European Market for Decentralized Waste Water Systems

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Abstract
In terms of decentralized wastewater treatment, small wastewater treatment plants are suitable and state of the art. In Europe there is a need of approximately 20 million plants. A successful CE-marking and a correct declaration of performance is necessary to enter this market. To ensure a functional product all requirements regarding to construction and environmental aspects must be fulfilled. These requirements are defined in the European Construction Products Regulation and they are implemented in detail in EN 12566. This harmonized standard describes the different tests applicable to small waste water treatment plants. Beside the activated sludge method, sequencing batch technology and fixed bed systems are common treatment processes among others. Beyond that small wastewater treatment plants can consist of different materials like concrete, plastic or steel and they can be deployed underground or in the basement of a house. The diversity and complexness leads to a significant number of applicable tests which shall be carried out by a notified testing laboratory. This procedure of assessment and verification of constancy of performance is the basic prerequisite of unimpeded access to the European single market.

Keywords
CE-marking, Construction Products Regulation, Declaration of Performance, European Harmonized Standard, Notified Body, Small Wastewater Treatment Plants

INTRODUCTION

Decentralized wastewater treatment systems are needed in rural areas in order to achieve adequate water quality throughout Europe. Because of this, 20 million systems are expected to go into long-term operation in Europe. Systems with a population equivalent (PT) of up to 50 are designated as small wastewater treatment plants.

Small wastewater treatment plants are construction products for the purposes of the European legal framework. The relevant regulation for small wastewater treatment plants is the Construction Products Regulation (EU No 305/2011) [1]. The term "construction product" refers to a product which is manufactured for permanent use in building works for structural and civil engineering projects.

An essential requirement of the EU Construction Products Regulation is to demonstrate the usefulness of a building product. Construction products are considered to be useful, if they have such characteristics that the works in which they are to be incorporated, can, if properly designed and built, satisfy the following essential basic requirements (according to Annex I EU No 305/2011) [1]:

Mechanical resistance and stability
Safety in case of fire
Protection of hygiene, health and environment
Safety and accessibility in use
Protection against noise
Energy economy and heat retention
Sustainable use of natural resources

Individual harmonised standards have been published for the various construction products within the framework of EU No 305/2011. The relevant harmonised standards for the Wastewater Treatment Plant product are the standards of series EN 12566 (small wastewater treatment systems for up to 50 PT).
The declaration of performance and the CE marking are visible signs of a wastewater treatment plant's conformity with the applicable requirements. Within the context of CE certification, which is done by the manufacturer or his agent, the provisions of the relevant sections of the European "Standard for Small Wastewater Treatment Plants," EN 12566, have to be taken into consideration in accordance with the type of system.

REQUIREMENTS FOR THE WASTEWATER TREATMENT PLANTS AS A CONSTRUCTION PRODUCT

Based on a mandate issued by the European Commission and the European Free Trade Association of the European Committee for Standardisation (CEN), Standard EN 12566, "Small Wastewater Treatment Plants for up to 50 PT," has been or will be developed for small wastewater treatment plants by Technical Committee CEN/TC 165 "Wastewater Technology." Standard EN 12566 currently consists of 7 parts.

Table 1. EN 12566 "Small Wastewater Treatment Systems for up to 50 PT" (July 2014)

EN12566	Title	Version
Part 1	Prefabricated Septic Tanks	EN 12566-1:2000+A1:2003
Part 2	Soil Infiltration Systems	CEN/TR 12566-2:2007-02
Part 3	Packaged and/or Site-Assembled Domestic Wastewater Treatment Plants	EN 12566-3:2005+A2:2013
Part 4	Septic Tanks Assembled In-Situ from Prefabricated Kits	EN 12566-4:2007
Part 5	Pre-Treated Effluent Filtration Systems	CEN/TE 12566-5:2009-01
Part 6	Prefabricated Treatment Units for Septic Tank Effluent	EN 12566-6:2013
Part 7	Prefabricated Tertiary Treatment Units	EN 12566-7:2013

