Programme d'appui scientifique à la normalisation et aux réglementations techniques

"Fitness for use"-evaluation of small (<20PE) domestic waste water treatment plants

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SAMENVATTING

A. Context

Tegen 2015 moet in de Europese Gemeenschap al het grond- en oppervlaktewater van "goede" kwaliteit zijn. Aan deze doelstelling, in 2000 vastgelegd door een Europese richtlijn, wordt echter al reeds meerdere tientallen jaren gewerkt, waarbij vooreerst de aandacht ging naar het zuiveren van het afvalwater van de grote stedelijke gebieden. Het realiseren van de 2015-doelstelling vereist dat nu ook stilaan een aanvang gemaakt wordt met het zuiveren van het afvalwater afkomstig van de gebouwen in rurale gebieden die, omwille van hun verspreide ligging niet aangesloten zijn op een openbare riolering. Men schat dat het voor België om 15 à 25% der gebouwen gaat, waarvan de ongezuiverde afvalwaterlozingen dan ook een belangrijke, zij het diffuse, bron van milieuverontreiniging betekenen. Voor het zuiveren van dit afvalwater zal een beroep dienen gedaan te worden op kleinschalige waterzuiveringsinstallaties (KWZI) en op individuele behandelingssystemenen van afvalwater (IBA). Toot op heden staat in de bouwwereld kleinschalige en individuele zuivering gelijk aan het plaatsen van een septic tank. Maar om de lozingsnormen te halen die in de verschillende Gewesten werden opgesteld om deze vorm van verontreiniging te beperken, is een septic tank totaal ontoereikend, andere meer performante systemen moeten toegepast worden. Bovendien moet men zeker zijn dat de geplaatste toestellen inderdaad zullen toelaten een effluent te realiseren dat aan de voorschriften voldoet. Reeds in het begin der jaren negentig werd er in Europa dan ook de noodzaak aangevoeld om tot een kwaliteitborging te komen voor deze kleine waterzuiveringssystemen en er werd geopteerd om producteisen vast te leggen in een Europese norm. De werkgroep TC 165 WG41 van het Europese Normalisatie Comité (CEN) werd met het opstellen van deze norm belast en bracht een eerste voorontwerp uit in de tweede helft van de jaren negentig van de vorige eeuw. Dit ontwerp, dat ondertussen gekenmerkt werd als prEN 12 566-3 (bijlage 1), vermeldde eisen en beschreef testen voor het controleren van zowel de zuiveringsprestatie van de systemen als van hun structurele stabiliteit. Voor het evalueren van de zuiveringsprestatie werden daarbij twee, 1 jaar durende, benaderingen vooropgesteld: hetzij een opvolging in strikt gecontroleerde voorwaarden, op een test-platform, hetzij een opvolging in situ.
Onmiddellijk rezen er in verschillende middens vragen over de validiteit van de voorgestelde procedures. Deze vraagstelling lag aan de basis van het onderzoek gevoerd door 4 Belgische onderzoekslabo's: Het Wetenschappelijk en Technisch Centrum voor het Bouwbedrijf (WTCB/CSTC/BBRI) in Brussel, het "Centre Belge de l'Etude et de Documentation de l'Eau" (CEBEDEAU) in Luik, de "Fondation Universitaire Luxembourgeoise" (FUL) te Aarlen en de Vlaamse Instelling voor Technologisch Onderzoek (VITO) te Mol.

B. Doelstellingen

Het doel van het onderzoek opgezet door de 4 Belgische ploegen, met de financiële steun van het Federaal Wetenschapsbeleid, was het valideren en het verbeteren van de voorgestelde testprocedures, teneinde er zeker van te kunnen zijn dat er een correcte evaluatie zou geschieden van de prestaties van kleinschalige afvalwater zuiveringssystemen, op basis van de Europese norm.

Hiertoe werd voorgesteld de in het normontwerp aangegeven methodes concreet uit te voeren en elke stap aan een kritische evaluatie te onderwerpen. Het volgende takenpakket vormde het basis-programma van het onderzoek:

- Taak 1: het operationeel maken van een testplatform (WTCB, CEBEDEAU,VITO)
- Taak 2: evaluatie van de prEN procedure voor het bepalen van de zuiveringsprestatie op een testplatform (WTCB, CEBEDEAU,VITO)

- Taak 3: evaluatie van de prEN procedure voor het bepalen van de zuiveringsprestatie door opvolging van systemen in situ (WTCB, FUL,VITO)
- Taak 4: evaluatie van de prEN benadering voor het controleren van de structurele stabiliteit van de systemen (WTCB)
- Taak 5: definiëren van verbeteringen voor het Europees normontwerp (allen)

C. Besluiten

Het onderzoek bevestigde dat het algemeen opzet van de procedure voor het bepalen van de zuiveringsprestatie zeker een als goed te bestempelen is. Mbt de sequentie van de voorgestelde testen werden echter wel belangrijke verbeteringen geïdentificeerd, zo bv:

- De noodzaak om tussen 2 stress-testen steeds een periode te hebben waarbij de installatie tot een normale werking kan terugkeren teneinde het effect van de uitgevoerde test te kunnen onderscheiden van het effect van de vorige.
- De vaststelling dat het onnodig is om lange perioden met stabiele werking vast te leggen: het kan volstaan slechts één dergelijke periode te voorzien op het begin van de testen, hetgeen tot een merkelijke reductie van duur van de testen kan leiden.
- De vaststelling dat het onnodig is punctuele wateranalyses uit te voeren na het realiseren van badwater en wasmachine lozingen.
- Ook werd aangetoond dat door het invoeren van een twee bijkomende korte fysische tests (meting van de beluchtingscapaciteit en bepaling van het hydraulisch gedrag) er kan vermeden worden dat er een dure testcampagne gestart wordt op toestellen die sowieso niet geschikt zijn.

Voor wat betreft de controle van de structurele stabiliteit werd aanbevolen berekeningen enkel toe te laten voor staal en beton. Voor het testen werd voorgesteld enkel de “pit-test” te weerhouden.

D. Bijdrage aan het proces inzake normalisatie en technische regelgeving

Door de actieve deelname van de partners aan het normalisatiegebeuren (alle partners namen deel aan het Belgische spiegelcomité dat door het BIN/IBN opgericht werd en 3 namen deel aan de werkzaamheden van TC 165 WG41) was het mogelijk de resultaten van het onderzoek in grote mate onmiddellijk te laten opnemen in het ontwerp van norm, zodat hierdoor concreet de doelstelling van het onderzoek gerealiseerd werd.
Bovendien bracht de deelname van de onderzoekspartners aan de normalisatie commissies hen in contact met de betrokken industrie zodat kennis kon genomen worden van hun noden, hetgeen de onderzoeksactiviteiten van de labo’s zeker zal beïnvloeden. Door het opnemen in de begeleidingsgroep van het onderzoek, van afgevaardigden van de verschillende betrokken gewestelijke administraties, werden deze tegelijk geïnformeerd van de aan de gang zijnde Europese initiatieven terzake.

E. Trefwoorden

Afvalwater, zuivering, kleinschalige zuivering, individuele behandeling, zuiveringsprestatie, mechanische stabiliteit

RESUME

A. Contexte

Pour 2015, les eaux de surface ainsi que les nappes phréatiques devront avoir, partout dans la Communauté européenne, une « bonne » qualité. La réalisation de cet objectif, défini par une directive européenne en 2000, a cependant déjà débuté il y a des décennies par la mise en place du traitement des eaux usées résiduaires urbaines. La réalisation de l'objectif 2015 nécessite cependant de prêter attention aux eaux usées en provenance des bâtiments en zone rurale qui ne sont pas raccordés à un égouttage public. En Belgique, on estime que 15 à 25% des bâtiments se trouvent dans ces conditions et la décharge de leurs eaux non traitées constitue une importante source –diffuse- de pollution de l'environnement. L'épuration de ces eaux nécessitera la mise en place de systèmes d'épuration individuelle. Dans ce contexte, les professionnels de la construction pensent actuellement encore uniquement à la mise en place de fosses septiques mais la réalisation des exigences légales, en ce qui concerne la qualité minimale de l'effluent des systèmes individuels de traitement, nécessite la mise en place de dispositifs plus performants. En plus, il faudra être certain que ces dispositifs réaliseront effectivement un effluent de qualité conforme. Ceci implique la mise en place d'une procédure de certification de la performance épuratoire. Ce besoin se faisait déjà ressentir dans différents pays au début des années nonante. Il fut alors décidé de rédiger une norme européenne et le groupe de travail CEN TC 165 WG41 du Comité Européen de Normalisation (CEN) fut chargé de cette rédaction. Une première version de projet de norme – norme identifiée comme prEN 12566-3 - était ainsi déjà disponible dans la deuxième moitié des années nonante. Cette version mentionnait des exigences et des procédures pour vérifier la performance épuratoire et la stabilité mécanique des systèmes concernés (annexe 1). Pour l'évaluation de la performance épuratoire deux approches alternatives –durant environ 1 an- étaient proposées : un essai sur plate-forme d'essai et un suivi sur site.
Tout de suite ce projet de norme suscita un tas de questions sur la validité des procédures proposées, dans tous les milieux concernés par la problématique. Cette mise en question a été à la base de la recherche menée par les 4 laboratoires belges : le Centre Scientifique et Technique de la Construction (CSTC/WTCB/BBRI) à Bruxelles, le Centre Belge d'Etude et de Documentation de l'Eau (CEBEDEAU) à Liège, la Fondation Universitaire Luxembourgeoise (FUL) à Arlon et l'Institution Flamande pour la Recherche Technologique (VITO) à Mol. Cette recherche était subsidiée par la Politique scientifique fédérale.

B. Objectifs

Le but de la recherche des 4 équipes belges est de valider et d'améliorer les procédures d'essai proposées dans la proposition de norme européenne prEN 12566-3, afin de pouvoir être certain d'une évaluation correcte des performances des systèmes testés selon cette norme.

L'approche proposée à cet effet était de réaliser les essais préconisés dans le projet de norme et d'évaluer de façon critique chaque pas de la procédure. Cette approche était basée sur le programme suivant :

- Tâche 1 : rendre opérationnel un poste d'essai (CSTC/BBRI, CEBEDEAU, VITO).
- Tâche 2 : évaluer la procédure pour déterminer la performance épuratoire sur plate-forme en exécutant des essais sur des systèmes commerciaux d'épuration individuelle (CSTC/BBRI, CEBEDEAU, VITO).

- Tâche 3 : évaluer la procédure pour déterminer la performance épuratoire sur site en faisant le monitoring de systèmes commerciaux d'épuration individuelle en utilisation (CSTC/BBRI, FUL, VITO).
- Tâche 4 : Evaluation de la procédure proposée pour le contrôle de la stabilité mécanique des systèmes (CSTC/BBRI).
- Tâche 5 : rédaction de propositions d'amélioration du projet de norme européenne prEN 12566-3 (tous).

C. Conclusions

L'approche générale proposée dans la prEN 12566-3 forme effectivement une bonne base pour évaluer la performance épuratoire. Cependant, en ce qui concerne la séquence préconisée pour l'exécution des différents tests, des améliorations ont été identifiées, comme par exemple :

- La nécessité de prévoir entre deux essais de sollicitation exceptionnelle, des périodes de sollicitation normale, afin de permettre à l'installation de retrouver un mode de fonctionnement normal et de pouvoir différentier les effets des différentes sollicitations exceptionnelles.
- Qu'il n'est pas nécessaire de prévoir plusieurs longues périodes de sollicitation normale : il suffit d'une seule période, par exemple au début des essais. Cette constatation devrait permettre de réduire fortement la durée totale des essais.
- Qu'il est inutile de faire des analyses ponctuelles après certains essais de sollicitation exceptionnelle, comme la décharge des bains.
- Que l'exécution de deux essais simples, au début de la campagne de mesures, permet d'éviter de démarrer une longue campagne de monitoring sur des dispositifs à priori inadaptés.

En ce qui concerne le contrôle de la stabilité structurelle, il fut recommandé d'admettre le calcul uniquement pour les dispositifs en béton et en acier.
La recommandation était de préconiser uniquement le « pit-test ».

D. Apport dans le contexte de la normalisation et la réglementation technique

Suite à la recherche, les partenaires ont eu la possibilité de participer au processus de normalisation :

- FUL, BBRI et VITO ont participé activement aux travaux du groupe CEN TC 165 WG41, ce qui a permis d'introduire les résultats de la recherche immédiatement dans les nouvelles versions de la norme en préparation.
- Suite à la demande explicite des partenaires de la recherche, l'Institut belge de normalisation a mis sur pied un comité miroir au CEN TC165 WG41, de façon à réunir au niveau belge les différents partenaires concernés par la problématique : fabricants, administrations, entrepreneurs, chercheurs,...

De cette façon, les chercheurs ont pu faire passer les résultats de leur recherche dans la normalisation en cours et ils ont pu prendre connaissance des besoins de l'industrie ce qui influencera certainement leurs futures activités. Finalement, il faut également souligner que le fait que cette recherche était suivie par un groupe comprenant des représentants des différentes administrations concernées a certainement contribué à ne pas prendre connaissance de la problématique de l'épuration individuelle, comme elle est abordée au niveau européen.

E. Mots-clés

Eaux usées, épuration, épuration individuelle, performance épuratoire, stabilité mécanique.

SUMMARY

A. Context

Before 2015, all surface and soil water must be of « good » quality in the European Community. Although this objective was established in a European directive, published in 2000, all Community Members are already working on the problem since several decades, putting their effort however mainly on the treatment of the urban waste water. But the realisation of the 2015-objective requires that also the waste water coming from buildings not connected to a public sewer, due to their spread, is taken into consideration. For Belgium it is estimated that 15 to 25 % of the buildings will never be connected to a public sewer. The discharge of untreated or not correctly treated waste water of this huge amount of buildings represents a considerable source of diffuse environmental pollution. The treatment of this waste water will require the use of small waste water treatment plants. For the construction professionals small waste water treatment means: "using a septic tank". However the regional requirements for the effluent coming from these treatment plants are such that the use of a septic is insufficient. Use will have to be made of better performing systems, of which can be assured that the treatment will lead to an effluent in accordance to the legal requirements. This need for quality assurance was already felt in Europe at the beginning of the nineties, in last century. This brought industry to request the European standardisation committee (CEN) to establish a European standard enumerating product requirements and procedures for the verification of the performances of the plants. The CEN working group CEN TC 165 WG41, was charged with this task and brought out a first draft standard in the second half of the late nineties, i.e. the pr EN 12566-3 (annexe 1). For evaluating the treatment efficiency, this draft proposed two alternative procedures, lasting for 1 year: the first is a monitoring of the plant on a test facility, the second a monitoring on site.
Immediately a lot of questions were raised from different sides, questioning the validity of the proposed procedures. This questioning was the basis of the research set up by 4 Belgian laboratories: the Belgian Building Research Institute (BBRI)in Brussels, the "Centre Belge d'Etude et de Documentation de l'Eau" (CEBEDEAU) in Liège, the "Fondation Universitaire Luxembourgeoise" (FUL) in Arlon and the Flemish Institution for Technological Research (VITO) in Mol. This research was financed by the Belgian Science Policy.

B. Objectives

The objective of the research launched by the 4 laboratories was to validate and improve the procedures proposed in prEN 12566-3, in order to be sure that the plants tested according to this standard would be correctly evaluated.
The approach adopted hereto was to realize the proposed procedures, evaluating critically each step. The programme was as follows:

- Task 1 : making operational a test rig (BBRI, CEBEDEAU, VITO)
- Task 2 : evaluating the prEN treatment efficiency procedure for laboratory testing, by measuring the performance of commercial plants on the test rig measuring (BBRI,CEBEDEAU, VITO)
- Task 3 : evaluating the prEN treatment efficiency procedure for on site testing, by measuring the performance of commercial plants in situ (BBRI, FUL, VITO)
- Task 4 : evaluating the prEN proposal for assessing the mechanical stability of small plants (BBRI)
- Task 5 : proposals for improving the prEN 12 566-3 (all partners).

C. Conclusions

The research confirmed that the general scheme for addressing the treatment efficiency was indeed a good basis for this assessment. However important improvements could be identified with respect to the different stress tests that are to be conducted, e.g.:

- Between two periods were the plants are submitted to stress loading, there must absolutely be a period with normal loading, allowing the plant to come back to normal working conditions. This being the only possibility to see the effect of the different stresses.
- There is no necessity to have several long periods of steady state working of the plants, it suffices to have only one such a period, for instance at the beginning of the test campaign. This allows certainly shortening the whole test duration.
- It is superfluous to do analyses on punctual samples taken just after certain stress tests (bath discharge).
- The execution of two simple physical tests (measurement of the aeration capacity and establishing the hydraulic response of the plant) allows to avoid the starting of a 1 year campaign on plants which obviously do not have the minimum capabilities.

Concerning the structural stability the recommendation was made to limit the calculation methods to concrete and steel. For the testing it was recommended to adopt only the pit-test for all materials.

D. Contribution to the process of standardisation and technical regulations.

The active participation of the research partners to the standardisation activities lead directly to the input of the research results into the standard. Two actions were set up hereto:

- FUL, VITO and BBRI participated actively in the meetings of CEN TC 165WG41, so that improvements could be argued during the discussion of the standard.
- At the level of the Belgian Standardisation Institute (BIN/IBN) a mirror committee to CEN TC 165 WG 41 was created, comprising delegates of industry, administration and the 4 laboratories. Also through the official comments of this group to CEN the research results were injected into the European standard. The meetings of this group allowed industry and administration to take knowledge of the ongoing European standardisation process. It allowed the laboratories also to take knowledge of the needs of industry. This knowledge will certainly influence their future research actions.

