University of Banja Luka
Faculty of Mechanical Engineering
26th - 28th May 2011

DEMI 2011

10th Anniversary International Conference on Accomplishments in Electrical and Mechanical Engineering and Information Technology

PROCEEDINGS

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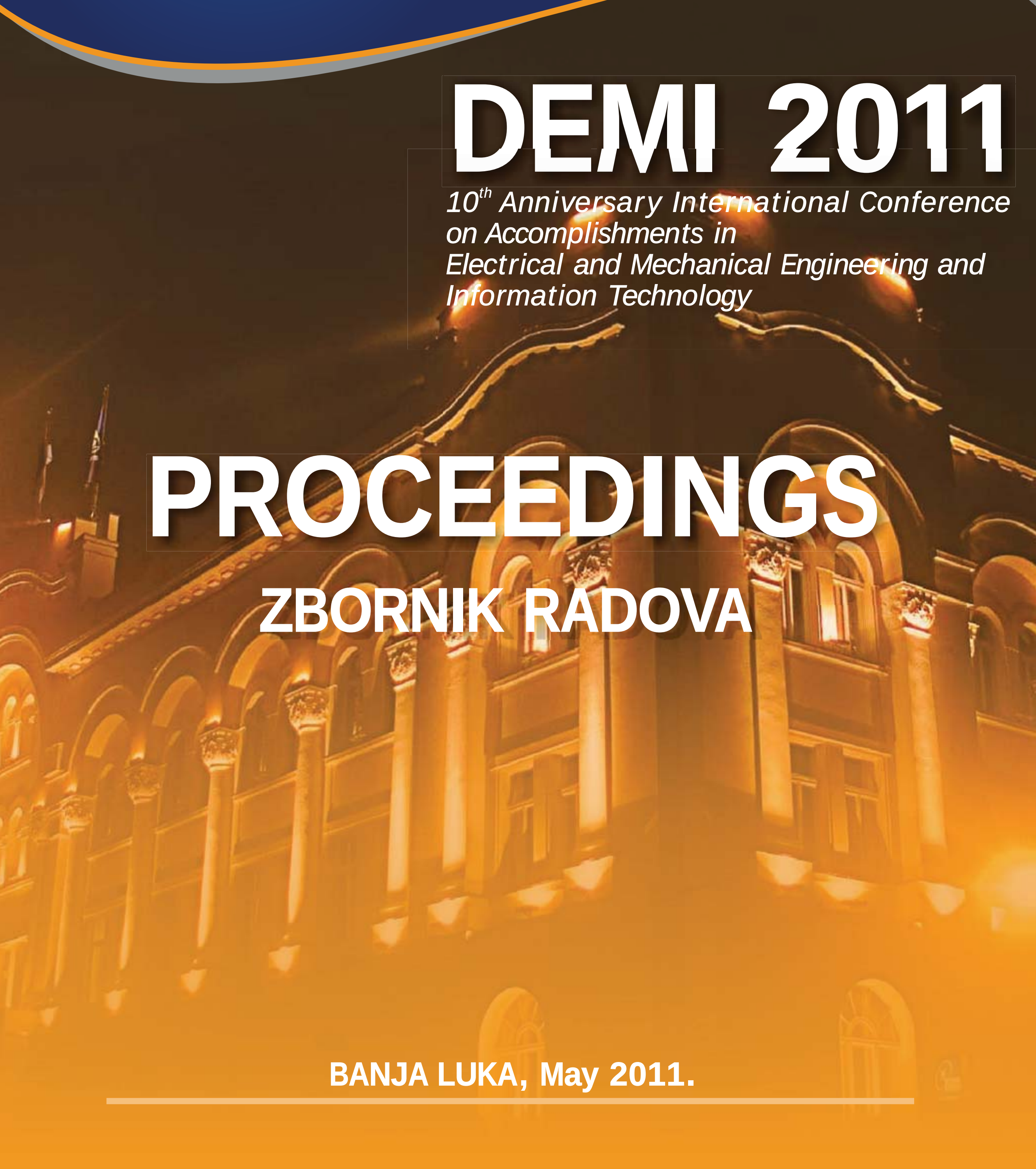