Parts 3 and 6 of EN 12566 are standards applied primarily in Europe for the use of small wastewater treatment plants with wastewater aeration.
EN 12566-3 [2] includes requirements for prefabricated and/or site-assembled systems for the treatment of domestic wastewater for up to 50 PT. The date of application as a harmonized European Norm was on 01/05/2006; the end of the coexistence period with national regulations, after several extensions, was on 01/07/2010.
The normative annexes A, B and C of EN 12566-3 describe the procedures for testing the water-tightness, the cleaning performance, and the stability and durability of installed soil systems. These tests must be performed as part of the initial assessment by a recognised testing laboratory (Notified

Body). The PIA (Development and Assessment Institute in Wastewater Technology) GmbH in Aachen has been implementing the required tests since 2003.
Depending on the material the system is made of, water-tightness (Annex A) can be tested with water or with negative or positive pressure. Systems must be watertight up to the amount specified by the manufacturer. For the specified minimum amount, it must be at the upper edge of the container. Concrete systems may only be tested with water.
In order to test the purification performance (Annex B), the manufacturer must install the system on a test bay in such a way that it corresponds to subsequent installation conditions. During the testing, the system is operated according to the specifications of the standard and the manufacturer's operating instructions. Testing includes the determination of the elimination capacities and the energy consumption for the parameters specified by the manufacturer.
The performance of stability testing (Annex C) depends on the material composition of the wastewater treatment plant with the following materials specified by the standard: concrete, GRP, PE, PP, PVC-U, PDCPD and steel. In this connection, the permissible load of the system is determined by load testing or detection procedures (calculation with mechanical values).
In general, only those construction products may be used for which the durability of the materials is given. Small wastewater treatment plants (including fixtures) must be constructed of materials that are suitable for use with wastewater, so in the case of concrete, for example, the compressive strength must be in conformance with Class C 35/45 pursuant to EN 206-1. For each type of container material listed in the field of application, the relevant and applicable national and/or European standards are listed in the normative references for EN 12566-3. Above this the treatment plant and its used materials must proof the fire resistance and there must not be any release of dangerous substances.

Table 2. Testing pursuants to EN 12566-3 or EN 12566-6

Test	Model in range
Treatment Efficiency	Smallest Model
Water-Tightness	Each Model
Structural Behaviour	Largest Model
Durability	All Materials
Reaction to Fire	All Materials
Release of Dangerous Substances	All Materials

TESTING OF SMALL WASTEWATER TREATMENT PLANTS ON A TEST FIELD

A major component of European standard EN 12566-3 for small treatment plants is the procedure for testing the purification performance. All applicable analysis procedures, a testing timetable and the definitions of the individual test modes are listed in EN 12566-3. Table 3 gives an overview of the type and duration of test modes to be performed as well as the type and number of samples to be taken.

Table3 . Testing Sequences EN 12566-3 [2]

Sequence	Time Elapsed in weeks	Sampling	Number of Measurement
Biomass Establishment	X	Grab Sample	X
Nominal: 100% Hydraulic Flow	6	24-h Mix Sample	4
Underloading 50% Hydraulic Flow	2	24-h Mix Sample	2
Nominal: 100% Hydraulic Flow with Power Breakdown (24 h)	6	24-h Mix Sample	5
Low Occupation Stress: 0% Hydraulic Flow	2	24-h Mix Sample on 2nd and 5th Day after Holiday Period	2
Nominal: 100% Hydraulic Flow	6	24-h Mix Sample	3
Overloading: 100% Hydraulic Flow with 150% Overloading (48-h)	2	24-h Mix Sample	2
Nominal: 100% Hydraulic Flow with Power Breakdown (24-h)	6	24-h Mix Sample	5
Underloading: 50% Hydraulic Flow	2	24-h Mix Sample	2
Nominal: 100% Hydraulic Flow	6	24-h Mix Sample	3
Total	38 + X		28 + X

Both overloading and underloading, as well as normal operation, are evaluated during the course of the annual inspection (38 weeks plus running-in period). While there is generally a 50% reduction in the inflow amount during the underloading phase, the overloading phase is dependent on the design parameters of the testing system. At a rated flow of up to 1.2 m^3/day, the total flow should be set to 150%; at a rated flow of 1.2 m3/day, it should be set to 125%.
There is also a 14-day "holiday mode" phase with no inflow and two 24-hour phases, one for a nominal load of 100% and one for power failure.
The feeding of the system takes place within a fixed diurnal cycle for all testing phases. The diurnal hydrograph must be set with a tolerance of 5% according to Figure 1. Wastewater must be added in even amounts during the individual daily steps. The example illustrated in Figure 1 is the diurnal hydrograph of a testing phase with a nominal load (100%) for a small wastewater treatment plant serving 10 PT. Applying a specific wastewater volume of 150 l/(P*day) results in a nominal load of 1.5 m3/day in the daily inflow to the testing system.
The total daily inflow occurs within two blocks of time, between 6:00 and 12:00 for the morning block and between 18:00 and 23:00 for the evening block. The greatest portion (40%) flows into the testing system between 18:00 and 20:00.