The information of the different regional administrations about the problem of small waste water treatment plants, was also enhanced by having them in the group guiding the research.

E. Keywords

Waste water, treatment, small waste water treatment, treatment efficiency, mechanical stability.

1. INTRODUCTION

In Belgium 15 to 25% of the buildings will never be connected to a collective waste water treatment plant. For the treatment of the waste water from these building small waste water treatment systems will have to be used. The legal effluent requirements for these kinds of systems are such that there is a need for products being certified to be able to realise the required effluent quality. Given the fact that a European directive requires that, in the Community, the surface and groundwater must be of *good* quality before 2015, this need was felt throughout the whole of Europe and initiated the drafting of a European standard, already in the early nineties of last century, aiming to set a minimum product-quality level. However the establishment of this standard had to rely on very restricted know-how and testing experience. The result was that the procedures proposed in the draft versions of this standard, i.e. the pr EN 12566-3 “Small waste water treatment systems up to 50 PT- Part 3: Packaged and/or site assembled domestic waste water plants”, were “prototypes”, missing validation and in many cases setting forward unrealistic requirements, or totally irrelevant tests.

In order to improve this standard proposal and to validate the requirements, BBRI (Belgian Building Research Institute, CEBEDEAU (Centre Belge d’Etude et de Documentation de l’Eau), FUL (Fondation Universitaire Luxembourgeoise) and VITO (Flemish Institution for Technological Research) set up a research with the financial support of the Belgian Science Policy. This research started on 1 April 2000 and ended on 30 June 2003.

This report presents a synthesis of the results obtained in the 3 years of research. It was established by BBRI who acted as coordinator. BBRI relied hereto on the reports which were issued in the course of the research by the different research partners. It should thus be clear that only part of the available information is presented in this report. The readers interested in the detailed data collected, will have to consult the different reports issued by the concerned research-partners, of which the references are given on the cover-page of this report.
The reading of this report requires having taken knowledge of the draft European standard prEN 12566-3 which the research tries to improve. The 1997-version of this draft standard is in annexe 1; annexe 2 presents the testing proposed for assessing the structural behaviour in the version of 2000.

2. METHODOLOGY

The aim of the research was to validate and improve the draft procedure proposed by European Standardisation Comity for evaluating the fitness for use of small (≤20 PE) domestic wastewater treatment plants (prEN 12566-3) versions between 1997 and 2000. Especially the testing methods for the treatment efficiency (where 2 possibilities are proposed: one on a test platform and one in situ) and the load bearing capacity were considered. In order to realize this aim, the following working program was adopted:

- Task 1 :
  making operational a test rig (BBRI, CEBEDEAU, VITO)
- Task 2 :
  evaluating the prEN treatment efficiency procedure for laboratory testing, by measuring the performance of commercial plants on the test rig measuring (BBRI,CEBEDEAU, VITO)
- Task 3 :
  evaluating the prEN treatment efficiency procedure for on site testing, by measuring the performance of commercial plants in situ (BBRI, FUL, VITO)
- Task 4 :
  evaluating the prEN proposal for assessing the mechanical stability of small plants (BBRI)
- Task 5 :
  Proposals for improving the prEN 12 566-3 (all partners).

The methodology adopted for the realisation of these different tasks, is the following:

2.1. Making operational a rig for testing the treatment efficiency in a test centre

In order to be able to appreciate the prEN procedure for testing on a test platform, an analysis was first made of the literature on the topic. This lead to the identification of

- a certain number of problems related to how to set-up the testing. Some of these problems were solved before setting the test rig (§3.1), others were evaluated during the task 2 (§3.2).
- several evaluation criteria, which are not addressed in the prEN, but are important in guarantying the performance in time of small wastewater treatment plants.

On basis of the information gathered, each of the three partners involved (BBRI, CEBEDEAU and VITO) constructed its own test rig.

2.2. Evaluating the prEN treatment efficiency procedure for laboratory testing

Once the test rigs where operational, the treatment efficiency of commercial plants was measured while submitting the plants to sequences of normal and stress loading, looking to the appropriateness of the prEN procedure for testing in laboratory (see annexe 1). Hereto the three partners involved, adopted different evaluation schemes on similar treatment plants:

- VITO tested two different plants, feeding them by a continuous flow (see table 2- I):
  - the first was an activated sludge system (AS Vit01) for 2 to 4 PE, following quite strictly the prEN procedure (see table 2-II);
  - the second a submersed aerated filter (SAF Vit02) for 1 to 5 PE, according to an adapted procedure with the tests of the prEN, applied flexible within a period of 38 weeks (see table 2-III).

TABLE 2-I: daily base inflow profile

	prEN	BBRI	VITO	CEBEDEAU
Daily base inflow profile				
Time of day	Percentage of daily flow [%]	Mean hourly flow realized by discharging volumes of 10 l wastewater for 5 PE [l/h]	Continuous hourly flow of waste water for 5 PE [l/h]	
06 - 09	30	70	75	
09 - 12	15	35	37.5	
12 - 18	0	0	0	
18 - 20	40	140	150	
20 - 23	15	35	37.5	
23 - 06	0	0	0	
Common peak flows				
Washing machines	Twice a week 2 laundry machine discharges within 1 hour, starting at 10.00	2 laundry machine dis-charges within 1 hour on Monday and Friday at 10.00 Total volume per machine: 75 l = (15 l clear water at 80°C *without* detergent) + (60 l clear cold water)	1 laundry machine discharge on Monday and Wednesday at 10.00 for AS and 9.00 for SAF, of 146 l = (26 l clear water at 60°C with detergent) + (4*30 l clear cold water); each volume created by a flow rate of 100l/h	2 laundry machine dis-charges per day, each day of the week, during one period of 2 weeks (table 2-IV) of each 45 l clear water at 60°C with detergent,
Bath discharges	Once a week twice 200 l of cold(1997)/ wastewater(2000) in 3 minutes	On Wednesday at 19.00 and 19.35: 200 l clear cold water discharged	On Friday at ??? : AS: 200 l clear cold water discharged SAF: 2x 200 l clear cold water	2 discharges a day of 200 l of wastewater during 4 days a week, for 2 weeks (table 2-IV)

- CEBEDEAU also worked mainly on a SAF (9 to 10 PE –SAF Ceb01-), but also to a certain extend on an AS (10 PE – AS Ceb02-), however adopting a different approach than VITO:
  - they evaluated first the capacity of the aerator of the plants,
  - then they characterised the hydraulic behaviour

TABLE 2-II : VITO test scheme for the AS

Period	Phase	Duration	Sampling
1	Starting up the plant: daily base inflow	4	none
2	Steady state : daily base inflow + common peak flows	10	Every 2 weeks : • a 24h composite of in- and effluent on Tuesday • 4 grab-samples taken at 15 minutes interval after the washing machine discharges • 4-grab-samples taken at 5 minutes interval after the bath discharge
3	Daily base inflow + common peak flows and a power breakdown for 24 h on Wednesday of 1st week	2	24h composite effluent samples on the 2nd and 5th day after power breakdown
4	Steady state : daily base inflow + common peak flows	6	See period 2
5	Steady state : daily base inflow + common peak flows	5	No sampling
6	50% daily base inflow + common peak flows	2	See 2
7	200% daily base inflow + common peak flows	2	See 2
8	Holiday stress test: no discharge of water	2	24h composite effluent samples on the 2nd and 5th day after power breakdown
9	Steady state : daily base inflow + common peak flows	6	See 2
10	Daily base inflow + common peak flows and a power breakdown for 24 h on Wednesday of 1st week	2	24h composite effluent samples on the 2nd and 5th day after power breakdown
11	Steady state : daily base inflow + common peak flows	2	See 2
12	Holiday stress test: no discharge of water	2	24h composite effluent samples on the 2nd and 5th day after power breakdown
13	Steady state : daily base inflow + common peak flows	2	See 2
	Total :	48	weeks

- afterwards they started the evaluation of the treatment efficiency, using continuous flow (table 2-I), however with a procedure (table 2-IV) differing from the one in the prEN 12566-3 : limited to 18 weeks, not considering the power breakdowns, nor the loading variations. Like VITO, CEBEDEAU fed the SAT-plant with a continuous flow. They also simulated the effect of a sludge accumulation, putting at a given moment sludge of a septic tank in the first compartment of the plant.

TABLE 2-III: VITO test scheme for the SAF

Period	Phase	Duration	Sampling
1	Starting up the plant: daily base inflow	6	none
2	Steady state : daily base inflow + common peak flows	9	Every 2 weeks : • a 24h composite of in- and effluent on Tuesday • 4 grab-samples taken at 15 minutes interval after the washing machine and the bath discharges
3	Daily base inflow + common peak flows and a power breakdown for 24 h on Wednesday of 1st week	2	24h composite effluent samples on the 1st, 2nd and 5th day after power breakdown
4	Steady state : daily base inflow + common peak flows	4	See 2
5	50% daily base inflow + common peak flows	3	See 2
6	Steady state : daily base inflow + common peak flows	2	See 2
7	Holiday stress test: no discharge of water	2	24h composite effluent samples on the 2nd and 5th day after power breakdown
8	Steady state : daily base inflow + common peak flows	11	See 2
9	200% daily base inflow + common peak flows	4	See 2
10	Steady state : daily base inflow + common peak flows	5	See 2
	Total :	48	weeks

TABLE 2-IV : CEBEDEAU test scheme

Period	Phase	Duration	Sampling
1	Starting up the plant: daily base inflow	14	2 weekly 24 h composite at the beginning; daily composite during week from week 12 on
2	Steady state : daily base inflow	2	Daily composite during week
3	Daily base inflow+ 2 washing machine discharges every day	2	Daily composite during week
4	Daily base inflow+ 2 bath discharges every day for 4 days a week	2	Daily composite during week
5	No flow and introduction of septic tank sludge	1 day	None
6	Starting up the plant: daily base inflow	3	Daily composite during week
7	Steady state : daily base inflow	1	Daily composite during week
8	Idem 3	2	Daily composite during week
9	Idem 4	2	Daily composite during week
	Total	28	weeks

- BBRI also adopted an approach different from the one specified in the draft European standard:
    - Like CEBEDEAU they also first measured the hydraulic behaviour of an AS (2 to 4 PE –AS Bbri01);

- o The treatment efficiency of a SAF (4 to 6 PE- SAF Bbri02) was evaluated based upon a 15-week period with some stress tests (table 2-V). The test rig of BBRI did however not have a continuous flow, the daily water input being realized by discharging water volumes of 10 , 15 and 200 l, creating pulse-like discharges: see table 2-I.

TABLE 2-V : BBRI test scheme

1	Starting up the plant: daily base inflow +common peak flows	6	Weekly ??composite influent
2	Steady state : daily base inflow +common peak flows	4	Weekly • 24 h composite influent??? • Grab-effluent samples
3	Daily base inflow + common peak flows and a power breakdown for 24 h on Monday	1	Influent: weekly 24h composite samples Effluent : • Daily grab-samples • 24 h composite samples twice a week
4	Steady state : daily base inflow +common peak flows	2	Influent: weekly 24h composite samples Effluent : • Daily grab-samples • 24 h composite samples twice a week
5	150% loading +common peak flows	2	Influent: weekly 24h composite samples Effluent : • Daily grab-samples • 24 h composite samples twice a week
6	Steady state : daily base inflow +common peak flows	2	Influent: weekly 24h composite samples Effluent : • Daily grab-samples • 24 h composite samples twice a week

2.3. Evaluating the prEN treatment efficiency methodology for on site testing

Three partners were involved in this task: VITO, FUL and BBRI.

VITO followed 4 installations during the 1st year and again 4 the second year, as indicated in the table 2-VI. As can be seen from this table, for each type of system, two installations with a different loading (expressed by the number of persons served by the system), were considered, trying to get a 50 and a 75% loading.

Before starting the monitoring of the 1st year VITO evaluated the effect of the effluent sampling mode on the results:

- Mode 1: 24 hour composite samples, composted by taking a fixed water volume at regular time intervals, i.e. time steered sampling
- Mode 2: 24 hour composite samples, flow-based
- Mode 3: grab samples

As a result of this testing and given the sampling equipment they had at their disposal (traditional samplers with refrigeration), VITO opted for the mode 1-sampling in the settling tank of the plants. For the influent, evaluated every 15 days, grab samples were taken in the pre-treatment tank (or settling tank).

Table 2-VI: Installations monitored in situ by VITO

N°	type	capacity	total volume	location	loading
1st year					
A1	SAF (*)	4-6 PE	5200 l	Bierbeek	4 persons (75%)
A2				Bierbeek	2 persons (50%)
A3	AS (**)	2-5 PE	3000 l	Geel	2 persons
A4				Geel	4 persons
2nd year					
B1	SAF (*)	1-5 PE	3300 l	Gierle	2 persons
B2				Brecht	3 persons
B4	BIOROTOR(*)	1-5 PE	Not available	Brasschaat	3 persons
B5				Mol	4 persons

(*) pre-treatment, treatment and settling all integrated in one reservoir, without any other preliminary treatment (eg. septic tank,...)
(**) this unit comprises two separate reservoirs: the first realizes the pre-treatment, the second the treatment (AS) and the clarification.

The systems were followed for about 1 year.

The **FUL** did the monitoring of 5 sites the 1st year and 6 the second year: table 2-VII.
The sampling of the FUL was as follows (see scheme in figure 2-1):

- The influent is stopped in an inspection chamber upstream of the plant and pumped into a cylindrical reservoir (DN 200 mm; L 600mm), placed horizontally, where a sample is taken using a traditional sampler. The pump being activated by the water level in the inspection chamber.
- The water flows from this 1st reservoir into a second (DN 90; L1400 mm) equipped with a Doppler-based flow meter, which steers the traditional sampler in order to realize a 24h flow based composite sample.
- The water coming out of the second reservoir is discharged downstream of the inspection chamber.

Table 2-VII: plants monitored by FUL

N°	type	capacity	total volume	location	loading
1st year: July 2001 – May 2002					
A1	AS (*)	2-5 PE	2000 l	Arlon	5
A2	Grease separator Septic tank Trickling filter	NA	2x560 l 6500 l 1500 l	Arlon	5
A3	Grease separator Septic tank Trickling filter	3-7 PE	560 l 3000 l 1500 l	Arlon	2
A4	Grease separator Septic tank Trickling filter(**)	3-7 PE	560 l 3000 l 1500 l	Léglise	5
A5	Grease separator Septic tank Trickling filter(**)	3-7 PE	560 l 3000 l 1500 l	Libramont	4
2nd Year: September 2002 – March 2003					
B1	SAF	6-9 PE	NA	Bertogne	2 à 12
B2	AS (***)	6 PE	NA	Hallourue	2
B3	Septic Tank Planted gravel bed lagune	NA NA NA	NA NA NA	Wibrin	2
B4	SAF	6-9 PE	NA	Bérismenil	2 à 10
B5	SAF	NA	7200 l	Narcimont	4
B6	AS	NA	4500 l	Transinne	Up to 14
(*) with no other preliminary treatment (**) with recirculation NA: not available					

- The effluent of the plant is sampled in the same way.
- Both traditional samplers are stored in a refrigerator.

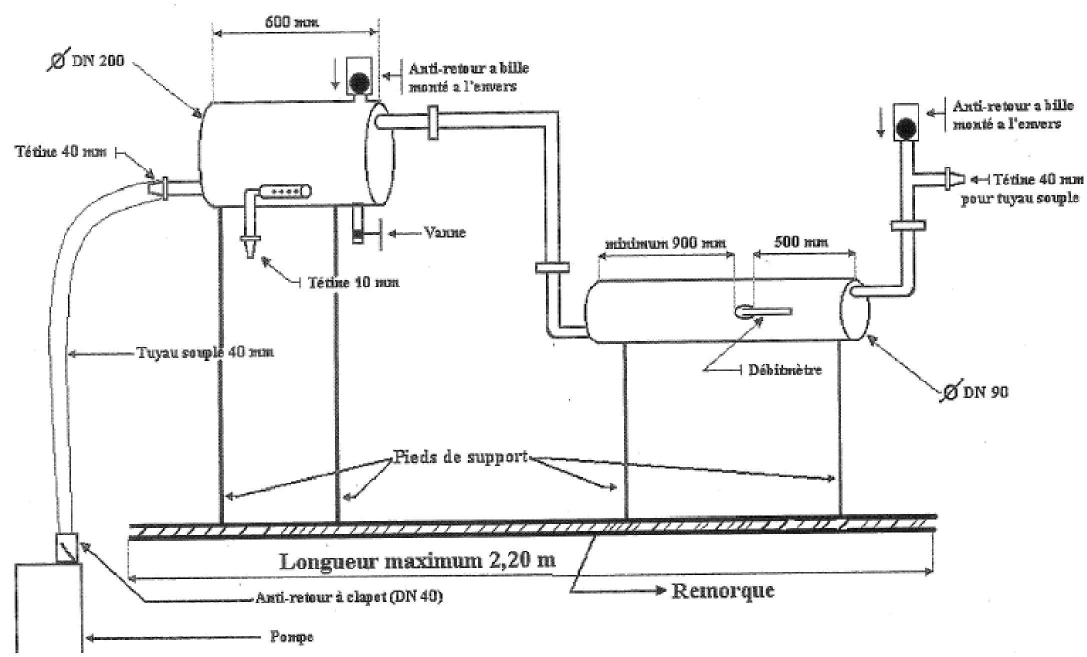


Figure 2-1 : FUL- in situ sampler: flow sheet

The plants monitored in situ by **BBRI**, are given in table 2-VIII. The monitoring was concentrated on the summer of 2003.
BBRI took punctual samples. The influent was taken in the first compartment of the septic tank or the first compartment in case of the compact plants without supplementary septic tank. The effluent was taken near the outlet of the clarification compartment.
The samples are taken using a hand pump connected to a flexible pipe with an external diameter of 25 mm.

