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IRRIGATION USABILITY OF WASTEWATER TREATED BY AN ON-SITE SMALL WASTEWATER TREATMENT UNIT

Introduction

Hungary began intensive development of wastewater treatment to meet EU requirement in the mid 2000's. Approximately 75 % of the population is connected to centralized public sewage system. A National Sewerage and Wastewater Treatment Program was established with a detailed implementation timetable until 2015. The plan was to solve wastewater management with tertiary treatment in settlements greater than 10,000 PE located in sensitive areas. However, the majority (76 %) of settlements are below 2000 PE, more than 800 of these were excluded from the National Sewerage and Wastewater Treatment Program. 13 and 55 % of Hungarian settlements have no more than 100 and 500 habitants, respectively. Small settlements are often remote and affected by outward migration and an aging population. Furthermore, they are heavily burdened by high investment costs in pipeline construction for common wastewater disposal of technical equipment, thus, many of these settlements are without wastewater treatment [1]. Untreated or not properly treated wastewaters from these settlements endanger ground waters. Depending on their location, they may also endanger sensitive surface waters, e.g. Lake Balaton. On-site wastewater treatment systems (OWTS) treat and dispose wastewater at the site of production, if function properly, they are a viable alternative in locations where pipeline construction is not possible or financially not feasible. OWTS include septic tanks, aerobic treatment units, and composting toilets [2]. Although there is a growing number of installed OWTS in Hungary, there is still some resistance and uncertainty regarding the use and treatment efficiencies. The aim of our current project is to evaluate the treatment efficiency and irrigation usability of small, on-site activated sludge systems, as well as to determine the effect the owner plays on treatment efficiency. Here we present the preliminary data obtained by the analysis of treated wastewater of a small activated sludge unit.

Materials and methods

The small treatment unit analysed is an activated sludge system with aerobic and anaerobic chambers to allow biological treatment. Part of the sludge produced is recirculated, the access sludge is stored in a sludge bag and has to be emptied once in 2–3 months and composted. The biological treatment is ensured by a compressor, with a minimal energy input of around 50 W. After biological treatment the wastewater enters the post-settler and the effluent is either stored in a storage tank or enters an infiltration shaft.

An independent organization [3] evaluated the unit and confirmed that the effluent (treated water exiting the post settler) meets regulatory requirements. The limits for the evaluated parameters are shown in the *Limit* column of Table.

Water samples were collected from the post-settler and a longer-term storage tank (2 m^3) according to Hungarian standards (MSZ ISO 5667-10:19).

To determine treatment efficiency, basic chemical parameters were measured and compared to the values listed in the certificate of the equipment: chemical oxygen demand (COD), biological oxygen demand (BOD_5), ammonium, total suspended solids, total nitrogen, and total phosphorus.

To evaluate the irrigation usability of treated wastewater, acute toxicity tests were performed using *Daphnia magna* (MSZ EN ISO 6341:1998), white mustard (*Sinapsis alba*, MSZ 22902-4/1990), and green algae (*Chlorella vulgaris*, MSZ EN ISO 8692:2005).

The owner's attitude was assessed by a questionnaire we developed. The questionnaire has not been standardized yet, but has been pre-assessed.

Results and discussion

In the unit analysed, the effluent is stored in a 2 m^3 storage tank before entering the infiltration shaft. Analytical measurements were performed on samples from the post-settler and the storage tank (Table). The 30-minute settling was 710 in the aerobic chamber.

Table – Analytical measurements of treated wastewater

Parameter	Post-settler	Storage tank	Limits
pH	7.58	8.55	–
DO, mg/l	3.21	2.88	–
DO, %	39.1	31.5	–
K, µS/cm	703	501	–
RDO, mV	166.8	–178.3	–
T, ^oC	23.6	17.1	–
Chemical oxygen demand COD_{Cr}, mg/l	42	<30	55
Biochemical oxygen demand BOD_5, mg/l	4	3	15
Total nitrogen (calculated), mgN/l	16.0	10.7	20
Ammonium, mg/l	3.2	0.46	10
Phosphorus, mg/l	84	0.99	5
Total suspended solids, mg/l	6	<2	18

According to the data, the effluent chemical parameters meet regulatory criteria except for phosphorus. Although phosphorus level in the post-settler is higher than the limit value, after storage (few weeks or months) it decreases below the limit, suggesting that biological phosphorus removal is further continues after the effluent leaves the unit. Similarly, other parameters, e.g. COD, BOD, nitrogen, etc. also continue to decrease during storage. Phosphorus removal during wastewater treatment is a key process to prevent eutrophication of surface waters. In municipal WWT plants this is mainly done by physico-chemical phosphorus removal. In individual wastewater treatment units chemical P removal is not a feasible option. Biological P removal is an environmentally favourable alternative and has been the focus of many studies (reviewed in [4]). In the system analysed, no enhanced P removal was applied, simply the storage allowed the biological P removal to be continued and was sufficient to achieve values below limit. Although phosphorus accumulating organisms may release accumulated phosphorus in the surface water, the present of phosphorus provides nutrient for plant if the water is used for irrigation.