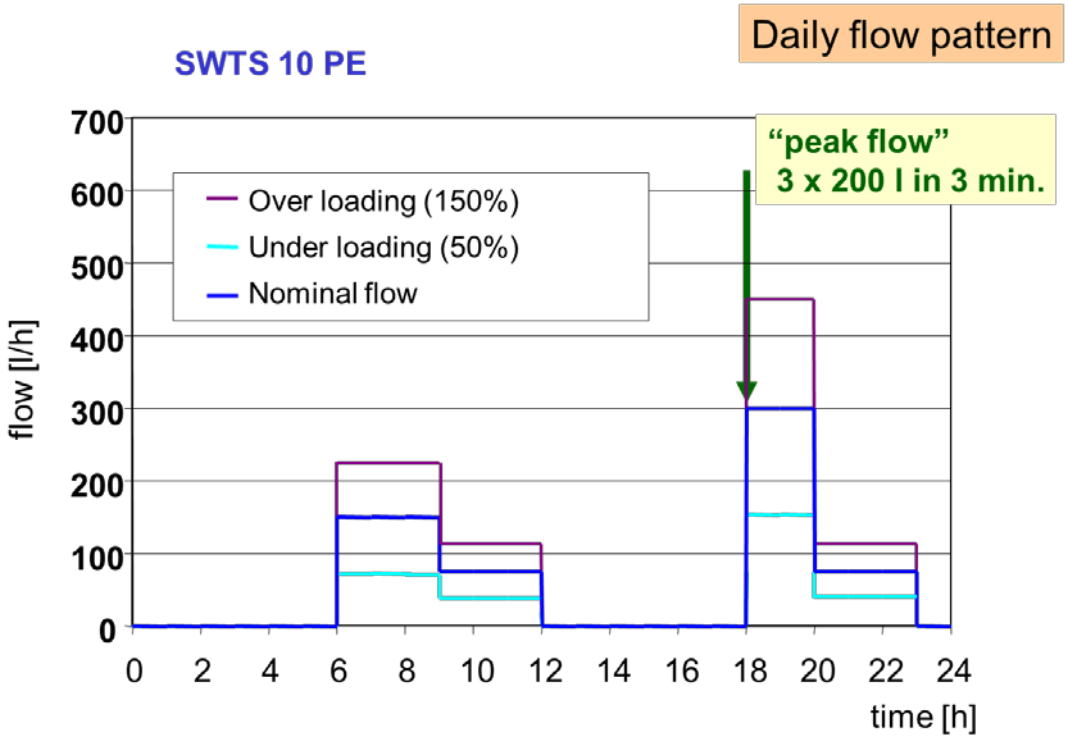

Figure 1. Daily Flow Pattern for Testing (EN 12566-3)

In addition to the diurnal cycle, a weekly testing cycle should include a peak loading event during the testing phases for a nominal load (100% inflow). For peak inflows, one or more "bathtub shocks" (200 litres of wastewater) are supplied as a function of the design parameters of the testing system. Each inflow peak must be added within three minutes of the maximum daily inflow (40%). There is no peak load on the day of a power breakdown.
Table 4 shows the number of inflow peaks as a function of the nominal daily inflow.

Table 4. Peak Flow Discharge for Testing (EN 12566-3)

Nominal Hydraulic Flow QN	Number of Peak Flow Discharge per 200 l
QN ≤0.6 m³/day	1
0.6 m³/day < QN ≤ 1.2 m³/day	2
1.2 m³/day < QN ≤ 1.8 m³/day	3
QN > 1.8 m3/day	4

The test systems are regularly sampled, so that the parameters necessary for the assessment of purification performance can be recorded. In addition to the classical parameters of COD, BOD5 and TSS, these parameters may include ammonium, nitrate and phosphate and possibly the microbial load (faecal coliforms), depending on the targeted certification.
In order to facilitate the comparability of statements on the purification performance of testing systems, regulations on wastewater composition for the feeding of testing systems have been incorporated into EN 12566-3.