BBRI verified also the correlation between punctual samples and 24 hours flow-composite samples. These composite samples, for the influent, were taken as follows:

- The influent is stopped upstream the plant and pumped to a sampler equipped with a double tipping tank (see scheme in appendix 1.3). The water falls in one side of the tank and when it reaches a certain level, the tank tips and discharges its water. Part of this water falls into a storage compartment, the rest is discharged into the plant. Afterwards the same will happen on the other side of the tank, resulting again in a partial accumulation.
- After 24 hours the water accumulated in the storage tank is a nearly flow-based composite sample, from which part can be taken for analysis.

2.4. Evaluating the prEN proposal for assessing the mechanical stability of plants

An analysis was first made of the methodologies proposed in the prEN 12566-3 and compared with those set forward in NBN EN 976-1.

An analysis was first made of the methodologies proposed in the prEN 12566-3 and compared with those set forward in NBN EN 976-1.

Table 2-VIII: plants monitored by FUL

N°	type	capacity	total volume	location	loading
1	SAF ©	6 PE	4400 l	Bierbeek	4
2	SAF ©(*)	6	4200 l		4
3	Septic tank AS Settling tank	6	2000 l 2000 l 2000 l		4
4	Septic Tank SAF ©	6	NA 4900 l		2
5	Biorotor	7	4000 l		2
6	Septic Tank AS Settling tank	5	1250 l 1250 l 1250 l		4
7	Septic Tank SAF ©	NA 5	NA 2700 l	Bierbeek	2
8	Septic Tank (Emscher) Trickling filter Settling tank	6	4500 l D 2.23 H 2.4 2000	Bierbeek	3
9	Septic Tank SAF ©	NA 6	NA 4900		1
10	Septic Tank SAF ©	NA 6	NA 4900		4
11	Septic Tank SAF ©	NA 6	NA 4000 l		4
12	Septic Tank SAF ©	NA 6	NA 4900 l		4
13	Septic Tank Gravel filter (**)	NA 7	6000 l 2.75*1.6*0.73m		2
14	Septic Tank AS ©	NA 6	NA NA		2
15	SAF + AS ©	5	3000 l		5
16	Septic Tank SAF ©	NA 7	NA 4900 l		4
17	SAF ©	7	4700 l	Dilbeek	4
18	SAF ©	7	4700 l	Ittre	4

© : this plant combines, within one reservoir, a pre-treatment, the treatment (SAF, AS,...) and a settling or clarification treatment; these plants are also called "compact systems or plants".
(*): sludge support is composed by plastic cylinders (D 20 mm H 20 mm) floating in the water
(**): a horizontal filter filled with special gravel (L 2.75m B1.6m H 0.73m)

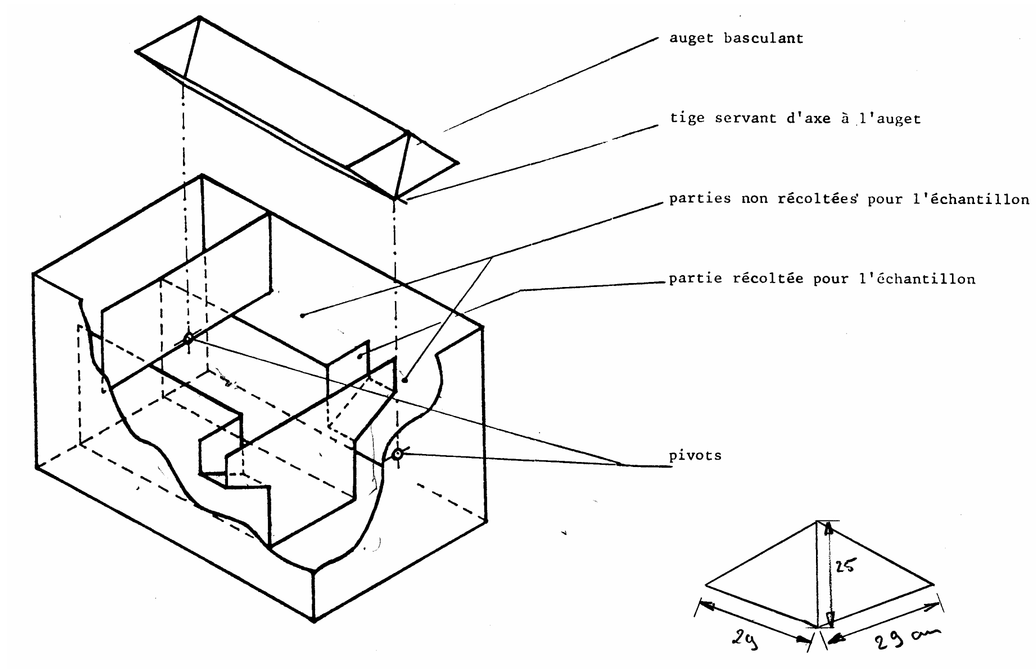


Figure 2-3 : BBRI-in situ sampler: tipping tank

2.5. Proposals for improving the prEN 12 566-3

The research findings were communicated directly to the CEN working group in charge of the finalisation of the standard prEN 12566-3. However in order to give these comments an official Belgian character, a mirror committee was created at the Belgian standardisation institute IBN/BIN, in which all research partners participated.

3. RESULTS

3.1. Making operational a test rig

From the analysis of the prEN, the review of the literature and some preliminary testing, it follows:

- That the daily flow profile set forward in the prEN is somewhat differing from the profile that comes out of field measurements, done on sanitary hot water consumption in dwellings. But it is probably quite near to reality.
- That this prEN inflow profile gives the impression that the plants have to be fed with water by a continuous flow rate, although in the given applications the flow is highly unsteady and much more impulse-like. This explains the fact that from the 3 partners involved, 2 adopted a continuous flow rate and only one (BBRI) an impulse-like feeding.
- That there is however no need to realize a real washing of clothes in order to simulate the discharge of this kind of water: the quality of the waste water from a washing machine, is the same as that of clear water to which a normal amount of detergent is supplied, as far pH, COD and P-PO4 are concerned: see Table 3.1-I.
- That the waste water quality specified is in fair good agreement with data provided by different authors, only the BOD seems to be somewhat lower.

Interesting criteria which are not addressed in the prEN are:

- Noise level,
- Requirements on the accessibility of the equipment inside the plant for maintenance and reparation,
- Requirements on the presence of systems providing an alarm signal when the plant is malfunctioning,
- Requirements on the availability and content of the technical specifications of the plant and of a user's and maintenance manual.

Table 3.1-I: Quality of washing machine effluent (CEBEDEAU)

	Test 1		Test 2		Test 3	
	Washing machine	Com-pound	Washing machine	Com-pound	Washing machine	Com-pound
Detergent (g)	238	238	85	85	124	124
Softener (g)	0	0	40	40	0	0
Water volume	87	87	45	45	59	59
Laundry (kg)	3.5	0	?	/	4.5	/
Setting temperature (°C)	40	/	60	/	90	/
Measured temperature (°C)	31	/	?	/	75	
pH	10.2	10	7.5	7.7	9.6	10.1
COD (mg/l)	1080	1765	1230	1980	695	565
P-PO4 (mg/l)	4.5	4.5				
Detergents (mg/l)	185	185	180	140	/	/

3.1.1 VITO

The scheme of the test rig of VITO is indicated in Figure 3.2-1.

The wastewater of a "Club House" (restaurant/hotel) on the VITO-site is collected into the buffer tank 1. This tank is needed in order to overcome the week-end, period during which the Club House is closed. Water from this tank 1 is pumped into a buffer tank 2, where the quality of the water is corrected for the suspended solids, using septic material from septic tanks, stocked in buffer tank 3. Hereto the turbidity is measured in tank1. From tank 2 the waste water is pumped to the test rig according to the daily base inflow profile given in table 2-I.
The steering of the process and of all other peripheral equipment (e.g. the boiler for the hot water for simulation of the washing machine discharge,...), is brought together in a prefabricated concrete cellar ("kelder"). The effluent from the plant tested ("Test KWZI"), is evacuated by pumping.
Photo 3-1 gives a view of the VITO test rig.

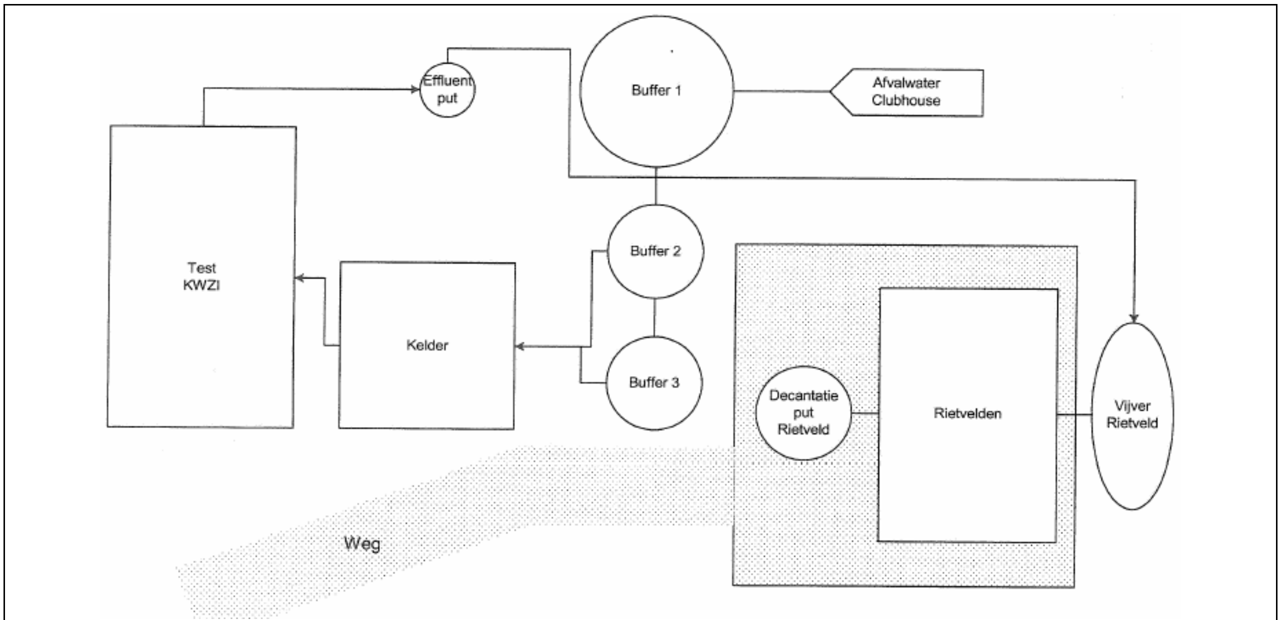


Figure 3.1-1: scheme of the VITO test rig

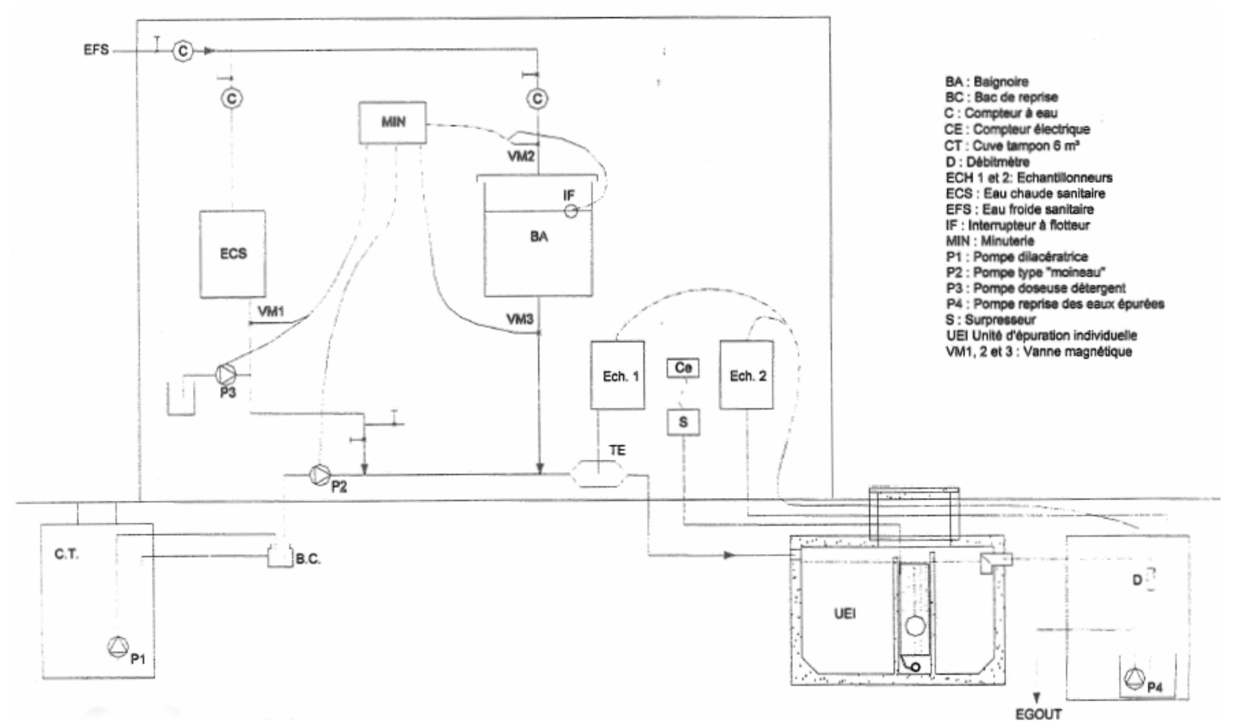


Figure 3.1-2: scheme of the CEBEDEAU test rig

3.1.2 CEBEDEAU

CEBEDEAU implemented their test rig at the site of an electrical power station, getting waste water coming from showers, wash tables, WCs and from a cafeteria. The scheme of the test rig is given in Figure 3.2-2. The waste water of the power station is collected in a buffer tank CT, from where it is pumped (P1) into an intermediate reservoir (BC). Water is pumped out of BC by a pump P2, and fed into the plant UEI. The pump P2 is steered by the regulator MIN, such that the daily base inflow profile is realised. The water discharged by the plant UEI is collected in a reservoir, from which it is pumped (P4) to the sewer. The flow coming from the plant is measured by the meter D. Composite samples (24 hours) are taken by the samplers Ech1 and Ech2. The central regulator (MIN) also commands the discharge of hot water from the boiler ECS (simulation of the washing machine) as well as the discharge of the 150 l cold water (simulation of a bath discharge). Water meters (C) measure the consumption of clear water. The different apparatus are localised within a container (photo 3.2).

3.1.3 BBRI

The scheme of the BBRI test rig is given in Figure 3.2-3. The working is as follows:

Wastewater from an office building (B) is pumped (P1) to a buffer tank R2, where its characteristics are corrected (feeding of clear water through tank R3) in order to meet the required quality.