To evaluate whether the treated water can be used for irrigation, we performed ecotoxicological tests and measured acute toxicity. Based on the algal-test (72hs), neither the effluent nor the stored water requires dilution. Although the undiluted and 2× diluted effluent caused slight, 7.6 and 1.3 % decrease of algal growth, respectively, according to the standard it does not need to be diluted before use. The undiluted water from the storage tank did not cause any growth inhibition. The Daphnia-test performed on the effluent showed slight toxicity (20–30 % immobility) in the undiluted sample and in the sample diluted twice, but further (5×, 10×) dilutions did not cause any immobility. Similar results were obtained for the water in the storage tank as well (data not shown). The evaluation of germination potential revealed that both untreated water samples stimulated the germination of white mustard seeds (Figure). Although diluted samples were less stimulating, they still showed some positive effect. Based on the ecotoxicology tests, treated water can be used for irrigation.

Next, we aimed to assess the owner’s attitude and asked them to fill out a questionnaire. In the questionnaire questions related to their water use, operational and maintenance practices, as well as their overall experience were listed. According to the answers, the unit has been operated for 4 years treating the domestic wastewater of a family of 4. They found the installation of the device easy; they got written material about operation and maintenance, although they feel it might be useful to provide proper education for users before they start the operation. They find the operation quite easy, check on the unit at least once a week, and cleanse it monthly.

The access sludge is put onto the compost and after composting they use it as a fertilizer for plants in the garden. The effluent is used for irrigation or for infiltration.

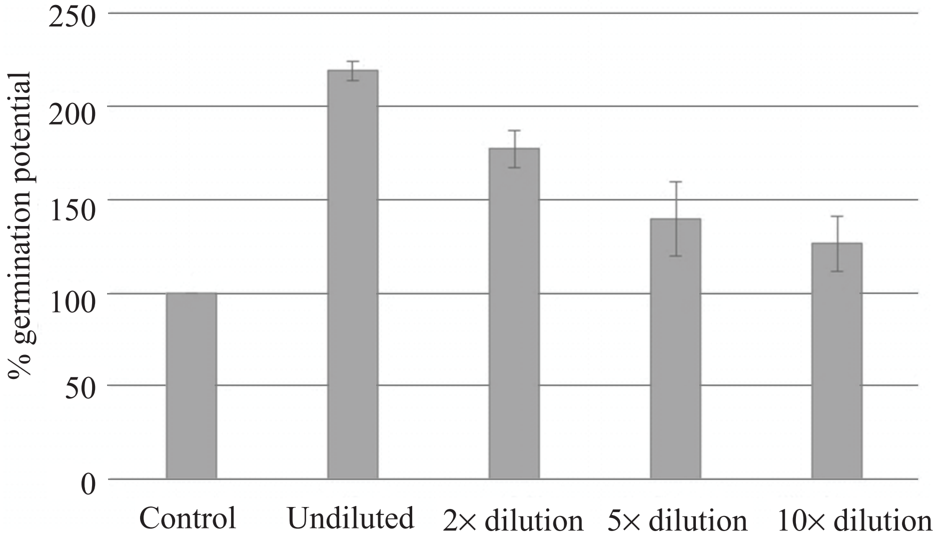

Figure – Germination potential of treated wastewater on white mustard (*Sinapsis alba*) seeds

Other small units of the same manufacturer were also evaluated (data shown) and revealed that not all owners are so informed, which is reflected in the treatment efficiency of the unit, too. Although the analysis of a single unit does not allow far reaching conclusions, it provides us a glimpse of factors that can pose difficulties when applying decentralized wastewater treatment solutions. For example, phosphorus removal is not as efficient in on-site units without chemical P removal, thus, direct discharge into recipient might result in eutrophication. The owner's attitude is a key factor in on-site units; the owner's awareness influences the chemicals used in the household, which subsequently influences the treatment efficiency of the unit, as a toxic chemical can deplete the whole biomass blocking biological treatment. Also the regularity and goodness of maintenance and operation are crucial factors. Indeed, it has been shown that many OWTS do not perform well, and maintenance problems are one of the main causes of inadequate functioning [5].

Conclusions

Here we described an OWTS that is maintained and operated properly, the chemical parameters of the treated wastewater meets most of the regulatory requirements. Storage of the treated water enhances the water quality and makes the treated water suitable for irrigation. Based on the presented preliminary data, decentralized, small wastewater treatment equipment can be viable alternatives to centralized wastewater treatment. However, a well-designed equipment is not enough, proper training, informed owners and regular maintenance are needed for adequate functioning.

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