Table 5. Wastewater Quality (inflow) for Testing (EN 12566-3)

Parameters	Mean	Range
$BOD_{5/7}$	325 mg/l	150 - 500 mg/l
or		
COD	650 mg/l	300 – 1,000 mg
SS	450 mg/l	200 - 700 mg/l
TKN	62.5 mg/l	25 - 100 mg/l
or		
NH_4-N	51.0 mg/l	22 - 80 mg/l
Ptot	12.5 mg/l	5 - 20 mg/l

In addition to performing tests, the manufacturer must implement and document a factory production control system. This factory production control system must include procedures for the in-plant monitoring of raw materials, components and production to ensure that products placed on the market comply with the standards of EN 12566. The relevant features of each system and the manufacturing process must be defined. This definition should include the frequency of inspections and testing and the criteria which are necessary for controlling the manufacturing process. The measures to be taken if control values or control criteria are not met should be indicated. The

measuring equipment must be calibrated and the procedure, its frequency and the corresponding criteria are to be documented. The warehousing of the finished products and the procedures for handling nonconforming products should also be documented.

CE-Marking and the Certification of Small Wastewater Treatment Plants in Germany

As of August 2002, a wastewater treatment plant may be certified in Germany only after an inspection pursuant to EN 12566-3. An evaluation of test performances demonstrates that small wastewater treatment plants can achieve the same purification performance that applies to municipal wastewater treatment plants of size categories GK 1 to GK 3.
Table 6 shows a summary of the requirements for the various size categories of decentralised wastewater treatment systems.

Table 6. Requirements for Wastewater Systems in Germany pursuant to German Wastewater Directive [3] and German Technical Approval (DIBt)

	COD mg/l	BOD_5 mg/l	NH_4-N mg/l	Ntot mg/l	SS mg/l
Municipal WWTP					
GK 1 < 1,000 PT	150	40	-	-	-
GK 2 ≤ 5,000 PT	110	25	-	-	-
GK 3 ≤ 10,000 PT	90	20	10	-	-
Sampling			Grab- or 2h-Mix		
SWTS (DIBt)					
C-Elimination	150/100	40/25	-	-	75/-
Nitrification	90/75	25/15	-/10	-	50/-

Nitrification/Denitrification	90/75	25/15	-/10	-/25	50/-
Additional Requirements "P-Elimination"	2 mg/l P				
Additional Requirements "Disinfection"	100 faecal coliforms per 100 ml				
Sampling	Grab- or 2h-Mix				

As part of the declaration of conformity, the manufacturer may provide a CE marking for each small wastewater treatment plant of a series which complies with the European Small Wastewater Treatment Plant Standard and has passed the prescribed tests. The marking always features details about the product and its production (factory production control and initial testing by the manufacturer). The manufacturer must supply detailed installation instructions, including details on site selection as well as comprehensive operating and maintenance instructions, for every system.
It should be stated that any requirements of other directives and standards, for example, those of the Machinery Directive and the Low Voltage Directive, must also be observed. Table 7 provides an overview of the key documents that must available for the CE marking of a small wastewater treatment system.

Table 7. Documents for CE-Marking of SWTS

Documents	Issuer
Treatment Efficiency Test Report	Notified Laboratory
Structural Behaviour Test Report	
Durability Test Report	
Water-Tightness Test Report	

Dimensioning of each Model in the Range	
Documents pursuant to Machineries Directive	
ATEX – Documents [7]	Manufacturer/ Distributor
EMC – Documents [8]	
CE-Documents for each Spare Part (pumps etc.)	
External Documents (manuals, declarations)	