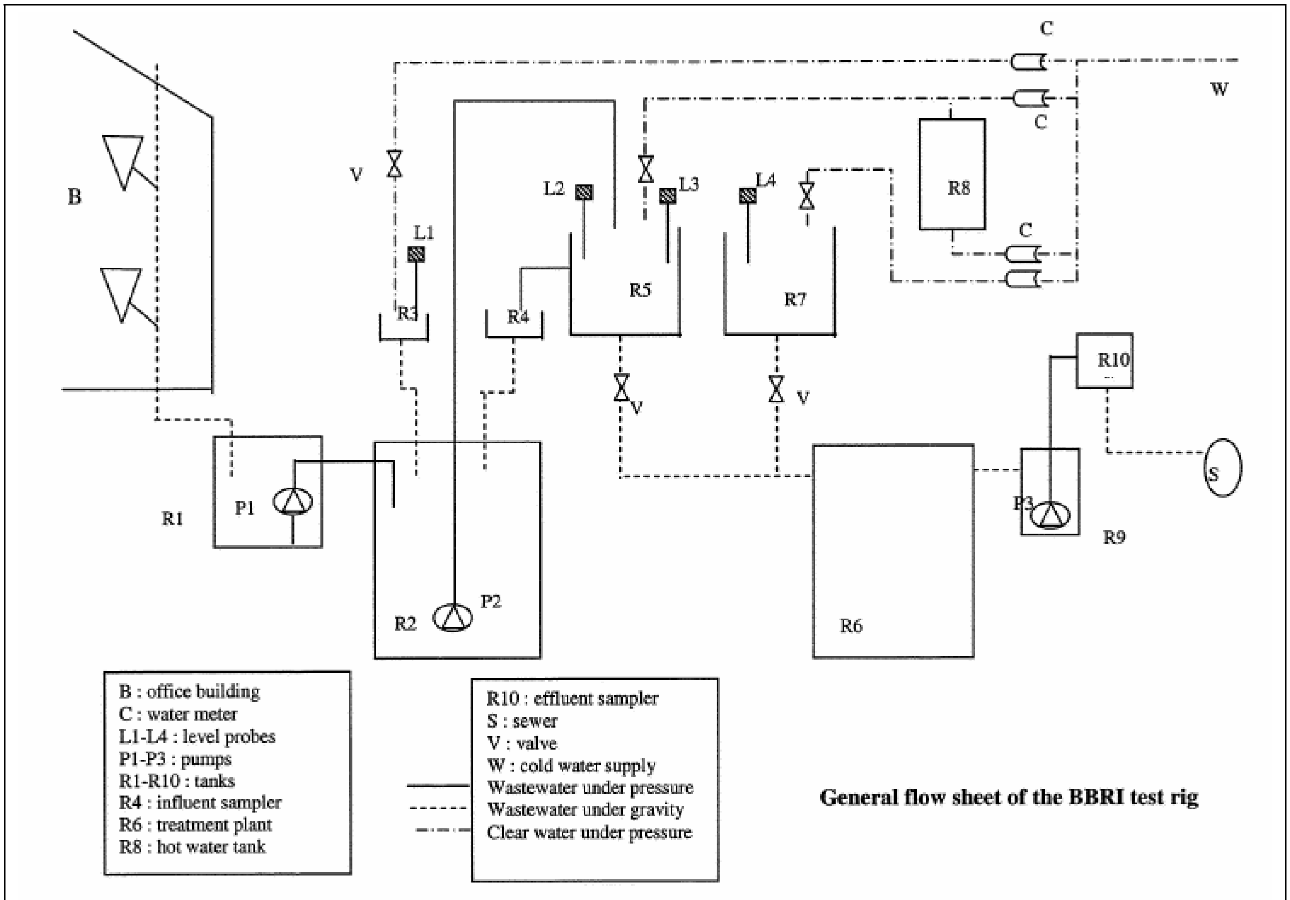


Figure 3.1-3 : Flow sheet test rig BBRI

Eleven liters of this corrected wastewater is pumped – P2- to tank R5. A timer and the level probe L2 control the working of the pump P2. One liter of this wastewater is drained to the influent sampler R4, the remaining 10 l are discharged by gravity to the treatment plant R6. Successive fillings and discharges of the tank R5, allow realizing the influent volumes specified in prEN 12566-3, for the different periods of the day.
The discharge of the washing machine is simulated by filling tank R5 with 16.5 of hot water from the hot water vessel R8. Of this water 1.5 l is first drained to the sampler R4, the rest is discharged to the plant R6. Afterwards a discharge of 15 l clear cold water is repeated 4 times. The discharge of the bath is simulated by empting 200 l clear cold water from the tank R7. The effluent of the plant R6 is evacuated by gravity to a tank R9. From this the water is pumped (P3) over the sampler R10 to the sewer.
Samplers R4 and R10 constitute a composite sample by accumulation of 10% of the volume of water fed to the plant or leaving the plant. From these samples an appropriate volume is taken for analysis, after 24 hours. A view on the container of the test rig is given in photo 3-3.

3.2 Evaluating the prEN treatment efficiency procedure for laboratory testing

3.2.1 VITO

VITO evaluated on two plants this prEN procedure: an activated sludge system (AS Vit01), during a first year and a submerged aerated filter (SAFVit02 - cfr. §2.2) during a second year. From this evaluation the following can be remembered:

3.2.1.1 Influent

The Table 3.2-I gives an overview of the influent characteristics at the VITO test facility. Except for the BOD-values in the case of the SAF, the composed influent satisfies in the mean the requirements of the prEN.
It is thus quite possible to create waste water for testing according to the proposed methodology, even in case the waste water is not coming from households.

Table 3.2-I

parameter	**mean**		**minimum**		**maximum**		**prEN**
	AS Vit01	SAF Vit02	AS Vit01	SAF Vit02	AS Vit01	SAF Vit02	
CODt (mg/l)	770	660	530	430	1060	830	300-900
NH4-N (mg/l)	53.6	43	38.1	27	63.6	63	23-68
BOD5 (mg/l)	283	121	141	65	588	176	150-450
SS (mg/l)	280	339	160	183	750	455	188-563
P-total (mg/l)	13.5	11.3	10.6	8.3	15.5	14.1	5-15

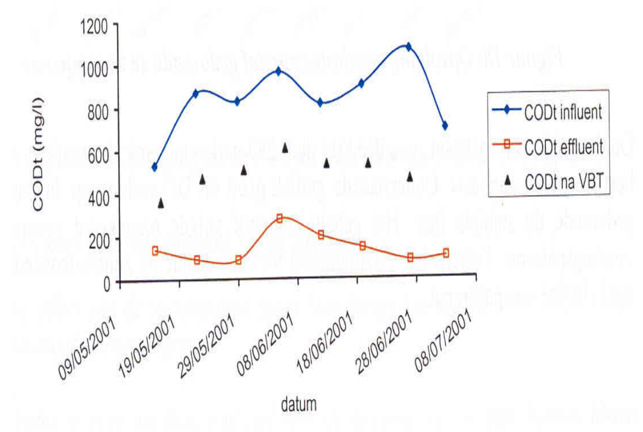
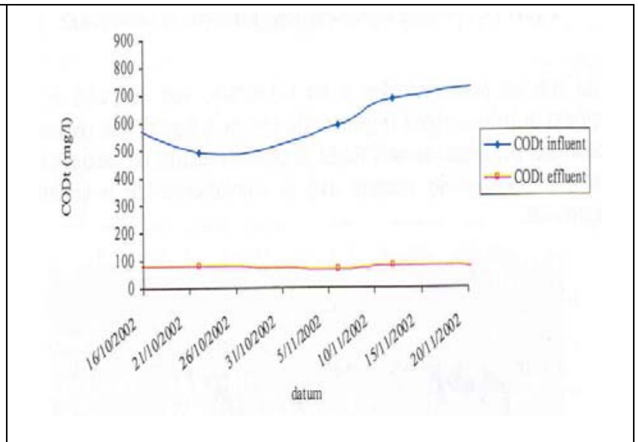
3.2.1.2 Starting up the plant

In both cases the plants were inoculated with 500 l activated sludge, coming from a collective waste water treatment plant. The analysis of the effluent on COD and NH4-N showed stabilisation after 4 weeks for the AS and 6 weeks for the SAF, so that the testing could be started.
This shows that the starting-up period can be limited by an appropriate inoculation. In this context it would be practical for the testing laboratory that the manufacturers specify the steady values to be awaited for these two parameters;

3.2.1.3 Steady state periods

Figure 3.2-1 indicates the quality of the influent and effluent –expressed by the CODt parameter- during some steady state periods for the AS and the SAF. It's obvious that maintaining long periods of steady state working

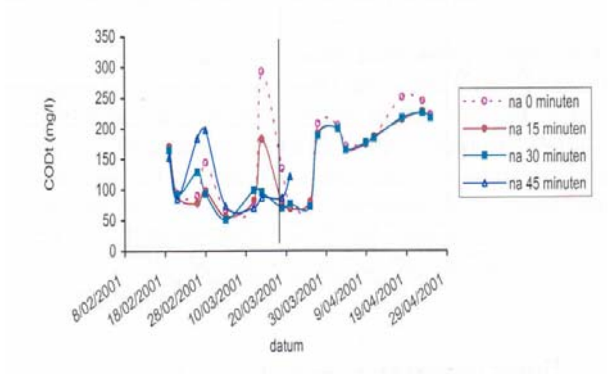
- is not generating any supplementary useful information on the plants efficiency
- and is not necessary for the "recovery" of the plant from past stress tests.

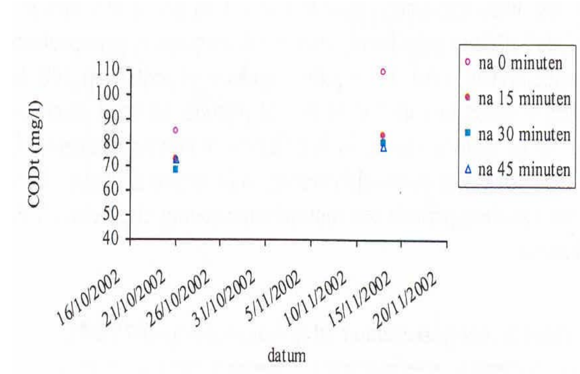
	
COD of influent and effluent of the AS Vit01 during the 2nd steady state period	COD of influent and effluent of the SAF Vit02 during the 2nd steady state period
Figure 3.2-1	

This means that the multitude of "6-week steady state periods", foreseen in the draft standard (annexe 1-table B2a), are not needed. It suffices to have one long period of steady state working, in order to be able to evaluate the normal performance of the plant. The length of the recovery periods, after the stress tests, should however be left to the appreciation of the testing lab, based upon the results of the water analyses.

3.2.1.4 Washing machine discharge

The different versions of the draft EN were not all even clear on whether samples had to be taken after the washing machine test: in the version of 1997 this was not required, but in the version of 2000 some confusion was introduced. VITO proposed to do a sampling, i.e. to take every 2 week, after the washing machine discharge, 4 samples each being taken at 15 minutes interval; the first just after having finished the discharge.
The results for the COD parameter are presented in Figure 3.2-2. It is clear that the 1st sample differs from the other: the measured values are higher, this as well for the AS as for the SAF. The fact that the following samples show diminishing values indicates that the effect of the washing machine discharge is very limited in time and would probably be subdue in a 24 h composite sample. This then also rises the question how to interpret this punctual values.
The suggestion would be to keep this kind of discharge within the weekly inflow profile of the plant, but without doing any sampling on it and to make that much more clear in the standard.





COD of effluent of the AS Vit01 after washing machine discharge	COD of effluent of the SAF Vit02 after the washing machine discharge

Figure 3.2-2

3.2.1.5 Bath discharge

After a bath discharge the following sampling is requested:

- In the prEN version of 1997:
  - o to take 4 samples, starting immediately after having finished the discharge
  - o the time between 2 samples being 15 minutes,
  - o only one bath of 200 l had to be discharged .

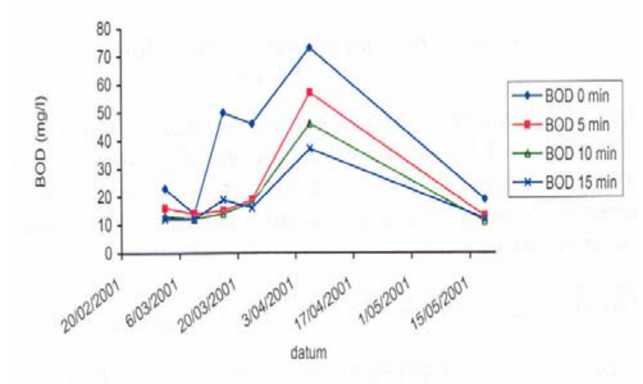
  This procedure was followed for the tests on the AS VITO 01.
- In the version of 2000 of the prEN, the requirement was somewhat changed:
  - o the discharge of 2 baths, was requested by feeding the plant for 2x3 minutes with a flow rate of 4000 l/h,
  - o the 4 samples had to be taken at 5 minutes interval.

  This procedure was adopted for the tests on the SAF Vit 02.

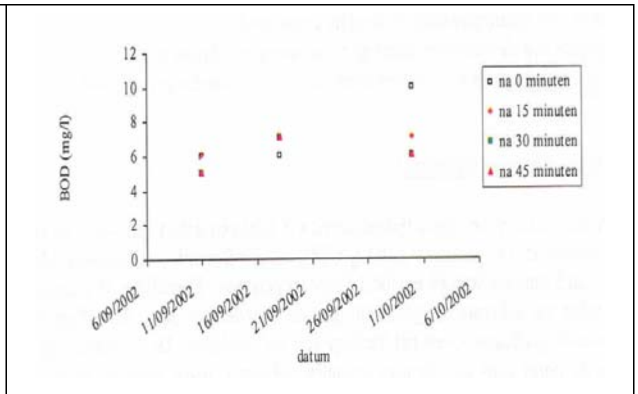
The results of the analysis of these samplings are given in the Figure 3.2-3 for the BOD parameter. They lead to the following comments:

- Also here it is the first sample that shows the most extreme values; the following samples have lower values, even at a 5 minutes time interval, indicating the limited effect in time of the test. Again one can suppose that the effect would be subdue in a 24 h composite sample.
- The effect can certainly also be illustrated by limiting the number of samples, e.g. to 2 instead of 4.
- There is no need to redo this kind of sampling on a regular base, as could be understood from the prEN: 1 or 2 of such samplings over the whole test period do generate enough information on the behaviour of the plant, no need to redo this for instance every 3 months. But the question remains also to know what to do with this information, given the fact that all other samples are taken as 24 h composite samples. This sampling seems to be questionable.

Finally it seems to be unrealistic to discharge 2 baths of 200 l after another for little plants i.e. with a nominal flow of only 601 l/day: the requirements of 2000 should be reconsidered.



BOD of effluent of the AS Vit01
after bath discharge: 1x200 l

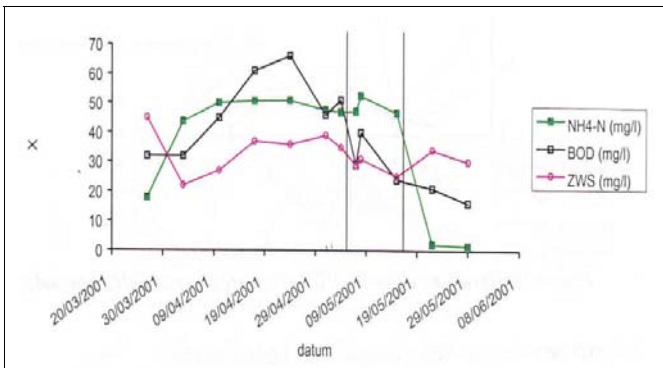


BOD of effluent of the SAF Vit02
after the bath discharge

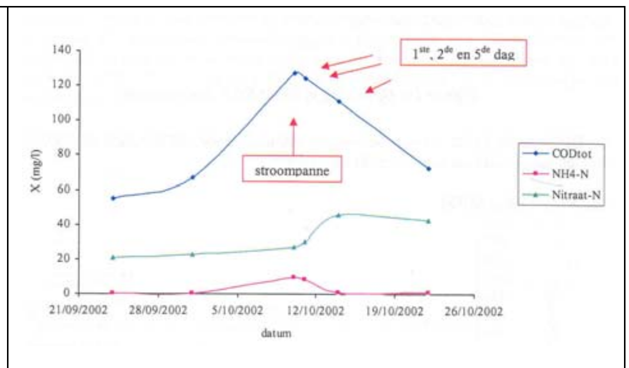
Figure 3.2-3

3.2.1.6 Power breakdown

The results of the analyses after power breakdown are illustrated in Figure 3.2-4 below.
For the SAF the effect of stopping the input of air is quite clear in the rise of the COD value and the drop in NH4-N. The results for this plant indicate also that the plant was not jet fully recovered after 2 weeks. The 2 weeks foreseen in the pr EN for this test are thus not sufficient if recovery is aimed at and better would be to leave the length of the recovery period over to the testing lab.
For the AS the results are less clear because the plant was in fact not working well at the moment of the power breakdown: one of the air diffusers was already out of working. This leads to the conclusion that the power breakdown test shall only be done when the plant s is working well. This conclusion rises also the remark that the standard actually does not give any guidance on how to handle plants which obvious do not work well and where the continuation of the tests will not provide any usable information.



effluent of the AS Vit01
after power breakdown



effluent of the SAF Vit02
after power breakdown

Figure 3.2-4

3.2.1.7 50% nominal load

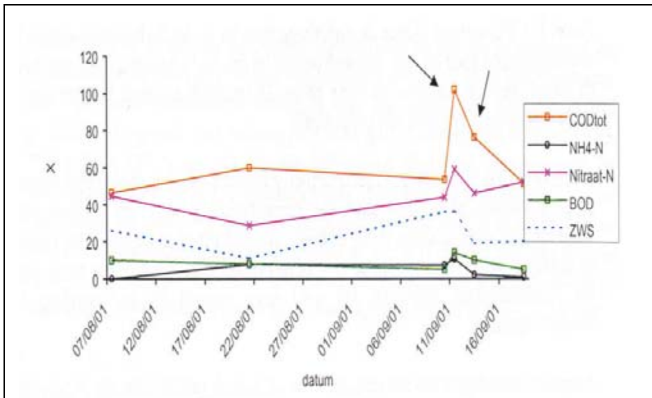
No specify findings are to be reported with respect to this test (for both plants), besides the fact that the requirement to conduct the 200% loading immediately after doesn't allow to appreciate the effect of the reduced loading on the behaviour of the plant.

3.2.1.8 200% nominal load

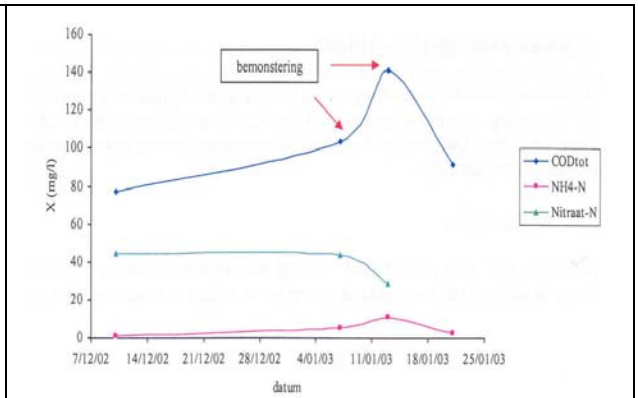
As indicated above it has to be recommended to have a sufficient steady state period before conducting this stress test in order to be able to evaluate correctly its effect on the working of the plant. No others comments have to made with respect to the pr EN proposal.

