre-heating burning air blowing in primer firebox. We use calorofics (4 pieces of 250 kW) for plant heating and in case of damage. The purity of environment is ensured by the unique stack gas cleaning system built in after the scale separating cyclonet with a significantly smaller emission than it is prescribed by the law. The phosphate is extracted from the stack gas, cinder.

MONO INCINERATION OF SEWAGE SLUDGE
This relates specifically to the treatment of sewage sludge. Those kinds of sewage treatment plants where there is no digestion or composting, where the resulting sludge is dried, dumped, or given to others for further processing (with additional fees) are relevant. There would be a minimum 16 to 17,000 t of 20% dry matter. The sludge containing 20% dry matter minimum annual amount from 16 to 17,000 t. This equates to a treatment plant large enough to deal with 160-170,000 L.E. (Model in Fig. 3)

THE CO-INCINERATION OF SEWAGE SLUDGE AND RDF WASTE
This is a complete waste management (recovery) process. The equipment is comfortably capable of providing the complete treatment and disposal of organic waste for settlements with a population of 30-40,000 inhabitants. No digestion or drying would take place in this case.

The resulting generated energy is practically pure profit; this, in addition to the savings in fees, reduces costs and increases profit.

If the generated electricity cannot be sold, it can be utilized for the production of marketable goods like wood pellets. This variation is efficient because it produces high profit margin goods when the price of waste-generated electricity is low. The situation in Hungary is remarkably unique. Energy generated from waste disposal has a market price of € 0.1 per 1 kWh; through the utilization of wood pellets to generate energy, a potential profit of € 0.16 per 1 kWh of generated energy sold exists. (CHP unit efficiency is 85% while 20% of the energy produced is for self-consumption. Thus, the usable energy is 68%). This could solve all the problems associated with the disposal of organic waste for a city of 80-100,000 people. (model: Figure 5)

CO-INCINERATION OF FERMENTATION RESIDUES AND RDF
This version is the most energy efficient. Nearly half of the energy contained within sewage sludge is recovered during the first step, which is the digestion process. More than 65% of the energy recovered here can be used or sold. (CHP unit efficiency is 85% while 20% of the energy produced is for self-consumption. Thus, the usable energy is 68%). This could solve all the problems associated with the disposal of organic waste for a city of 80-100,000 people. (model: Figure 3)

In the interest of thoroughness, mention should be made of solar drying option because the method is being utilized in a few places. There is no denying that this method creates significant savings in fossil fuel or other energy consumption. It can also increase the amount of usable energy. However, it should be noted that solar drying is a special composting process, (oxidation process). As such, it creates significant emissions, as well as reduction in mass and a reduction in energy content.

III.Summary
The development's benefit - supported by the European Commission SME and the Baden-Württemberg Ministry of Environment - is that the pollutant emissions are below the limit, as well as there is no need to transport hazardous waste and the appliance can be installed next to the waste place (storage). This sludge incineration from heat energy produces approximately as much electricity as a wastewater treatment plant needs. The system can be set precisely on the basis of the composition of the waste to be processed; it requires no extra installation conditions and can be easily relocate to other places.

The BIOFIVE - in collaboration with scientific researchers and practitioners - is working in a number of innovative developments, trying to solve operational environmental problems for an industrial park, a town, or even more for a residential community.

Such development is the BIOFIVE-AQUA SOLUTIONS water treatment technology. The technology is based on the method of filtration by electro dialysis, which offers a number of
technological advantages: the basic unit has simple design, as well as the fully automated control unit applying a telemetric system; during desalination it is unnecessary to modify the salt content; and the desalinated water received as end product meets all the requirements and standards specified by WHO both in terms of physical and chemical properties.

Our other significant product is the plasma technology for disposing hazardous waste, disposing such chemicals totally, without releasing harmful substances to the environment.

The setting of the plasma torch, which can only operate in a space of more than 2500 Co

Design of the plasma torch always based on the particular composition of the targeted hazardous waste.

Our unit has 400 kW power plasma torch and auxiliary equipment. Our plasma torch can operate continuously with capacity up to 3,000 tons / year, maximum 1 ton / hour.

Finally, we would like to thank that we could present on the conference dedicated to the famous Romanian hidroenergetic, Dorin Pavel on 5 th June. Prior this request, a presentation was held in Timisoara, for the Romanian Northern Rwgion. Shortly afterwards, in Timisoara Aquatim we could held a performance for a company, determined to cooperate. We hope that this new direction is away of a friendly cooperation.

To be continued in Budapest and Eger: in September we are planning Budapest’s exclusive environmental conference , in the memory of Kvassay Jenő, who was a leader in the 19th century, turning the water service available. The conference’s current themes will be the following ones: our habitats, so the earth, water, the insurance of keeping the purity of air with different cultures engineering technologies, including the place of origin of the waste thermal disposal (incineration in confined spaces), simultaneous energy, chemical and biological recovery. We want our Romanian engineer friends raise standards with their presence and contribution (lecture and participation). (In each case, the presentations will flow in the native language, interpretation will be provided.) We would like to devote serious attention to international co-operation in Timisoara, Cluj and Bucharest scientific contribution, workshop work. We want to implement our primary goal in the Danube Region. (We plan the event for 2 days flat, on the second day we hold a practical presentation in Eger city.)

The catchment area of the Danube is an enormous challenge for Europe, but especially for us: Romanians and Hungarians. Because within the Danube Region Strategy the environment is Romanian-Hungarian, the competitiveness is German competitiveness and the energy is a Slovak, Czech, Hungarian competence.

Budapest, 21 July 2015
IV. Magyarázatok /Szakkifejezések

The mechanical-biological waste treatment (MBH) arising after the unsorted municipal waste and other processes (eg.: selective waste collection) called. for the treatment of residual waste, which combines the classification, enrichment processes of biological processes such as composting, anaerobic biological fermentation and drying. The aim of the procedure, the environmental hazard of the waste, volume, weight reduction and stabilization. It is used for stabilization before landfilling or the production of a second fuel in Europe.

Secondary fuel (RDF - Refuse Derived Fuel): This is a special team in the process, high calorific fraction that is burned or burned together, and cement factories recovered burned in power plants.

Tertiary even suitable for burning waste (RDF stable): which had "not accepted" the power plants and the cement industry, a relatively high calorific value (12-18 MJ / kg sz.a.) And high solids (65-85%) and can be fired

CHP combined heat and power generation (Combined Heat and Power Technology)

ORC (szerves Rankine-ciklus - Organic Rankine Cycle) a hagyományos szemben, melyénél a munkaközeg vízgő, nagy moláris tömegű szerves folyadékot használ. Olyan tulajdonságokkal rendelkező közeget használ, mely lehetővé teszi a kishőmérsékletű hőforrások, mint a hulladékkő, geotermikus energia, napenergia hasznosítását áramtermelésre

Global warming (GWP): the sum of greenhouse gas emissions over the lifecycle

Acidification (AP): The given amount of sulfur dioxide and nitrogen oxides emissions over the lifecycle

Eutrophication (EP): The given changed lifecycle under load of phosphorus and nitrogen, which finally appears in water resources

Decrease in resources (ADP): the amount of energy used during the lifecycle

Photochemical ozone formation (POCP): the amount of volatile organic compounds released during the lifecycle

Ozone depletion (ODP): the release of halogenated hydrocarbons during the lifecycle

Toxicity: Emissions of substances that have a toxic impact on the ecosystem, especially on human life, (toxic heavy metals, toxins and other harmful residues).

V, References, literature

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