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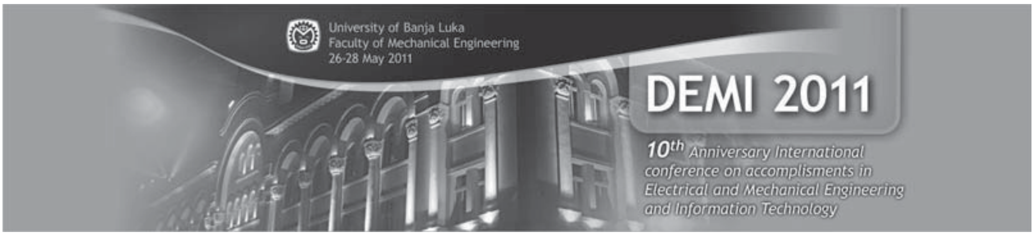

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Under patronage of:
Ministry of Science and Technology of the Republic of Srpska,
Ministry of Industry, Energy and Mining of the Republic of Srpska
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Publisher:
Faculty of Mechanical Engineering Banja Luka

For publisher:
PhD. Miroslav Rogić, Full Professor

Editor in Chief:
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Technical processing:
Milivoj Stipanović

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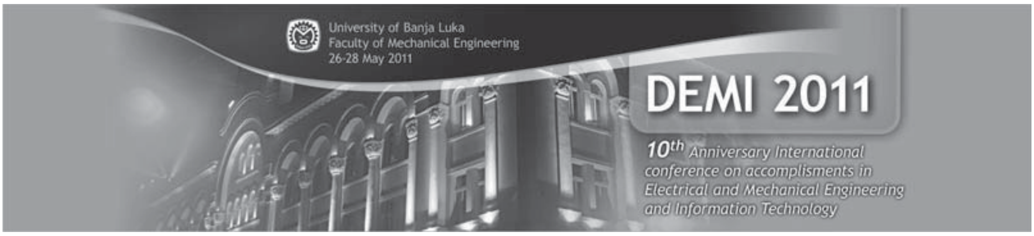

DECENTRALIZED WASTEWATER TREATMENT SYSTEMS IN LARGE SETTLEMENTS

Danijela Nikolic [1], Vanja Sustersic[2], Jasmina Skerlic [3]

Summary: *Up to the considering of wastewater treatment, compared to the size of settlements, we can select a process type of wastewater treatment. Group of large settlements include settlements with over 20 000 inhabitants. Many of them are not covered by the centralized systems of water treatment, so the wastewater treatment of these settlements uses a special type of waste water processing. This paper provides an overview of this process through the pre-treatment, primary, secondary and tertiary treatment, with special attention to each of these procedures. Today, these ways of wastewater treatment are dominant in world practice.*
Key words*: wastewater treatment, decentralized systems, large settlements*

1. INTRODUCTION

The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. According to the definition of the *Best Available Technique* (BAT), term best available wastewater treatment of settlement includes some processes of waste water treatment with the regard to quality of raw sewage, requirements quality of treated waste water and convenience of using wastewater treatment processes in practice. Conventional wastewater treatment consists of a combination of physical, chemical, and biological processes and operations to remove solids, organic matter and, sometimes, nutrients from wastewater.

This paper represents decentralized wastewater treatment system (DEWATS) in large settlements. Large settlements include settlements with over 20 000 inhabitants. Waste water treatment of these settlements is quite natural choice type of purification process of municipal wastewater. Today, it is dominant in the global practice. This is the type of process which consists of:

- Preliminary (pre-) treatment - removes materials that can be easily collected from the raw waste water before they damage or clog the pumps and skimmers of primary treatment clarifiers.

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- Primary treatment - temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface.
- Secondary treatment - removes dissolved and suspended biological matter. It is typically performed by indigenous, water-borne micro-organisms in a managed habitat.
- Tertiary treatment - treated water is sometimes disinfected chemically or physically (by lagoons and micro filtration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is clean, it can also be used for groundwater recharge or agricultural purposes.