3.2.1.9 Low occupation period

The effluent characteristics after a period of holidays (=no water discharge) are given in the Figure 3.2-5. Also here it has to be recommended that this test must be done after a steady state period and not immediately after the 200% stress test.
In the case of the testing of the SAF the behaviour of the plant could also have been influenced by the sudden cold environmental temperatures, which lowered considerably the temperature in the plant (the plant was –for testing reasons- no well buried into the soil). The standard must throw attention to the fact that when doing this holiday test, a period with not to much varying temperatures should be looked for.



effluent of the AS Vit01
after low occupation



effluent of the SAF Vit02
after low occupation

Figure 3.2-5

3.2.2 CEBEDEAU

3.2.2.1 Influent

The Table 3.2-II gives an overview of the influent characteristics of the influent available at the CEBEDEAU test rig. The quality of the used wastewater falls within the range specified in the prEN for all considered parameters. Again is illustrated that a waste water different from households can be a source for conducting the tests according to the draft standard.

Table 3.2-II

parameter	Cebedeau test rig	prEN
COD (mg/l)	830	300-900
NH4-N (mg/l)	40	23-68
BOD5 (mg/l)	395	150-450
SS (mg/l)	425	188-563
P-total (mg/l)	8	5-15

3.2.2.2 Verification of the capacity of the aerator

Most of the plants considered rely upon a biologic treatment in aerobic conditions which are generally realised by blowing air into the water. The quantity of oxygen available in the biological compartment must be in relation with the nominal loading of the plant. In case an insufficient quantity of air is blown in, the testing of the plant on a test rig, during nearly one year would be a complete loss of money and time. Therefore CEBEDEAU measured, before starting the test on the rig, the aeration capacity of two plants : SAFCeb01 and ASCeb02 (§2.2). Hereto the plants were filled with water, from which the oxygen was then removed using sodium sulphur. The blowers are then started and the variation of oxygen content of the water is measured: Figure 3.2-6. From these measurements the "standard oxygen transfer rate (SOTR)" (kgO2/h) can be deduced:

$$SOTR = k_La_{10} . C_{S,10} * V$$

Where:

$k_La_{10} = k_La_T * 1.024^{(10-T)}$: transfer coefficient at 10°C

$k_La_T = \ln(C_S - C_o) - \ln(C_S - C)$ ➔ to be deduced from the measurement

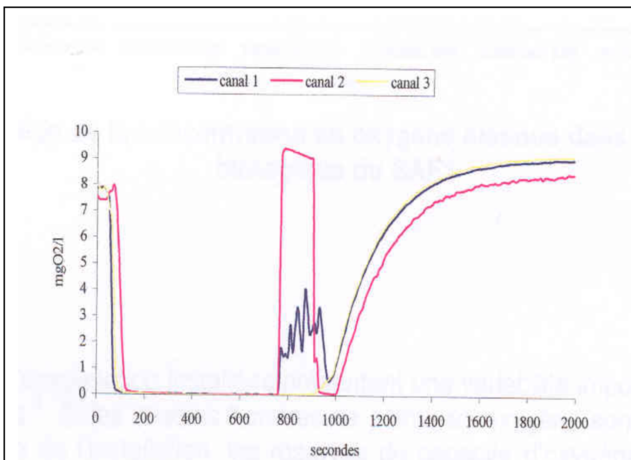
$C_{S,10} = C_{S,T,p} * (C_{S,ST,10}/C_{S,ST,T}) * (1013/p)$

P : atmospheric pressure at the moment of measuring

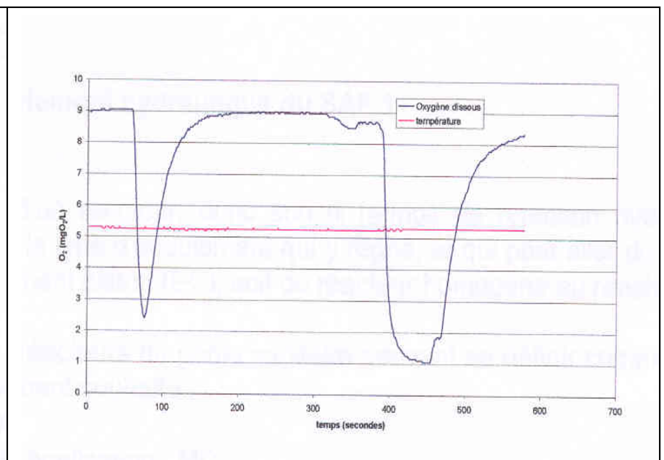
T : water temperature in (°C) at the moment of measurement

$C_{S,T}$: oxygen saturation concentration at T °C

V : the volume of the compartment in which the air is blown (m³).



Aeration measure of SAF Ceb01



Aeration measure of AS Ceb02

Figure 3.2-6

The established SOTR is a “clear water”-capacity. When the plant is loaded however, the capacity falls back to about 50% of the SOTR. So, if the plant wants to have some change to give good results on the test rig, 0.5 SOTR must at minimum be above the theoretical capacity needed for the oxidation of the waste water leaving the preliminary settling treatment (septic tank), i.e. some 10.66 gO2/h.EP. The results for both plants are given in Table 3.2-III.

Table 3.2-III

parameter	SAF Ceb01	AS Ceb02
SOTR (gO2/h)	190	440
EP	9	10
Total theoretical oxygen required: 9.1*EP (gO2/h)	96	106.6

In both cases the capacity of the aerators seems to be satisfactory and the testing on the rig can be meaningful. It is obvious that the capacity in reserve is not the same in both cases: problems with the aerators will lead much more rapidly to problems in the case of the SAF Ceb01.
It seems that the standard should take on board this quite simple test, which would allow to avoid to start expensive tests on plants with an insufficient oxygenation capacity.

3.2.2.3 Hydraulic behaviour of the plant

The performance of waste water treatment plant is not only linked to their good aeration, also their hydraulic behaviour is an important element. The hydraulic quality of a reactor can be characterised between others by:

- its equivalent number n of reactors with complete mixing, placed in series: the higher the number, the more the flow in the plant will be near to a piston-like flow, as requested in the settling and clarification compartments of the plant,
- its retention time,
- its dead zones,
- the existence of short circuits,
- …

These parameters can be deduced when conducting a hydraulic test whereby

- a flow is created through the reactor (=plant),
- introducing in the flow, at the beginning of the test, punctually a tracer,
- the concentration of the tracer is monitored at the outlet flow of the reactor (plant),

In such a test the considered outlet concentration responds to the following relation:

$$Cn = Co *[(n^{n} * t^{n-1})/((n-1)! * tth^{n-1})]*e^{(-n*t/tth)}$$

Where:

n: is the number of completely mixed reactors
Cn : the concentration at a certain time
Co the initial concentration of tracer in the flow
tth: the theoretical retention time, i.e. the water volume of the plant divided by the mean flow rate through the plant.
t: time

Fitting the above curve to the measured points (figure 3.2-7)allows then to identify the characterising parameters. For the SAF considered, this gives the following for the whole plant (i.e. “sortie UEI”:

- n = 2.4; i.e. a small number of completely mixed reactors in series, which means that the plant behaves merely like a fully mixed reactor, although its first and third compartment are settling compartments. This implies that the settling- efficiency of these compartments is low.

- tth = 12h 56

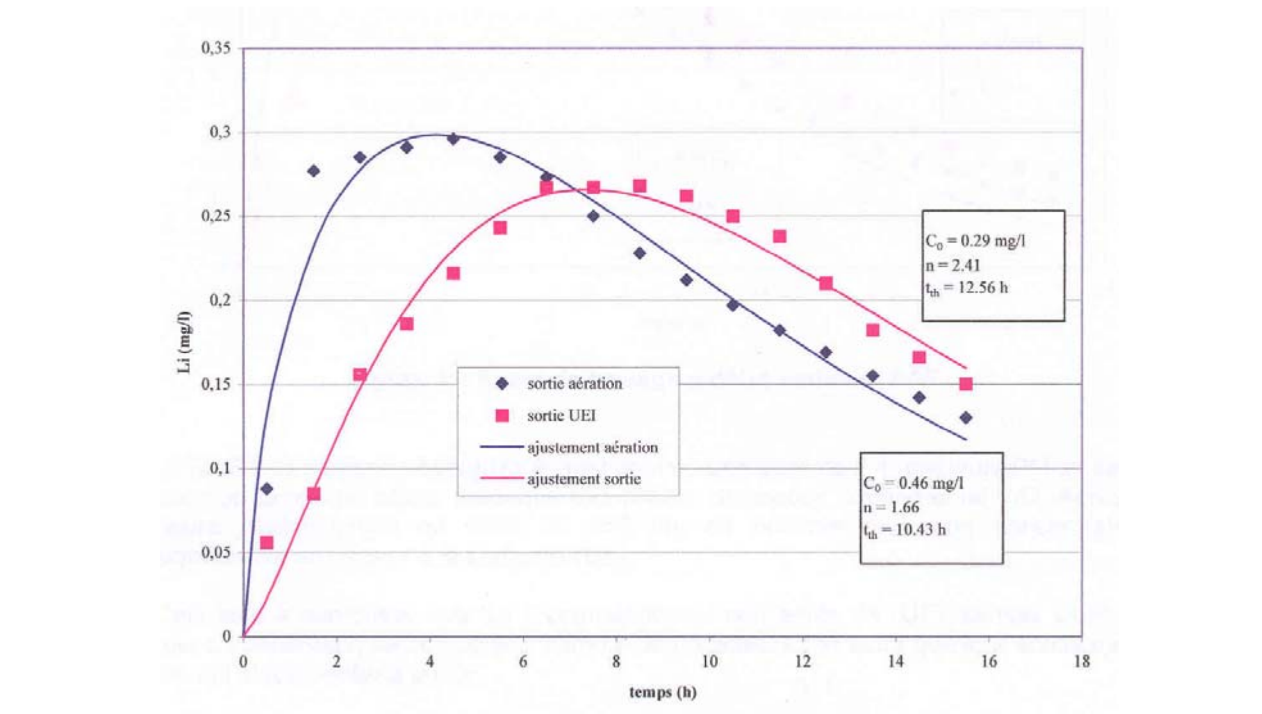


Figure 3.2-7 hydraulic response of SAF Ceb01

CEBEDEAU did the same kind of measurements in order to evaluate the hydraulic transfers within the plant itself. Hereto the tracer was injected in the aerated compartment and while the plant was submitted to the prEN daily flow profile, the concentrations in the 1st and 3rd compartment being measured. The results are represented in Figure 3.2-8. It is remarkable to notice that the tracer is also communicated to the first compartment, which indicates leakages between the both compartments.

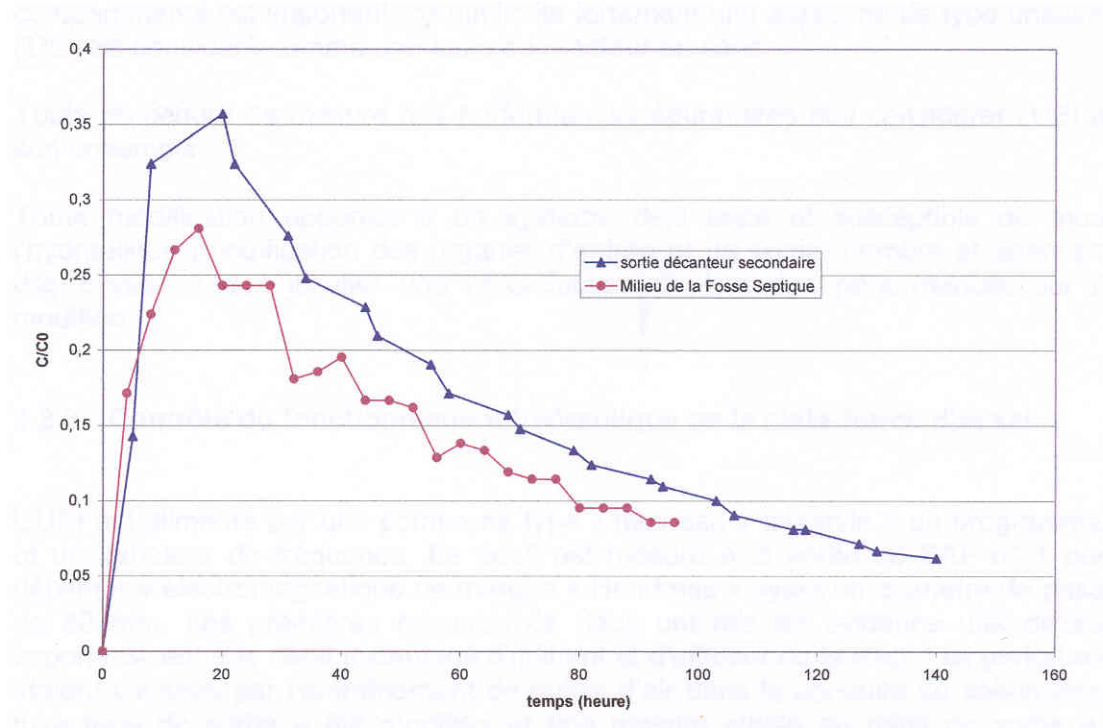


Figure 3.2-8 SAF Ceb01: transmission between compartments

From these tests it is clear that a lot of indications are generated on how the plants efficiency. Given the fact that this hydraulic test is easy to realise it is suggested that also this test should be taken up in the standard.

3.2.2.4 Variation of the temperature

CEBEDEAU measured the temperature in the biological compartment of the SAF Ceb01. The result of this monitoring is indicated in Figure 3.2-9.
As can be seen the temperature variation can be important: up to 13.5°C, between 11.5 and 25°C, even although the plant was buried into the soil. This stresses the need for having a system tested in the conditions in which it will normally be used. This aspect is not sufficiently addressed in the prEN.

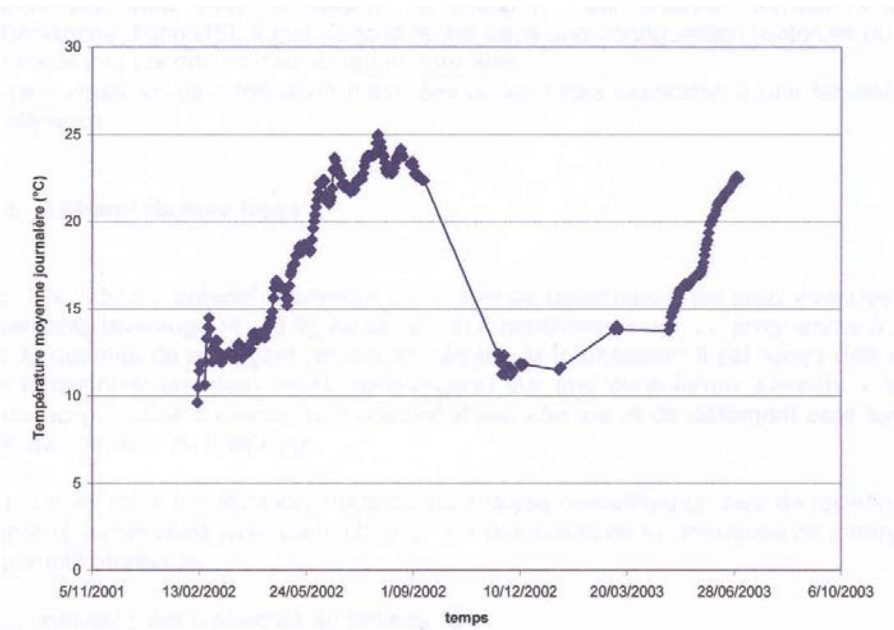


Figure 3.2-9 SAF Ceb01: temperature variation.

3.2.2.5 Washing machine and bath stress tests

In Table 3.2-IV are given the mean effluent values for the COD and SS parameters for the periods without and with respectively washing machine and bath discharges (see table 2-IV for the CEBEDEAU test scheme). These results refer to 24h composite samples. As can be seen the effect of these stress test is negligible on the treatment efficiency. This confirms in fact the limited effect seen by VITO. There is thus no need to monitor these stress tests frequently.

Table 3.2-IV: mean effluent values at the outlet of the plant

	period	SS (mg/l)	COD (mg/l)
Before adding septic tank sludge	Reference	15	55
	Washing machine	18	52
	Bath	8	29
After adding septic tank sludge	Reference	55	169
	Washing machine	49	126
	Bath	65	153

3.2.2.6 Effect of adding septic tank sludge in the first compartment of the plant

During the working of the plant there is an accumulation of sludge in the first compartment of the plant. As the maintenance frequency of the plant is often once in 2 years, an evaluation -even over 52 weeks- will not address the effect of the sludge accumulation on the treatment efficiency. In order to simulate this accumulation CEBEDEAU brought 1 m³ of septic tank sludge in the first compartment of the SF Ceb01(see table 2-IV). Together with the sludge already accumulated this volume they created a sludge volume corresponding with one full year working.
The effect of this intervention is important:

- more than 2 weeks are needed in order to come back to a steady situation;
- but anyhow, there is a clear degradation of the treatment performance: see Table 3.2-IV.