Standard EN 12566 contains no reference to the assessment of systems and no guidelines for effluent concentrations. Free trade with these systems in the European market might have the effect that small wastewater treatment plants could, for example, be purchased at the hardware store and installed by anyone without any technical knowledge. The respective water laws and regulations of many countries (e.g., Germany, France, Belgium, Netherlands and Austria), stipulate requirements with respect to effluent concentrations which must be adhered to. So, in Germany for example, there is an application approval for the CE marking of small wastewater treatment systems.
In Germany the water law requirements for the construction and operation of small wastewater treatment systems are regulated through the General Building Inspectorate Approvals (Application Approvals) of the German Institute for Building Technology (DIBt).
The Water Construction Products Code (WasBauPVO) [5] regulates mass-produced wastewater products. The verification of water law requirements in general building approvals is carried out pursuant to this code. This means that the conditions for the installation, start-up, operation and maintenance of the Small Wastewater Treatment Plant construction product, are regulated from the perspective of water legislation via the instrument of the General Building Inspectorate Approvals.

Figure 2 shows the general format of an EN 12566-6 compliant CE marking for a small wastewater treatment plant manufactured by "Any Co Ltd" with concrete tanks. The CE marking was affixed in 2013. The testing of the purification performance was carried out with an average inflow BOD5 concentration to the secondary treatment unit of around 170 mg/l. The tested system had a rated size of about 20 PT, which means that the manufacturer, Any Co Ltd, probably does not provide a smaller size. The average BOD5 effluent concentration in the test phases with 100% feeding of the nominal daily inflow (3 m^3/day) was 34 mg/l. Although these small wastewater treatment systems may bear the CE mark, they receive no General Building Inspectorate Application Approval in Germany.
As the Small Wastewater Treatment Plant construction product is also subject to requirements from other areas of law (water law) in Germany, evidence of applicability and compliance with these requirements can be performed according to the building codes.

CE

Any Co Ltd, P.O. Box 21, B-1000

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EN 12566-6:2013

Prefabricated secondary treatment unit for treatment of septic effluent in small wastewater treatment systems for a population up to 50 PT

- Material: Concrete
- Nominal organic daily load: 0,7 kg/d
- Nominal hydraulic daily flow: 3 m^3/d

Reaction to fire:	A1
Effectiveness of treatment, as:	
- Secondary treatment efficiency ratios (at tested organic daily load BOD_5 = 0,52 kg/d)	COD: 80 % BOD: 80 % SS: 80 %
- Micro-organism reduction	NPD
Treatment capacity (designation), as:	
- Nominal organic daily load	0,7 kg/d
- Nominal hydraulic daily flow	3 m^3/d
Watertightness (water test):	Pass
Release of dangerous substances	NPD
Crushing resistance, as:	
- Load bearing capacity (pit test):	0,3 m - Wet
Durability	Pass

Figure 2. CE-Marking Document (example) pursuant to EN 12566-6:2013 [6]

REFERENCES

[1] NN Regulation (EU) No 305/2011 of the European Parliament and of the Council laying down Harmonised Conditions for the Marketing of Construction Products and Repealing Council Directive 89/106/EEC.

[2] CEN EN 12566-3:2005+A1:2009 Small Wastewater Treatment Systems for up to 50 PT- Part 3: Packaged and/or Site-Assembled Domestic Wastewater Treatment Plants.

[3] NN Regulation on Requirements for the Discharge of Wastewater into Water Bodies (AbwV) Annex 1: Domestic and Municipal Wastewater (2004).

[4] NN Approval Guidelines for Small Wastewater Treatment Plants pursuant to DIN EN 12566-3 of the German Institute for Building Technology - DIBt (Feb. 2014).

[5] NN Regulation for Determining the Suitability of Water Law for Construction Products and Building Techniques (WasBauPVO) of 27 March 2006, GVBl [Legal and Regulatory Gazette]. LSA 2006, pp. 173.

[6] CEN EN 12566-6:2013 Small wastewater treatment systems for up to 50 PT – Part 6: Prefabricated treatment units for septic tank effluent.

[7] EU Directive 94/9/EC of the European Parliament and the Council of 23 March 1994 on the Approximation of the Laws of the Member States concerning Equipment and Protective Systems intended for use in Potentially Explosive Atmospheres ATEX (OJ L 100, 19/4/1994).

[8] EU DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the Harmonisation of the Laws of the Member States relating to Electromagnetic Compatibility (recast) EMC, Official Journal of the European Union L 96/79 from 29/3/2014.