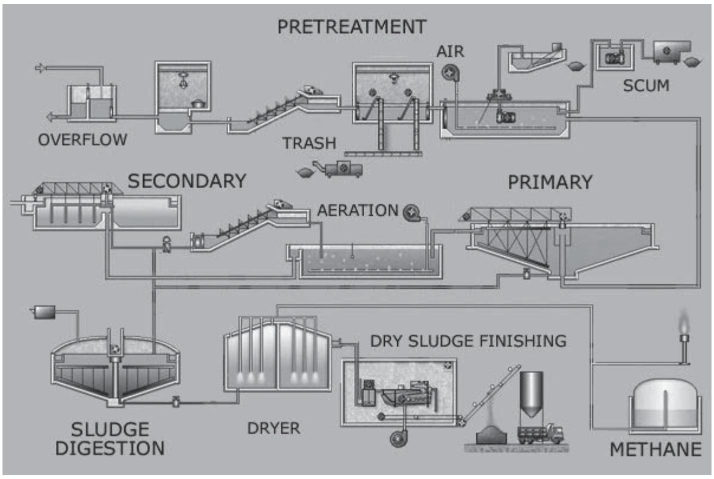

Fig. 1 *Process Flow Diagram for a typical treatment plant*

The treatment applications are based on the principle of minimal maintenance, the critical parts of the treatment system work continuously and uninterrupted with low energy inputs. The technology provides treatment for domestic and industrial (non-toxic) sources. It can treat effluent flows from 1 up to 1000 m³ per day.

2. PRELIMINARY (PRE-) TREATMENT

The objective of preliminary treatment is the removal of coarse solids and other large materials often found in raw wastewater. Removal of these materials is necessary to enhance the operation and maintenance of subsequent treatment units. Preliminary treatment operations typically include coarse screening, grit removal and, in some cases, comminution of large objects. In grit chambers, the velocity of the water through the chamber is maintained sufficiently high, or air is used, so as to prevent the settling of most organic solids. Grit removal is not included as a preliminary treatment step in most small wastewater treatment plants. Comminutors are sometimes adopted to supplement coarse screening and serve to reduce the size of large particles so that they will be removed in the form of a sludge in subsequent treatment processes. Chlorination may be used in preliminary treatment.

A device called a settler is used for this phase. If needed, a screening device, for preventing unwanted large materials to enter the system can also be installed. The settler is an underground constructed tank with one partition wall. Within the settler two main treatment processes take place, first a sedimentation and second a stabilization and digestion of the settled sludge through biological treatment. Storage volume is provided for 18 up to 36 months, this parameter defines the necessary desludging period.

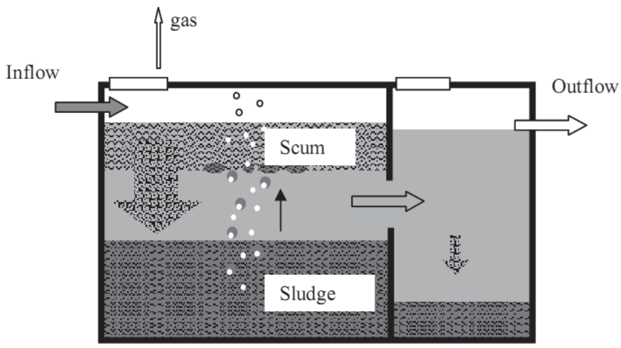

Fig 2 *Typical Section of a Settler*

3. PRIMARY TREATMENT

In the primary sedimentation stage, sewage flows through large tanks, commonly called "primary clarifiers" or "primary sedimentation tanks." Sedimentation is often used as a primary stage in modern waste water treatment plant, reducing the content of suspended solids as well as the pollutant embedded in the suspended solids. Due to the large amount of reagent necessary to treat domestic wastewater, preliminary chemical coagulation and flocculation are generally not used.