This illustrates clearly that the method of evaluation has to take into account the accumulation in time of the plant. The prEN method has to be modified accordingly e.g. by prescribing the adduction of septic tank sludge as was done here.

3.2.3 BBRI

3.2.3.1 Influent

In the actual standard proposal it is not clear how to calculate the daily base flow: the fact that the washing machine and bath discharges are defined separately as stress tests, do give the impression that they are to be considered as a supplement. This doesn't correspond to reality and BBRI therefore suggested to define more clearly the daily base loading (Vo) going out from the weekly loading :

$$7x\ Vpe \times PE = 7xVo \times PE + 200 \times Nbt + 2 \ x7\ 5 \times Nwm$$

giving:

$$\mathbf{Vo = (7x\ Vpe \times PE - 200 \times Nbt - 2\ x7\ 5 \times Nwm)/(7 \times PE)}$$

where:

PE : is the number of population equivalent, i.e. 5 for the plant tested

Vpe : is the volume of wastewater produced by 1PE (population equivalent) in one day. In Belgium a value of 180 l is hereto considered since the early seventies of last century. But the actual water consumption in households is only 120 l/day and per person in Belgium, so that testing with 180 l/PE. day seems to be an unrealistic loading, certainly if one wants to be able to compare with test results gained in situ. However in order to have some "reserve" a value of 150 l/PE.day was adopted for the testing on the test rig. Note: it is this volume Vpe which has to respond to the quality requirements of the prEN!

Vo : the daily "base loading" according to the standard, i.e. the volume of real waste water needed to realise a total influent volume of Vpe; to be calculated from the equation above.

Nbt : number of baths (200 l of cold drinking water) to be discharged once a week; Nbt= 2, for the plant to be tested by BBRI

Nwm : the number of washing machines (75 l: 15 l hot water (80°C) and 60 l cold drinking water) to be discharged twice a week; Nwn= 2, for the plant tested by BBRI

In case of a plant like the one tested by BBRI, with a capacity up to 5 PE, the daily bas loading par PE becomes then:

Vo = 130 l/PE day

The quality of this water is indicated in table 3.2-V. The quality of the plants' influent can the easily be calculated, given the clear water complements from the washing machine and bath discharges: table 3.2-V. As can be seen from this table, the ratio of COD is BOD is too high, around 3.5, indicating that this water contains probably a lot of chemical products. The waste water used for the influent, is collected from an office building with only water coming from the use of WCs and wash tables and from cleaning activities. The high COD level is probably the result of the daily office cleaning activity by a special firm. The influent of the BBRI test rig was thus not fully in compliance with the pr EN requirements (table 3.2-V).

One can conclude from this that composing a correct influent going out from a source which comprises only some of the household activities is not always that simple.

Table 3.2-V: BBRI test rig :mean influent values

	COD	NH4	BOD	SS	P tot
	mg/l O2	mg/l N	mg/l O2	mg/l	mg/l P
BBRI: daily loading water					
min	825.0	38.5	260.8	328.0	6.3
max	2256.0	72.0	560.9	1572.0	23.1
mean	1251.2	55.5	373.2	650.4	15.4
st.dev.	627.8	9.4	108.3	469.0	5.4
BBRI: mean calculated influent quality					
mean	1067	47.6	305.6	535.2	12.9
pr EN values					
min	300.0	23.0	150.0	188.0	5.0
max	900.0	68.0	450.0	563.0	15.0
mean	600.0	45.5	300.0	375.5	10.0

3.2.3.2 Hydraulic behaviour of the AS Bbri01 plant

Just like CEBEDEAU (§ 3.2.2.3) BBRI also evaluated the relevant hydraulic characteristics of the plant AS Bbri01. This plant is in fact the plant AS Vit01, which was recuperated by BBRI after the 1 year testing on the rig of VITO.

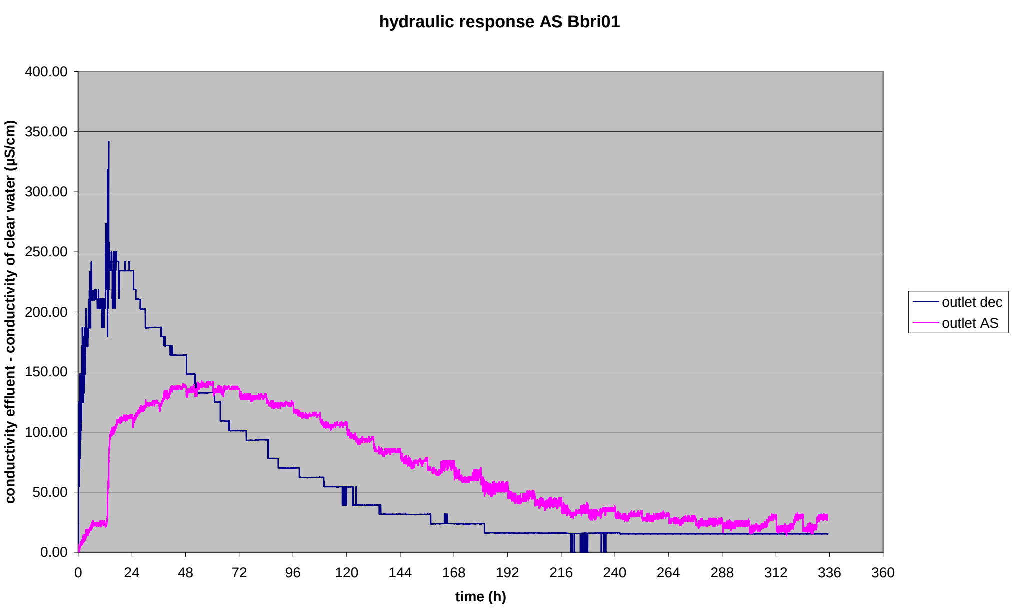


Figure 3.2-10 Hydraulic response of the AS Bbri01

The testing was conducted with a sodium nitrate (Na NO3), by measuring continuously the conductivity at the outlet of the plant as well as on the outlet of settling tank. The figure 3.2-10 illustrates the results of the test and table 3.3-VI groups the main characteristics.

Table 3.2-VI : hydraulic parameters for AS Bbri01						
	n (-)	t_{th}(h)	t_m(h)	t_{mo}(h)	Idz (%)	Icc (-)
Pre-treatment	1.4	64	56	13.63	12.5	0.76
Whole plant	2	128	120	60.30	6.26	0.5

n	number of equivalent completely mixed reactors in series	t_{mo}	time needed to observe the maximum concentration
t_{th}	theoretical retention time	Idz	dead-zone index
t_m	mean retention time	Icc	short circuit index

Although the plant has two settling compartments (one of 2000 l before the biological compartment and one of 1000 l after), the plant behaves mainly as a fully mixed system. Furthermore the short-circuit index is quite high (0.5), so that washing out must be feared at high flow rates. This was noticed by VITO when conducting then washing machine and bath discharge tests. This illustrates that this kind of testing is certainly complementary to the tests foreseen in the prEN. It seems us to be indicated that the usefulness of this kind of tests, which are less costly and shorter in time, should be evaluated in more detail, together with for instance the measurement of the aerator capacity (cfr. § 3.2.2.2).

3.2.3.3 Starting up the SAF Bbri01

The considered plant was initially filled with clear water and then fed with influent. After 2 weeks was started with taking weekly a grab sample at the outlet of the plant.

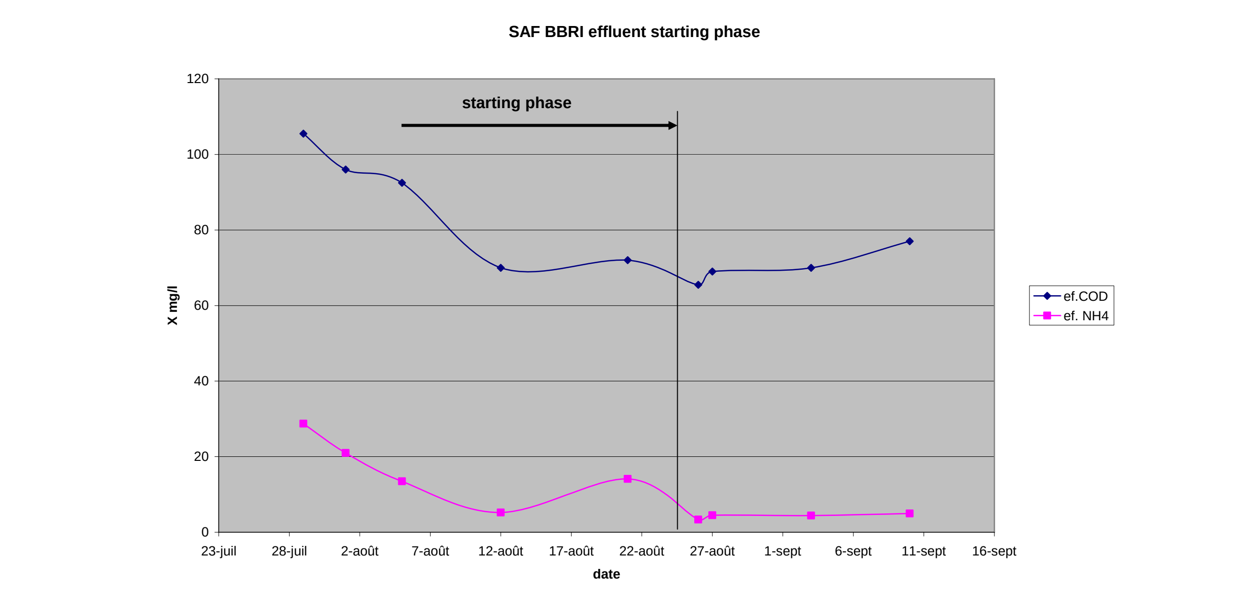


Figure 3.2-11 : SAF Bbri01: effluent quality in the starting up period

This sample was analysed on COD and NH4-N: figure 3.2-11. This allowed establishing when the plant was coming to steady state working, i.e. when the measured parameters tended to stabilize. In the case of the SAF Bbri01 this was after a period of 6 weeks.

Actually the prEN provides no guidance on how to decide when the plant is in working conditions, we suggest that the follow up of the COD and the NH4-N should be monitored on weekly basis and to start the testing once these parameters remain steady over 2 successive weeks.

3.2.3.4 Effluent sampling analysis

In order to evaluate the real need to take composite samples at the outlet of the plant, grab/ composite samples were taken in parallel, at 10 occasions:

the 24h composite sampling was started the morning of the 1st day; the 2nd day, between 8 and 9 in the morning, 1 l of the composite sample was taken and at same time a grab sample of 1l was taken at the outlet of the plant.

Table 3.2-VII gives the results of this sampling.

Table 3.2-VII

comparison between grab and composite samples

	SS	COD	NH4	P tot	BOD
	mg/l	mg/l O2	mg/l N	mg/l P	mg/l O2
24h composite sample					
min	4	66	4.6	7.7	5.2
max	44	120	38	9.9	24.9
gem	26	91.5	21.96	8.92	13.6
st dev	11.51	17.47	12.69	0.66	5.95
grab sample					
min	0	67	4	7.7	4.7
max	28	101	37.7	9.4	20.5
gem	15.2	84.4	23.17	8.63	11.18
st dev	8.39	10.73	12.2	0.65	4.18

It's obvious that the values of the grab samples are well within the variation of the 24h composites. At least for this plant it seems not required to use composite samples at the outlet of the system. There is thus no need to require in all cases the use of 24 h composite samplings.

3.2.3.5 Steady state period

BBRI started the testing at 25/08/03 and allowed a steady state period of about 1 month, i.e. less than set forward in the prEN, but more than sufficient for characterising the behaviour of the plant. As VITO we are convinced that there is no need to require too long steady state periods and we would suggest:

- one steady state period at the beginning of about 1 month, or longer if requested by the testing lab.
- steady state periods after each stress period, the length of these periods should be decided by the testing laboratory.

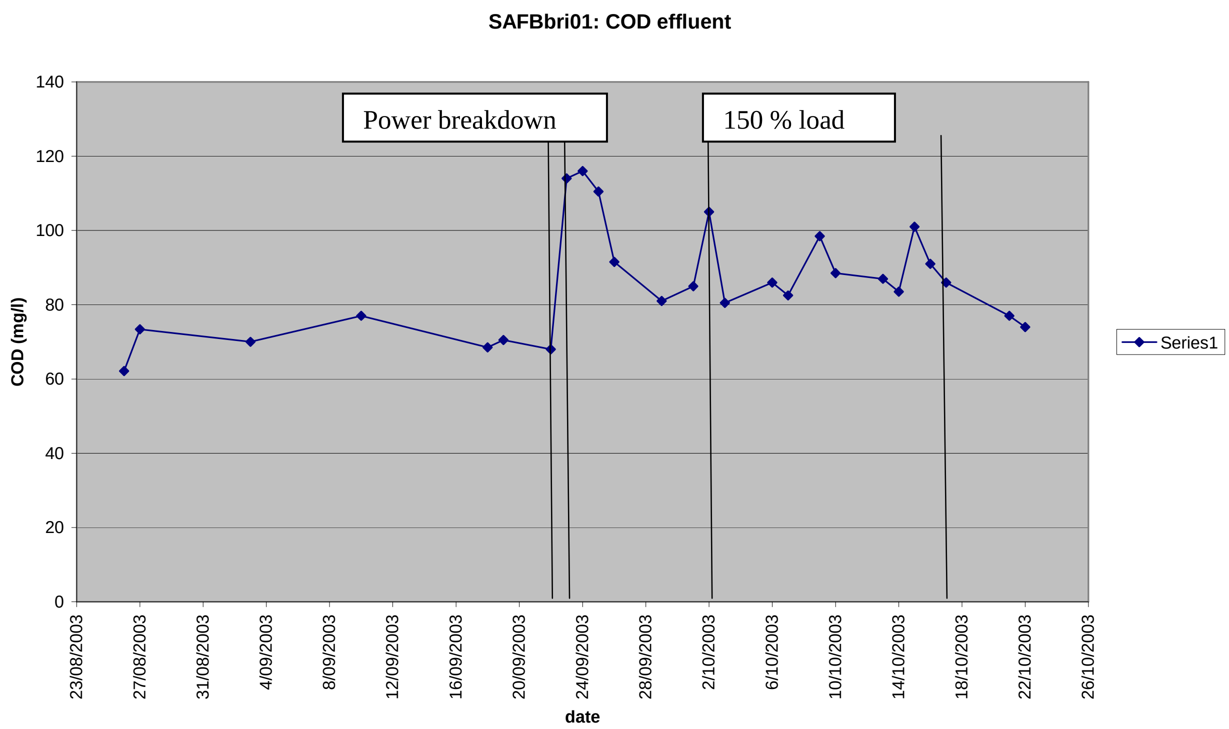


Figure 3.2-12 : SAF Bbri01: effluent quality during testing

3.2.3.6 Stress testing

The first stress test that was conducted was the power breakdown. Immediately samples were taken every day, excepted in the weekend. The effect of the power breakdown can be seen in for instance the evolution of the COD parameter (figure 3.2-12): there is a sudden rise. When the aeration starts again, the recovery also sets in and after a week the plant is nearly back to its initial efficiency. From this moment on further stress testing can in our opinion be considered, allowing shortening the steady state period between two stress tests. But it should be clear that also a longer period of steady state conditions can be decided in case the plant doesn't return to its initial efficiency.

The second stress period was a period of 150 % overloading for two weeks.
The COD of the effluent is also given in the figure 3.2-12.
Remarks:

- the test rig was designed initially for an overload of 125% according to the prEN of 1997, however the version of 2000 adopted an overload of 200%, which the BBRI test rig couldn't realize.
- Probably this second stress test was realised too soon after the power breakdown: the plant was not yet back at its initial efficiency. This implies that if the decision of the length of the steady state period has to be left over to the testing lab, some guidance must anyhow be indicated in the standard, e.g. requesting that the steady state conditions are at least confirmed after a supplementary week with a normal feeding profile.

3.3 Evaluating the prEN treatment efficiency procedure for on site testing

3.3.1 FUL

The sampling methodology as well as the sites sampled by the FUL are described in §2.3.
A main problem with the testing in situ was the lack of accessibility of the plants with respect to placement of the sampling equipment. This problem should be addressed in much more detail in the prEN, as well as in the different national specifications.

3.3.1.1 Influent

Over a period of 2 years 11 plants were monitored by FUL. The parameters indicating the mean quality of the influent found at these sites are indicated in table 3.3-I.

Table 3.3-I : FUL mean influent characteristics on site

INFLUENT		SITES											mean	max	min	prEN		
		1	2	3	4	5	6	7	8	9	10	11				mean	max	min
COD	mg/l	1049	752	928	731	1155	2400	885	309	151	309	566	839.55	2400	151	600	900	300
SS	mg/l	397	239	521	363	345	965	309	306	261	117	98	356.45	965	98	375.5	563	188
NH4-N	mg/l	22	6	28	3	9	51	17	24	2	30	86	25.27	86	2	45.5	68	23
BOD5	mg/l	574	332	452	265	631	826	225	56	84	101	234	343.64	826	56	300	450	150
VOLUME	l/d	750	844	359	620	477	363	343		88	527	211	458.20	844	88			
PERSONS		5	5	2	5	4	2	2.5		1	2.5	1	3.00	5	1			

It is obvious that the variation of the waste water in situ, is greater than foreseen in the draft European standard: all parameters do have extremes lying out of the prEN range. But besides the COD parameter, the mean values are quite near to the European ones. This indicates that the proposed standard values are quite good, but that the variation around the mean might be reconsidered.
This comment however raises a fundamental question, i.e.:

At which loading do the plants have to be tested: at the mean values or at the maximum values?

