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Small wastewater treatment plants in Austria – Technologies, management and training of operators

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ABSTRACT

In Austria, about 95% of the population are served by 1865 wastewater treatment plants (WWTPs) with design size > 50 population equivalent (PE). Besides, there are about 27′500 small WWTPs with design size less than 50 PE. Among these small WWTPs, the technologies implemented most frequently are about 7020 conventional activated sludge plants, 5560 treatment wetlands and 5240 Sequencing Batch Reactors. About 45% of the small WWTPs have a design size between 5 and 10 PE. It has been shown that design standards for small WWTPs increased the numbers implemented for both technical and nature-based technologies. A permit given from the local authorities is required for operating a small WWTP. If the design of a small WWTPs follows a design standard, the process to get a permit is simplified. Most authorities request that owners of small WWTPs have a maintenance contract with a company and/or that owners/operators have to pass the training course for operators of small WWTPs offered by the Austrian Wastewater and Waste Association (ÖWAV). Within the 1.5 days long training courses, owners/operators gain basic knowledge on wastewater treatment and thus better understand their plant. This should finally result in well operated and maintained small WWTPs. Since the year 2000, more than 200 training course have been held and more than 5500 owners/operators of small WWTPs have been trained.

1. Introduction

In Austria, 1865 wastewater treatment plants (WWTPs) with design size > 50 population equivalent (PE) treat the wastewater of about 95% of the population (BMLFUW, 2016). The remaining 5% of the population live in single houses and small settlements that require on site and decentralized wastewater treatment technologies. There is no common database on small WWTPs with design size ≤50 PE thus data had to be collected from the Austrian federal states and compiled in a database. According to Langergraber and Weissenbacher (2017), the total number of WWTPs with design size ≤500 PE is about 28′700 comprising about 1300 WWTPs with design size 51–500 PE and 27′400 with design size < 50 PE, respectively.

The effluent quality of WWTPs is only regulated for WWTPs > 50 PE (AEVkA, 1996). For WWTPs with design size ≤50 PE, the local authorities usually apply the same requirements for effluent concentrations as for > 50 PE. Since 1991, biological treatment with nitrification is required for all WWTPs. For organic matter the maximum effluent concentrations are 25 mg BOD_5/L and 90 mg COD/L. The maximum effluent concentration is 10 mg NH_4-N/L (however, only for effluent water temperatures > 12 °C). There is no standard for nitrogen and phosphorus removal for small WWTPs. However, for sensitive receiving water bodies authorities can request removal of nitrogen and phosphorus. For single objects in extreme locations (objects that are occupied less than 200 days per year, that can not be reached with vehicles and that are not connected to the power grid), less stringent requirements have to be met (AEVkA, 2006). For these objects (e.g. alpine refuges) only removal of solids and organic matter (70% and 80% removal of COD and BOD_5, respectively) is required.

The paper presents the status of small WWTPs with design size ≤50 PE in Austria including their management and the provisions taken to train the operators of these small WWTPs. To our knowledge, this is the first study on small WWTPs in such detail. For neighbouring countries of Austria even data for WWTPs with design size ≤2000 PE are scarce and a lot of small settlements are nor served at all (Istenic et al., 2015).

2. Material and methods

As described by Langergraber and Weissenbacher (2017), there is no general database for WWTPs ≤ 50 PE in Austria. Thus, data were collected from the water information systems of the seven federal states (Carinthia, Lower Austria, Salzburg, Styria, Tyrol, Upper Austria, and

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Vorarlberg) and for the remaining two federal states with a low number of small WWTPs (Burgenland and Vienna) data have been received from the responsible persons at the federal governments.

Data collected for each WWTP included design size, treatment technology, date of comissioning, etc. As data are recorded slightly different in all federal states especially the categorisation applied to the technologies had to be unified. Treatment technologies have been grouped according to those defined in the design standards for technical plants (Ö-NORM B 2502-1, 2012) and treatment wetlands (Ö-NORM B 2505, 2009), respectively, as follows:

- Primary treatment only
- Conventional Activated Sludge (CAS)
- Sequencing Batch Reacktor (SBR)
- Membrane Bioreactor (MBR)
- Trickling Filter
- Fixed bed (several types)
- Rotating Biological Contactor (RBC)
- Soil Filter
- Vertical flow (VF) wetland

Additionally, relevant technologies for single object in extreme locations (e.g. composting toilets, filter systems to retain solids) have been considered.

For Lower Austria, additional data had to be collected during site visits at the district offices as for 40.1% of the WWTPs with design size ≤500 PE (i.e. for about 2000 of 5000 plants) information on the treatment technology was not available in the Lower Austrian water information system (Langergraber and Weissenbacher, 2017). 10 out of 25 disctrict in Lower Austria were visited, in these districts 90.8% of the WWTPs with design size ≤50 PE with unknown treatment technology were located.