In the late 1800s, began the use of septic tanks for primary treatment of wastewater, and discharge of septic tank effluent into gravel-lined subsurface drains became a common practice during the middle of the 20th century.

Today, the tanks are used to settle sludge while grease and oils rise to the surface and are skimmed off. Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank where it is pumped to sludge treatment facilities. Grease and oil from the floating material can sometimes be recovered for saponification. The dimensions of the tank should be designed to effect removal of a high percentage of the floatables and sludge. A typical sedimentation tank may remove from 60 to 65 percent of suspended solids, and from 30 to 35 percent of biochemical oxygen demand (BOD) from the sewage.

The simple septic tank system is the most commonly known primary treatment method for onsite wastewater treatment because of its considerable advantages. Septic tanks remove most settle able solids and function as an anaerobic bioreactor that promotes partial digestion of organic matter. A device called an anaerobic baffled tank is used often for this phase. Several tanks are constructed in series to digest degradable substances. Baffle walls or down-flow PVC pipes direct the waste water stream between the chambers from top to bottom and up again. During this process the fresh influent is mixed and inoculated for digestion with the active blanket deposit of suspended particles (floating bacteria media) and microorganisms occurring naturally at the bottom of each chamber. Because of the physical separation (multiple chambers), various microorganisms are present at different stages, allowing a high treatment efficiency.

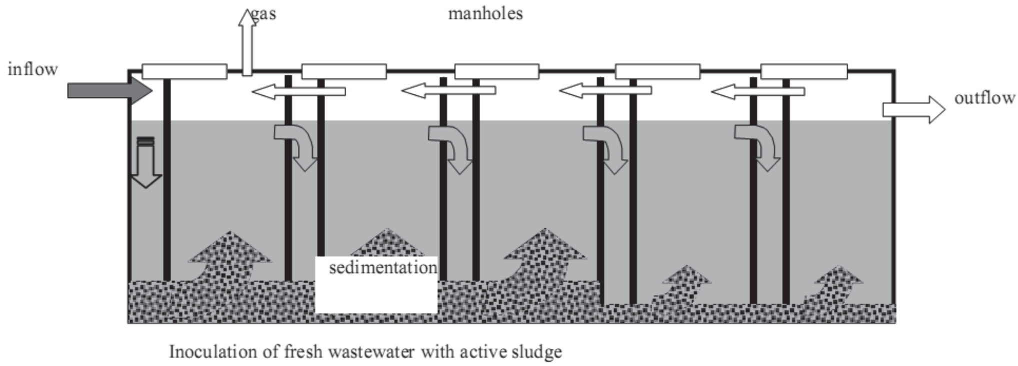

Fig 3 *Typical section of an Anaerobic Baffled Tank*

In many industrialized countries, primary treatment is the minimum level of preapplication treatment required for wastewater irrigation. It may be considered sufficient treatment if the wastewater is used to irrigate crops that are not consumed by humans or to irrigate orchards, vineyards, and some processed food crops.

4. SECONDARY TREATMENT

The objective of secondary treatment is the further treatment of the effluent from primary treatment to remove the residual organics and suspended solids. In most cases, secondary treatment follows primary treatment and involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes. Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_3, and H_2O).

There are many secondary treatment methods for DEWATS. Considering that sand is the most common and available media for filters, sometimes media filter is equivalent to sand filter. Generally, in areas with deep, permeable soils, septic tank–soil absorption systems can be used. On the other hand, in areas with shallow, very slowly permeable or highly permeable soils more complicated onsite systems will be required.

At the end of the last chamber of the baffled tank reactor one or more chambers can be fitted out as an anaerobic filter in order to improve further the treatment efficiency. A filter media allowing widespread contact with the effluent stream is used which is very efficient in retaining and digesting the left over pollutants. The problem of encountering clogging is minimized due to the digestion and treatment that occurred already in the baffled tank treatment. The process works with fixed bacteria media. The pre-treatment (settler), first treatment (baffled tank) and second treatment (anaerobic filter) are constructed below ground level. The different phases can be built together, or as a separate set-up. The effluent passing out of the anaerobic filters will have a 90% of the original pollution load removal.