With the actual regulations in Belgium, where maximum values for the effluent are specified, independent of the quality of the influent, testing with maximum values should be considered in order to be sure in all cases that the plant will satisfy the regulations. Actually this problem is not at all addressed in the standard proposal, nor in the national regulations. Consideration should however be given to it.

3.3.1.2 Effluent

The mean effluent values are given in the table 3.3-II. No specific comments are to be made with respect to the standard.

Table 3.3-II : FUL- mean effluent values in situ

EFFLUENT		SITES											mean	max	min
		1	2	3	4	5	6	7	8	9	10	11			
COD	mg/l	559	289	486	360	526	114	172	86	119	192	149	277.45	559	86
SS	mg/l	383	134	372	232	207	42	85	34	69	69	33	150.91	383	33
NH4-N	mg/l	46	42	43	44	52	5	25	11	26	28	46	33.45	52	5
BOD5	mg/l	146	94	135	98	189	23	33	13	23	55	34	76.64	189	13

3.3.1.3 Bath discharges

A main problem in realising the bath-discharge test is respecting the flow rate: 200 l in 3 minutes. Also with respect to the volume a comment can be made: current bath tubs do have a water volume of 200 l up to the overflow opening. When filling the tub up to this level, the overflow opening already discharges a volume corresponding to the body volume when the person enters the bath. So in practice, in the great majority of the cases, there will never be 200 l discharged when emptying a bath. This problem should be readdressed in the standard as the 200l are unrealistic in the mean.
The results of the bath discharge-monitoring, taking 4 samples at 15 minutes interval, are given in figure 3.3-1.

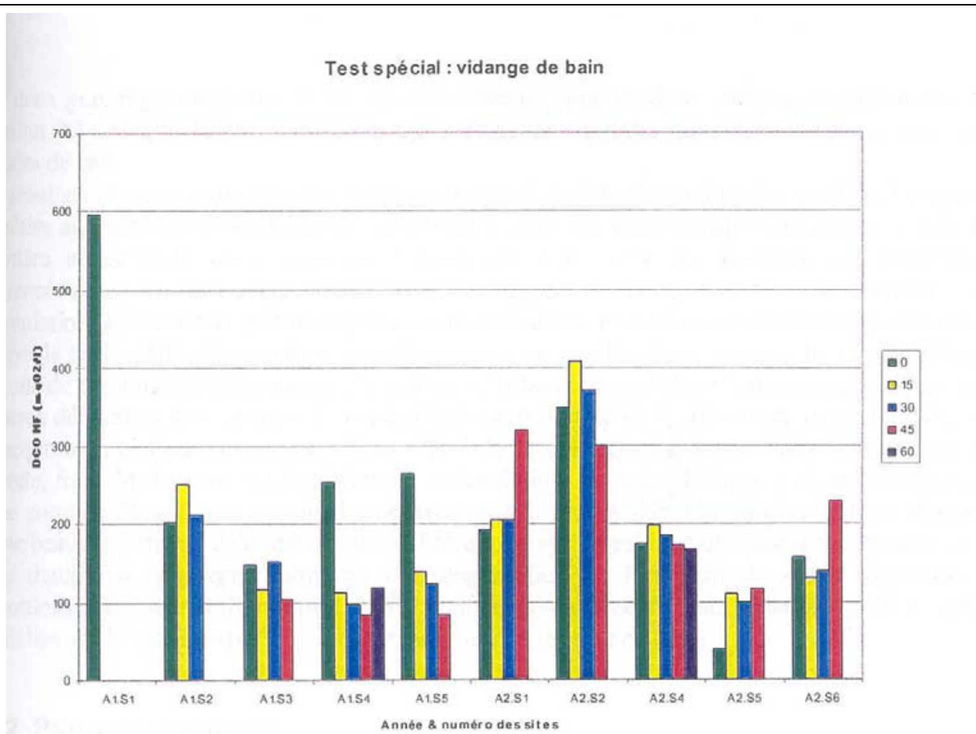


Figure 3.3-1 FUL – COD of the effluent after a bath discharge in situ

The first thing to remark is that it not always the first sample that presents the highest value, as was observed with the on site testing (§3.2.1.5).
If we compare these punctual results with the mean effluent values, for instance for the COD parameter, see table 3.3-III, we do have the feeling that these values fall well within the normal variation of the analyses, so that it is questionable whether these tests are really relevant, certainly if one takes into account the difficulty to realise comparable test conditions.

Table 3.3-III : FUL - comparison between mean COD values and values after stress testing in situ

parameter	Sites										
	1	2	3	4	5	6	7	8	9	10	11
	Maximum effluent values after bath discharge										
COD	600	250	150	250	270	330	420	-	200	120	220
	Mean effluent values of the 24h composite samples										
COD	559	289	486	360	526	114	172	86	119	192	149
	Effluent values after power breakdown										
COD 2nd day	200	220	-	220	380	170	200	-	210	210	200
COD 5th day	900	180	-	175	520	120	220	-	350	220	250

3.3.1.4 Power breakdown

Here also we see (table 3.3-III) that the COD-values are probably also within the normal fluctuation of the effluent characteristic, so that again the necessity of the test is questioned.

3.3.2. BBRI

The plants investigated in situ are described in table 2-VIII; the sampling procedure is presented in §2.3.

3.3.2.1 Influent

A main problem for a correct sampling of the influent is indeed the lack of devices allowing to intercept the waste water flowing to the plant : on the 18 plants monitored only 1 (plant n°2 table 2-VII) presented the possibility for introducing a sampling pump: an inspection chamber with an opening of 250 mm.

Table 3.3-IV: BBRI comparing influent grab- and 24h composite samples

parameter	units	type	Min.	Max.	Mean
SS	mg/l	grab	88	360	143.5
		24h comp	112	744	590.7
BOD	mg/l O2	grab	223.8	1227.3	447.5
		24h comp	323.8	612.7	493.4
COD	mg/l O2	grab	567	2096	956.5
		24h comp	752	1624	1354.8
P tot	mg/l P	grab	8.4	20.5	13.8
		24h comp	15.1	33	26.3
NH4	mg/l N	grab	27.5	94	60.5
		24h comp	27.5	66.5	35.3

The consequence of this situation is that effluent sampling on site is limited to grab sampling in the first compartment of the plant. In order to verify the correlation between such grab samples and 24h composite samples, a parallel monitoring was done on plant n°2 (a SAF): a 24 h composite sample was collected and at the end of the 24 h a grab sample was also taken in the 1st compartment of the plant.

The results are given in table 3.3-IV. In case we look to the mean values we see that the grab sample always gives lower values than the composite, except for the NH4-N. This seems quite logical for a plant that is in good working conditions, because then the water flowing in the first compartment is immediately mixed with water that already got certain purification. Influent-grab samples, taken in the plant do not at all characterise the incoming water.

3.3.2.2 Effluent

The tests on the BBRI test rig (§3.2.3.4) indicated that grab-samples taken at the outlet of a plant characterise quite well the effluent of that plant. In order to take the sample in site there is however, just as for the influent, a problem : nearly never there is a possibility to take the sample outside the plant. This implies that in many cases the sample is taken in the last compartment of the plant. Different techniques are used hereto:

- Using a can
- Or sucking the fluid using a (hand)-pump.

When a can or pot is used one introduces quite a lot of turbulence, mixing the clarified water with floating material. The result is that the sample might be different from the real effluent. Too great turbulence can be avoided by using the sucking technique, but then the question rises which diameter should be used for the flexible pipe. Some use very tinny pipes, i.e. DN <5 mm, other use flexibles with a DN up to 20 or 25 mm. We compared both techniques, the result are given in table 3.3-V.

Site or plant	**SS**	**COD**	**N tot**	**P tot**	**NH4**	**NO3**	**NO2**
	mg/l	mg/l O2	mg/l N	mg/l P	mg/l N	mg/l N	mg/l N
Tinny pipe DN 4 mm							
site 6	8	35	16	10.1	0.96	11	0.114
site 5	8	50	54	8.5	1.04	36	0.356
site 3	48	172	121	7.9	86.5	0	0
Pipe with DN 25mm							
site 6	48	50	16	10.3	0.61	11.6	0.273
site 5	4	56	46	8.3	1.1	35.2	0.32
site 3	68	158	109	8.3	86	0	0

Table 3.3-V: BBRI comparing two effluent grab-sample techniques

As can be seen, the results are quite similar, so that both techniques can be considered as equivalent. To be noted is that in order to avoid the accessibility problem for sampling at the outlet, some manufacturers do have on outlet appropriate for effluent sampling: see photo 3.4.

3.3.2.3 Stress testing

The effect on the effluent of a power breakdown (PBD) is given in figure 3.3-2 for the BOD and in the figure 3.3-3 for the COD parameter.

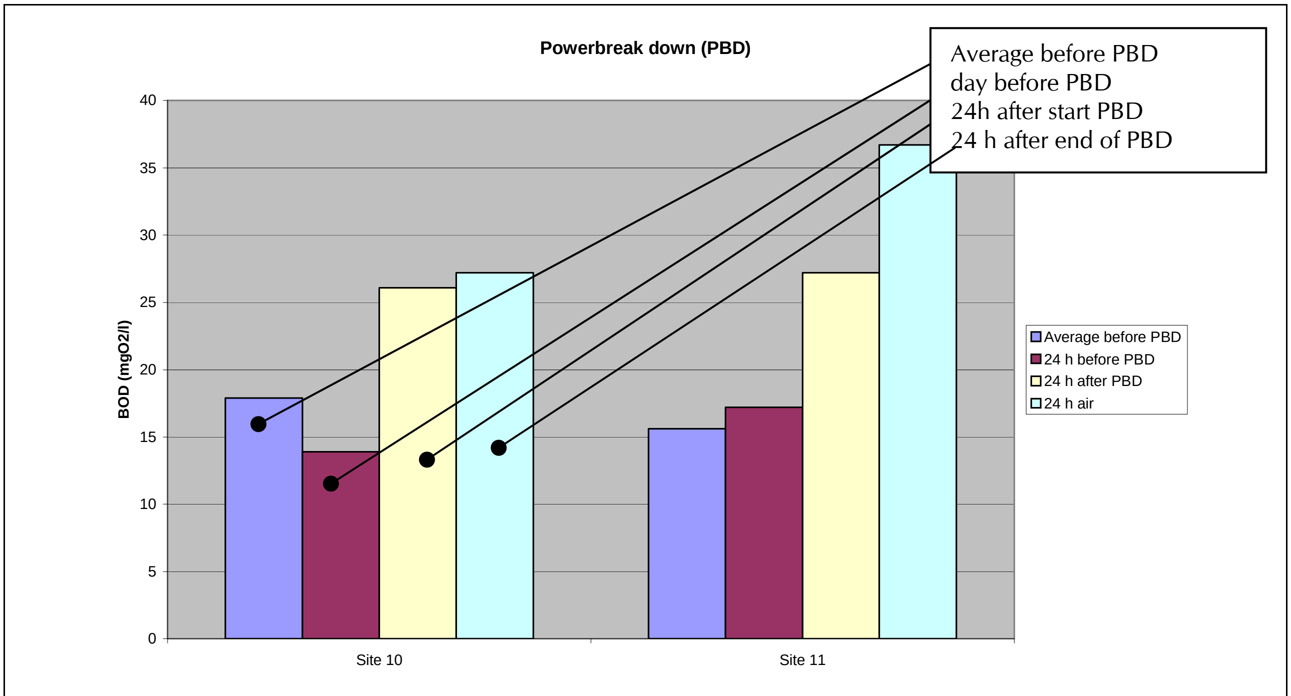


Figure 3.3-2 : BBRI on site testing: power breakdown - BOD

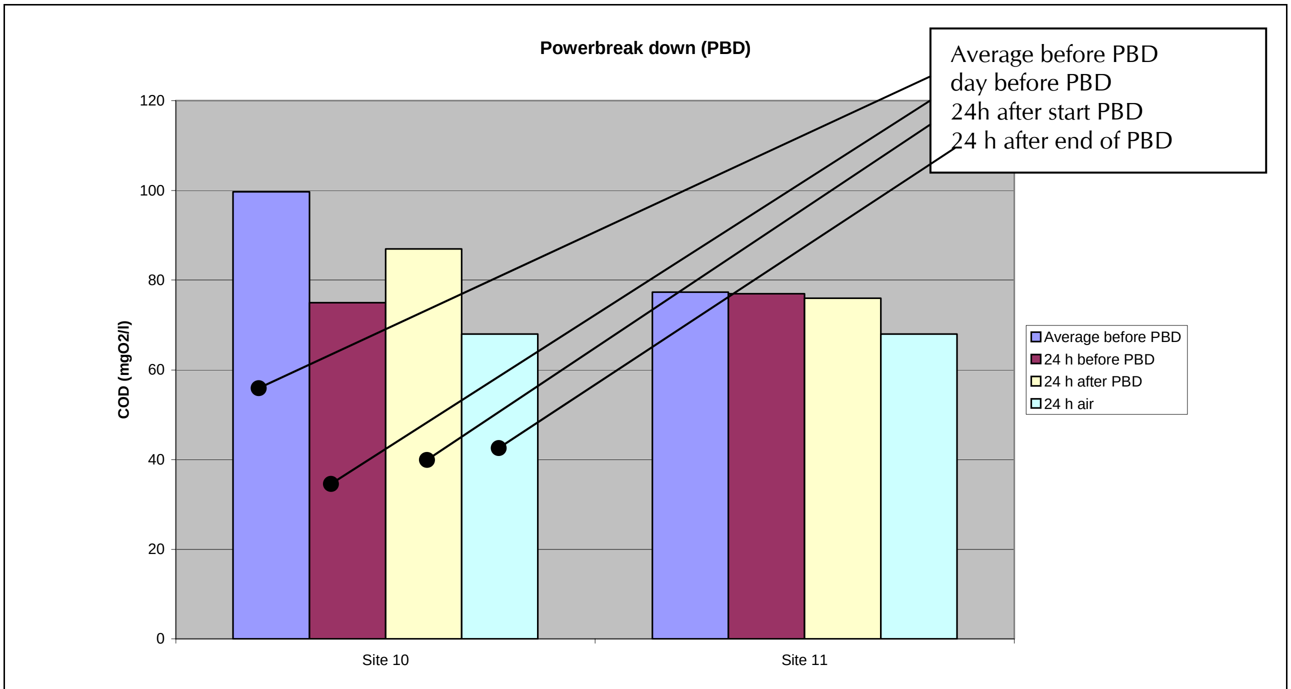


Figure 3.3-3 : BBRI on site testing: power breakdown -COD

As can be seen from these figures, the variation of both parameters is not the same and the interpretation of the effect of the stress test would be different if only one of the parameters would have been measured. This tends to indicate that it is to a certain extend dangerous to leave, as proposed in the prEN, a choice between COD and BOD. Best is to measure both.

One of the problems in realising some of the stress test requested in the prEN, is the difficulty to find an appropriate bath discharge, as was also noticed by FUL.

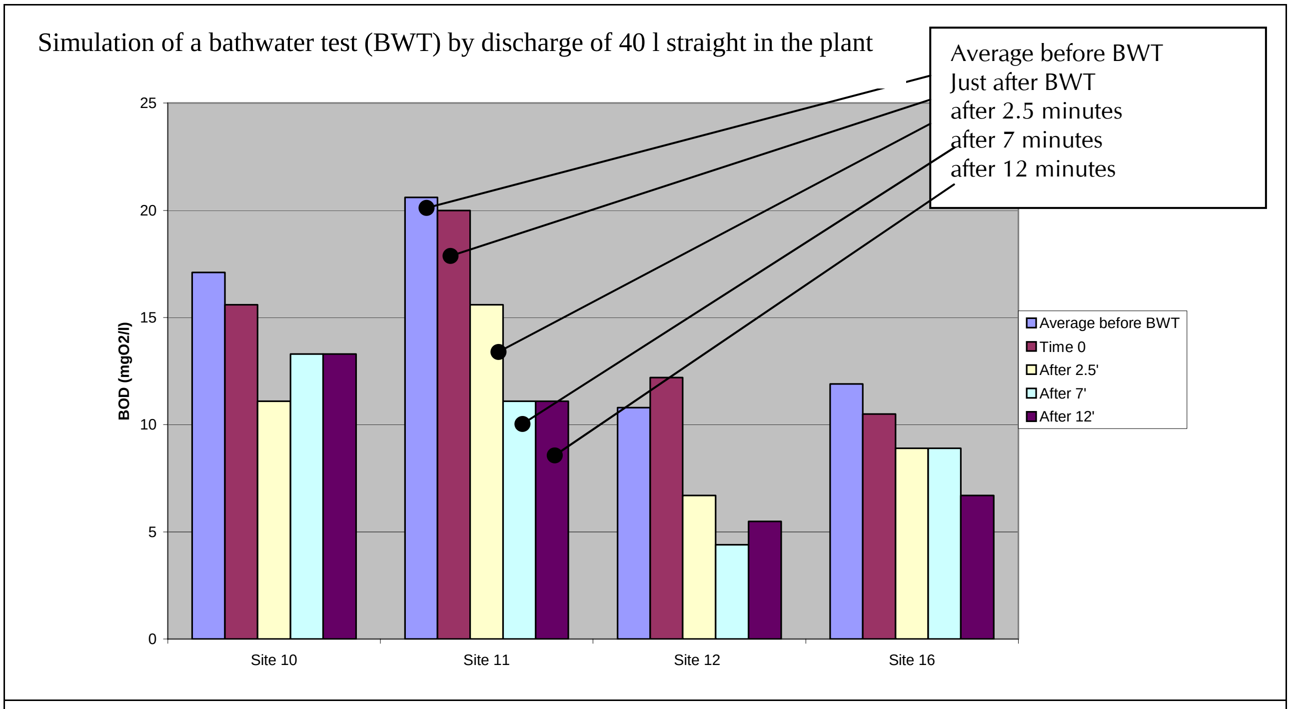


Figure 3.3-4 : BBRI on site testing: effect of the sudden discharge of 40 l (q ~ 1.1 l/s)

One way to solve that problem partly is to discharge, immediately in the first compartment of the plant, a certain volume of water e.g. 40 l, respecting the same flow rate as requested in the draft standard, i.e. about1.1 l/s. Figure 3.3-4 illustrates the effect of such a discharge on the BOD.
Just as in the bath stress tests done by FUL (§3.3.1.3) the effect remains within the variation of the mean effluent characteristics, which confirms the lack of relevance of the test.