3. Results and discussion

3.1. Technologies used for small WWTPs

Table 1 shows the treatment technologies applied for WWTPs with design size ≤50 PE. For about 800 plants (2.9%) the technology is not recorded in the databases. The highest number of unknown technologies is in Lower Austria (about 190 plants, i.e. about 4% of the 4500 plants) and Styria (about 340 plants, i.e. 3% of the 10′650 plants). The main technologies for secondary treatment are CAS (ca. 7020 plants or 25.6%), treatment wetlands (TWs, ca. 5560 plants or 20.2%; as nitrification is required, only VF wetlands are implemented in Austria) and SBR plants (ca. 5240 plants or 19.1%). Still more than 22% of the plants are classified as only primary treatment. These are mainly old septic tanks from which mechanically treated wastewater is discharged. This technology is no longer state-of-the-art. However, most of these WWTPs have been implemented before 1991 and still have a valid operation permit.

In comparison to the 1230 WWTPs with design size from 51 to 1999 PE that have a cumulative design size of 465′000 PE (BMLFUW, 2016), the 27′450 small WWTPs (≤50 PE) only have a cumulative design size of 260′500 PE (Table 2). Wastewater of about 72′900 people is treated with small CAS plants, wastewater of about 57′600 and 50′600 people with SBRs and VF wetlands, respectively.

Fig. 1 shows the design size of different treatment technologies of small WWTPs. According to Langergraber and Weissenbacher (2017), all 2570 of the WWTPs < 500 PE with unknown design size have been assumed to be ≤50 PE. About 45% of the small WWTPs are of design size between 5 and 10 PE, 23% < 5 PE. Most unknown design sizes are for plants, which only have primary treatment, indicating that the design size was not recorded accurately for older systems. For the main technologies used, i.e. conventional activated sludge, treatment wetlands and SBRs, the design size distribution is quite similar.

Fig. 2 shows the year of comissioning of different treatment technologies applied for small WWTPs. Before the requirement for nitrification has been introduced, mainly septic tanks from which mechanically treated wastewater is discharged have been implemented, i.e. most plants with only primary treatment have been implemented before 1992. In the first years after introducing the requirement of nitrification in 1991 mainly CAS plants have been implemented. The share of activated sludge-type technologies is the highest whereby SBR plants became more popular over time and nowadays have a share of about 35% of new plants. Since about 2000, also treatment wetlands have become a popular technology for small WWTPs. TWs have a share of about 30% of new small WWTPs since the early 2000s. The establishment of design standards for small WWTPs, i.e. Ö-NORM B 2502-1 (2012; first version released in 2001) for technical plants and Ö-NORM B 2505 (2009; first version released in 1997) for VF wetlands, accelerated implementation of small WWTPs.

Fig. 3 shows the geographical distribution of small WWTPs in the Austrian political districts. The districts with the highest number of TWs are Wolfsberg (Carinthia, 1852 plants), Graz-Umgebung (Styria, 1287 plants), Weiz (Styria, 1273 plants), Deutschlandsberg (Styria, 1219 plants), St. Veit/Glan (Carinthia, 1164 plants) and Amstetten (Lower Austria, 1130 plants). The highest density can be found in Wolfsberg (Carinthia) with 35 small WWTPs per 1000 inhabitants.

3.2. Development of treatment wetland technology

Research on TWs in Austria started in the early 1980s. Soil-based horizontal flow wetlands, turned out to be a very appropriate technology for rural areas providing high stability in their efficiencies regarding the elimination of organic matter, with low levels of operation and maintenance. However, problems concerning the hydraulic conductivity when using soil as a filter medium occurred, resulting in

Table 1
Treatment technologies applied for small WWTPs with design size ≤50 PE in Austria.

Federal state	Total	Primary only	CAS	SBR	Trickling Filter	Fixed bed	Soil Filter	VF wetland	Unknown + other*
Burgenland	20	0	4	1	1	0	0	14	0
Carinthia	6961	2248	3051	566	7	55	308	556	170
Lower Austria	4541	256	452	2513	33	24	81	893	289
Salzburg	1655	304	234	274	82	53	368	279	61
Styria	10′665	2385	2532	1044	374	334	378	3276	342
Tyrol	1096	660	92	107	39	4	80	61	53
Upper Austria	2398	381	646	702	100	0	27	475	67
Vienna	13	1	6	3	1	1	0	1	0
Vorarlberg	129	14	7	28	2	4	66	4	4
Total	27′452	6249	7024	5238	639	475	1308	5559	986
		22.7%	25.6%	19.1%	2.3%	1.7%	4.8%	20.2%	3.6%

* Including 52 MBR and 131 RBC plants.