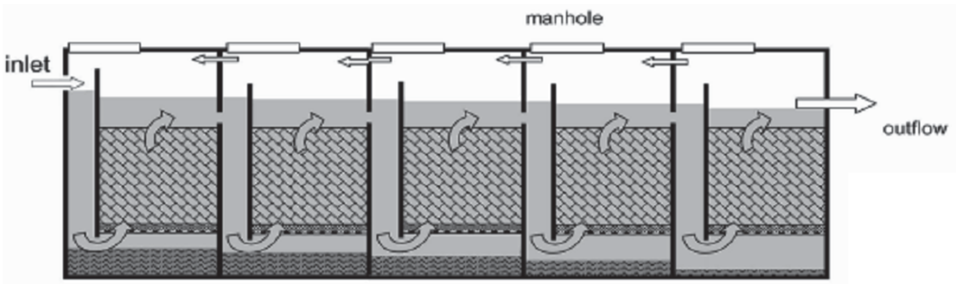

Fig 4 *Typical section of an Anaerobic Filter*

Since the system works in a closed environment without oxygen supply (anaerobic conditions) the effluent will continue to smell despite the fact that a major part of the effluent treatment has occurred already. For this reason an additional treatment is included in the design lay out, being the third treatment in the form of a planted gravel filter.

5. TERTIARY OD ADVANCED TREATMENT

The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called "effluent polishing." Tertiary or advanced wastewater treatment is employed when specific wastewater constituents which cannot be removed by secondary treatment must be removed. Individual treatment processes are necessary to remove nitrogen, phosphorus, additional suspended solids, refractory organics, heavy metals and dissolved solids. The removal of nitrogen is effected through the biological oxidation of nitrogen from ammonia to nitrate (nitrification), followed by denitrification, the reduction of nitrate to nitrogen gas. Nitrogen gas is released to the atmosphere and thus removed from the water. Phosphorus removal is important as it is a limiting nutrient for algae growth in many fresh water systems. Phosphorus can be removed biologically in a process called enhanced biological phosphorus removal. Phosphorus removal can also be achieved by chemical precipitation, usually with salts of iron (e.g. ferric chloride), aluminum (e.g. alum), or lime. Chemical phosphorus removal requires significantly smaller equipment footprint than biological removal, is easier to operate and is often more reliable than biological phosphorus removal. Another method for phosphorus removal is to use granular laterite. Once removed, phosphorus, in the form of a phosphate-rich sludge, may be stored in a land fill or resold for use in fertilizer. Improvement and upgrading of wastewater treatment units as well as the need to minimize environmental effects has led to the increased use of tertiary treatment.

6. ADVANTAGES OF DEWATS

There are many advantages of DEWATS, such as: minimum or no requirement of energy, low-cost and minimum operation and maintenance, treatment of wastewater flows from 1-1000 m³ per day, modular design of all components, tolerant towards inflow fluctuations, reliable and long-lasting construction design, easy integration to landscaper, involving local communities in the management, etc.

7. CONCLUSION

The concept of decentralised wastewater management aims at the development of wastewater systems that are more financially affordable, more socially responsible, and more environmentally benign than conventional centralised systems. This approach allows wastewater management to be broken down to the neighbourhood level and to serve disaggregates of the larger urban areas, resulting in small-scale and low-cost facilities directly related to reuse of valuable components in the wastewater.

The decentralised concept promises a number of advantages over conventional practices in the development of new wastewater systems. The flows at any point would remain small, implying less environmental damage from any mishap. System construction would also result in less environmental disturbances as the smaller collection pipes would be installed at shallow depths and could be more flexibly routed. The system expansion would be afforded by adding new treatment centres rather than routing ever more flows to existing centres. Financial advantages would result from the elimination of a great deal of the collection system infrastructure, the use of small diameter sewers, and the choice of technologies that incur minimal maintenance costs.

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