3.3.3. VITO

Vito monitored 8 plants in situ (table 2-VI) according to the procedure in § 2.3.

3.3.3.1 Influent

A main problem noticed by VITO is the difficulty to get in certain cases, information on the exact amount of waste water which is discharged, mainly because a lot of households do use also rainwater in the house. The presence of alternative water sources, which are not measured, should be an element of awareness when choosing plants in situ: in these cases a sampling method as used by FUL or BBRI shall be adopted.

It is not easy to identify 2 plants, one loaded to 50 and one loaded to at least 75%, as requested by the prEN, because the only element known at the time selection is the hydraulic loading, which is not always representative for the organic load. The question can be asked whether there is a real need to have a partial loaded plant monitored. This should be re-examined in the group working on the standard.

To characterise the influent VITO took also grab-samples in the 1st compartment of the plants. Interesting is to compare the influent characteristics noticed by the different partners: table 3.3-VI, which indicates that the load on site seems to be somewhat heavier than set forward in the prEN. An explanation could be that the pr EN relied upon samples which were taken in the 1st compartment of septic tanks, which, as showed by BBRI, underestimate the real loading. Research on the real value of the influent, based upon sampling stream upwards the plants should be considered.

Table 33.-VI : mean influent values for COD and SS according to the different partners

influent on site										
	COD (mg/l)					SS (mg/l)				
	FUL	BBRI 24H	BBRI 1°	VITO	prEN	FUL	BBRI 24H	BBRI 1°	VITO	prEN
mean	839	1454	1033	593	600	356	591	255	79	375
min	1151	752	372	64	300	98	112	80	5	188
max	2400	1624	3395	2852	900	965	744	1716	764	563

3.3.3.2 Effluent

In order to evaluate whether the samples had to be strictly flow based composite or could be time steered, a pre-screening was done on each plant. The results for one plant are given in table 3.3-VII, the other are comparable.

Table 3.3-VII : VITO- comparison of effluent sampling methods on site

	mean values			
	COD	**SS**	**BOD**	**Ptot**
	mg/l			
equal in time spaced samples	73	49	/	7.6
flow rate steered samples	72	11.7	17	7.9

Both results are comparable, so simple time steered samples can be taken.

A problem on site is the request to realize all the stress tests required in the standard, only the power breakdown seems not to present a major problem.

3.4. Evaluating the prEN proposal for assessing the mechanical stability of the plants

3.4.1 Analysis of the proposal

The prEN, version November 2000 (annexe 2), proposes two manners to assess the structural behaviour of small waste water treatment plants:

- by testing the product
- or by calculation.

For the calculation, the standard indicates that some mechanical characteristics have to be established, whereby however the required parameters are not enumerated for the different materials considered i.e. concrete GRP, PE, steel. This probably is linked to the fact that no reference is made to a specific calculation method.
It is obvious that the 2000 proposal is totally insufficient to allow a calculation as an equivalent to the testing, certainly for the plastic materials, where long term creep and ageing effects have to be taken into account.

For the testing different kind of test methods are considered, as indicated in the table 3.4-I (see also annexe 2).

Table 3.4-I: tests for the mechanical stability of plants

	crushing	Vertical load test	vacuum	pit test
Concrete	x			X
GRP			x	X
PE		x		X
Steel			x	x

But also here there seems to be a lack on completeness, given the fact no criteria are given for the assessment of the test results. Also no information is provided on the correlation between different tests proposed for a given material.
It is also here obvious that the proposal is insufficient for correct product evaluation.

3.4.2 Improvements

With respect to the calculation methods for plastics it seems us necessary that, besides the tensile properties, also the creep and ageing properties shall be evaluated. Anyhow at this stage we fear that there is actually too little experience with the different calculation methods for plastic materials, to allow them as an alternative to testing. We thus suggest that, for plastic materials, the standard shall only allow testing methods for the structural behaviour.

In order to avoid problems of correlation we propose to adopt only the pit test, which initially was already proposed for all materials. This is logical given the fact that the pit test simulates the real use of the plant.

For plants up to 2x6x3m the pit could be realized according to the scheme presented in figure 3.4-1.

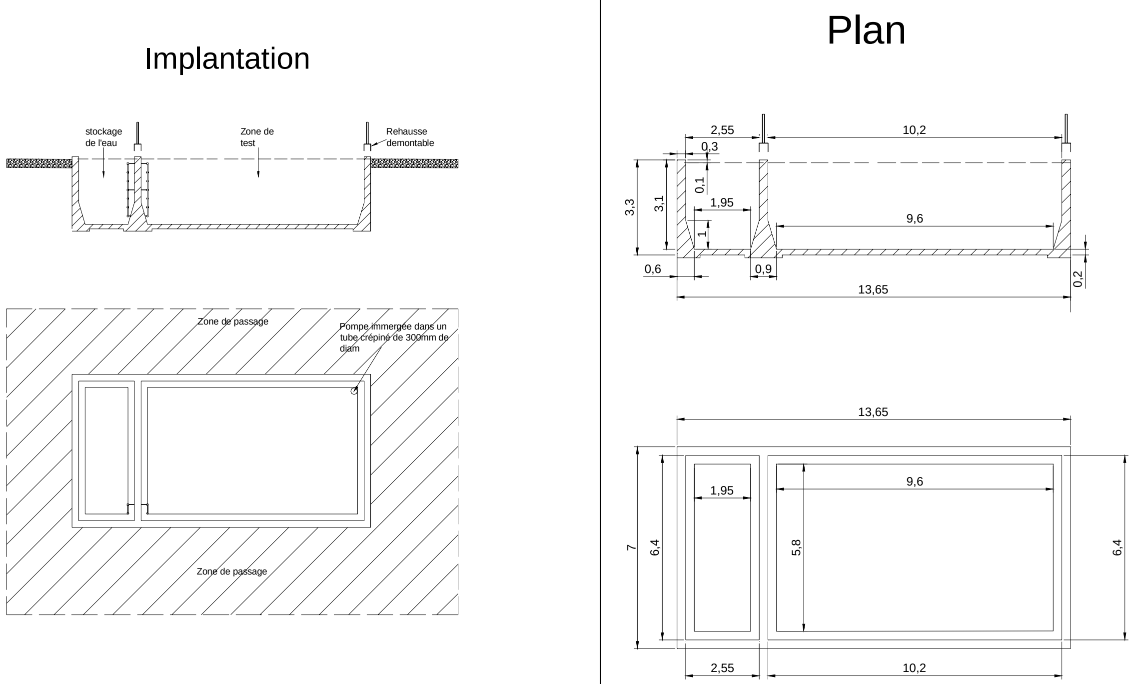


Figure3.4-1:
scheme for the construction of a pit for testing plants on mechanical stability.

3.5. Proposals for improving prEN 12 566-3

3.5.1 Testing on a test rig

3.5.1.1 Data to be monitored on both the influent and the effluent:

The following shall be measured:

- total biological oxygen demand : BOD
- total chemical oxygen demand: COD
- temperature of the liquid phase
- total power consumption if applicable
- the daily hydraulic flow
- pH
- nitrogen parameters: Kjeldahl, NO3-N and NH4-N
- total phosphorus

The measuring of other parameters might be considered, e.g.:

- sludge production
- dissolved oxygen
- conductivity

3.5.1.2 Influent characteristics

The values proposed in the prEN can, for the time being, be maintained. However we would suggest setting up, in the different CEN-member countries, in situ measuring campaigns for a better characterisation of the mean household waste water. This, because some of our results indicate that the waste water on site seems to have a somewhat higher waste load than indicated in the standard.
Guidance must be given on the minimum weekly organic load that the plant must receive, in order to avoid that the whole testing would be conducted with a water with the minimum load.

3.5.1.3 Daily base loading

The daily flow pattern of the prEN proposal can be adopted.
The water discharged by the baths and the washing machines must however be included in the daily base flow-volume.
Laundry washing machine discharge can be simulated by using clear water to which detergent is added. The total water volume shall be about 75 l of which 15 l at 60°C.
Bath discharge shall be a volume of 130 l clear cold water.
In that case the daily base flow can be calculated with the following formula:

V= (7xVpexPE -130xNbt-2x75xNwm)/7, in l/day

Where the different factors are as defined in §3.2.3.1.

3.5.1.4 Stress simulation

The different stress simulations proposed (overload, low occupation, under loading, bath discharges, washing machines, power breakdown) can be maintained. However the 200% overload seems to be unrealistic high, 150 % seems to be more appropriate.

3.5.1.5 Test schedule

Before starting the testing with waste water, we propose to do the following preliminary tests:

- the measurement of the aeration capacity (§3.2.2.2)
- the measurement of the hydraulic response of the plant using a tracer that can be detected for instance by a conductivity measurement (§ 3.2.2.3 or 3.2.3.2)

In case the aeration capacity is too low, further testing will be stopped.

The standard must indicate clearly that inoculation be allowed for starting up the plants.

At the beginning there must be a long period of steady state working.

Afterwards the stress testing can start. Between every stress test there must be a period of steady state working. The length of these periods shall be limited. A minimum length of this steady state period can be defined in the standard, however longer periods can be adopted by the testing lab in case the steady state is not reached within the minimum time-length.
The sequence of the different stress test shall be flexible and left over to the decision of the testing lab.

Given the fact that sludge accumulation seems to be important, we suggest to do, at the end of the testing period, a simulation of sludge accumulation by filling the sludge storage compartments with septic tank sludge.

The standard must also indicate in which conditions further testing should be stopped.

3.5.1.6 Sampling

During the starting period the effluent shall be followed weekly by grab samples and analysed on COD and NH4-H in order to establish when steady working conditions are reached.

Once the testing starts, all samples must be 24 h composite samples, taken every 2 weeks.

No sampling shall be requested after peak flow discharges (bath or washing machine).

3.5.2 Treatment efficiency testing on site

3.5.2.1. Data to be monitored

See §3.5.1.1

3.5.2.2. Influent characteristics and loading of the plant

The site to be monitored must be selected to be sure that the plant will be correctly loaded.

3.5.2.3 Stress simulations, test schedule

The following stress situations shall occur:

- Power breakdown
- Low occupation stress for at least 2 weeks, to be decided by the occupants.

3.5.2.4 Sampling

All samples shall be 24 h composite, taken every 2 weeks. The test site must allow to take the influent samples outside the plant. The effluent must be sampled at the outlet of the plant.

3.5.3 Structural behaviour

Calculations shall only be allowed for concrete and steel.
For the testing of plants, only the pit test shall be considered.

4. INFORMATION TRANSFER AND VALORISATION

The aim of this research was to improve and validate a European standard being prepared by the group CEN TC 165 WG41, i.e. WG41, since the early nineties. As the finalisation of the work was planned before the end of 2003, the redaction of the standard was thus going on while the research was conducted. In order to be able to bring the research results to the knowledge of the CEN working group, two actions were undertaken:

- At the request of the research partners the Belgian Standardisation Institute (BIN/IBN) created a special working group for the follow up of the activities of the CEN group. This made possible to present the research findings as official comments from BIN/IBN and as such these comments had to be taken in consideration by WG41.
- Three of the research partners, i.e. BBRI, FUL and VITO, were also delegated to WG 41 by BIN/IBN. This allowed them to participate in the meetings of CEN TC 165 WG41, were they intervened actively in the discussions, introducing here also the research results.

The result of these actions was visible in each new draft version issued of the standard: the great majority of the modifications proposed were adopted.

At the end of the research (May 2003) the research partners organised a two days symposium in Arlon for the building professionals, manufacturers of small treatment plants, administrations, CEN TC165 WG41-members and other research groups active on the same topic, were the results of the research were presented.

FUL also participated in a symposium on small waste water treatment in Turkey where the research results were presented to the worldwide research community.

Finally it must also be remembered that the research was guided by a working group in which different concerned (regional) administrations were represented. This had between others as a consequence that CEBEDEAU was asked by the Walloon Region to work out an evaluation frame for small domestic waste water plants.

5. CONCLUSION

For the 4 laboratories participating in this research, it was the first time that their research results were so quickly valorised. The fact that the research allowed them to come into contact with the ongoing European standardisation allowed them to take knowledge of the needs of the European industry, which should certainly influence their future working.
Through this research the different partners gained very important expertise in the field of the individual waste water treatment, just in a period where this topic is becoming more and more important gives the European objectives: "having good surface and soil water till 2015". This is illustrated by the fact that regulations are being worked out in the different Belgian regions. The expertise acquired will certainly be fruitful in this context.

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And finally a word of thanks is addressed to Mrs A. Calderone Belgian Science Policy officer responsible for the follow up of this research for her excellent assistance with the administrative matters.

PHOTOS

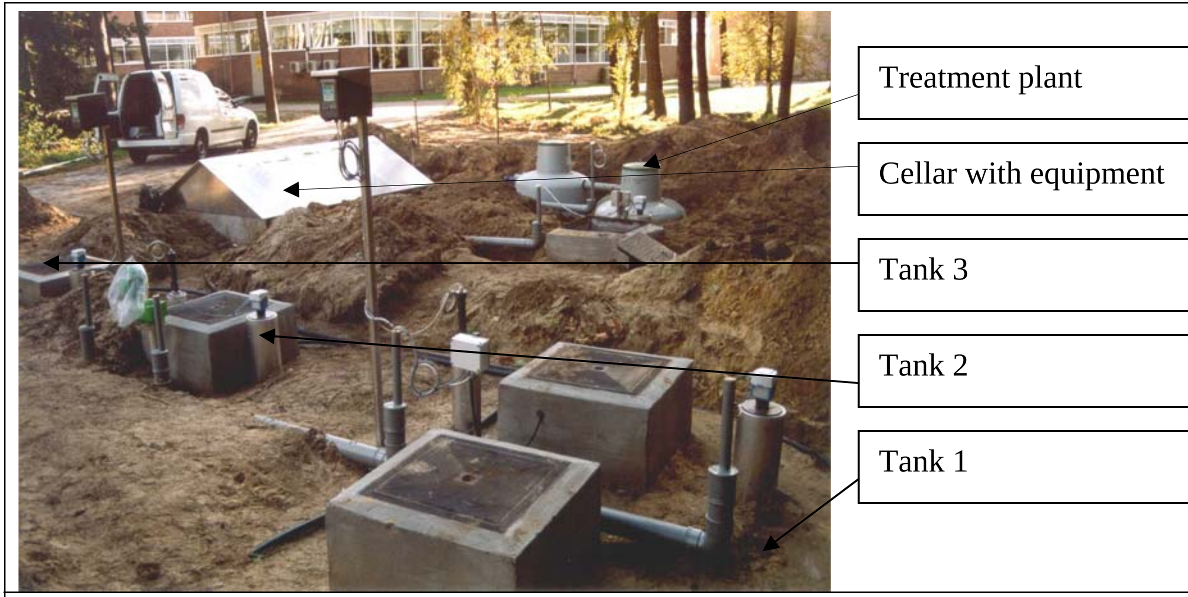

Photo 3-1 : test rig VITO

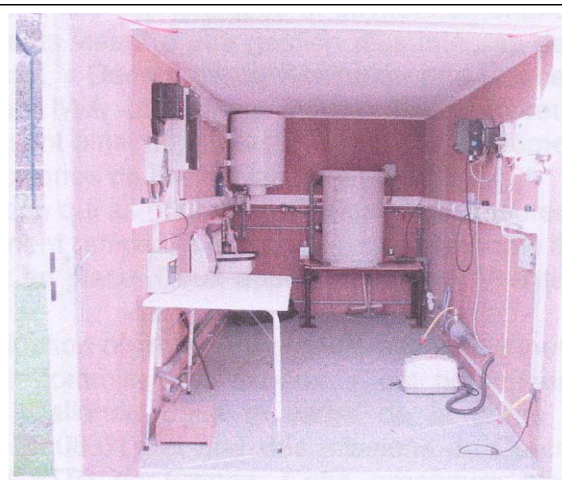

Photo 3-2 : container of the CEBEDEAU test rig

Photo 3-3 : Container of the BBRI test rig.

Photo 3-4 : plant with an outlet appropriate for effluent sampling

ANNEXE 1

ANNEXE 2

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