Report initial type test (ITT) "treatment efficiency" of the small wastewater treatment systems for up to 50 PT conform EN 12566-3:2005

Range "BioKube Aerated Wastewater Treatment System"

Of BioKube

BES/N9902/PP/pp/09.001v4

Translated version

October 2010

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192 INSP
192 PROD

Technical Manager	Signature	Date
Peter Peeters		**October 2010**

Contents

1 Introduction

This document is the report covering the initial type tests in compliance with EN12566-3+A1 of the range small wastewater treatment systems of Biokube.

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2 Procedure Initial Type Tests (ITT)

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The initial type tests (ITT) were conducted in compliance with:

EN 12566-3: Small wastewater treatment systems for up to 50 PT - part 3: Packaged and/or site assembled domestic wastewater treatment plants

European Construction Products Directive EG/89/106

More specifically it concerns:

- *ITT treatment efficiency EN 12566-3, Annexe B*

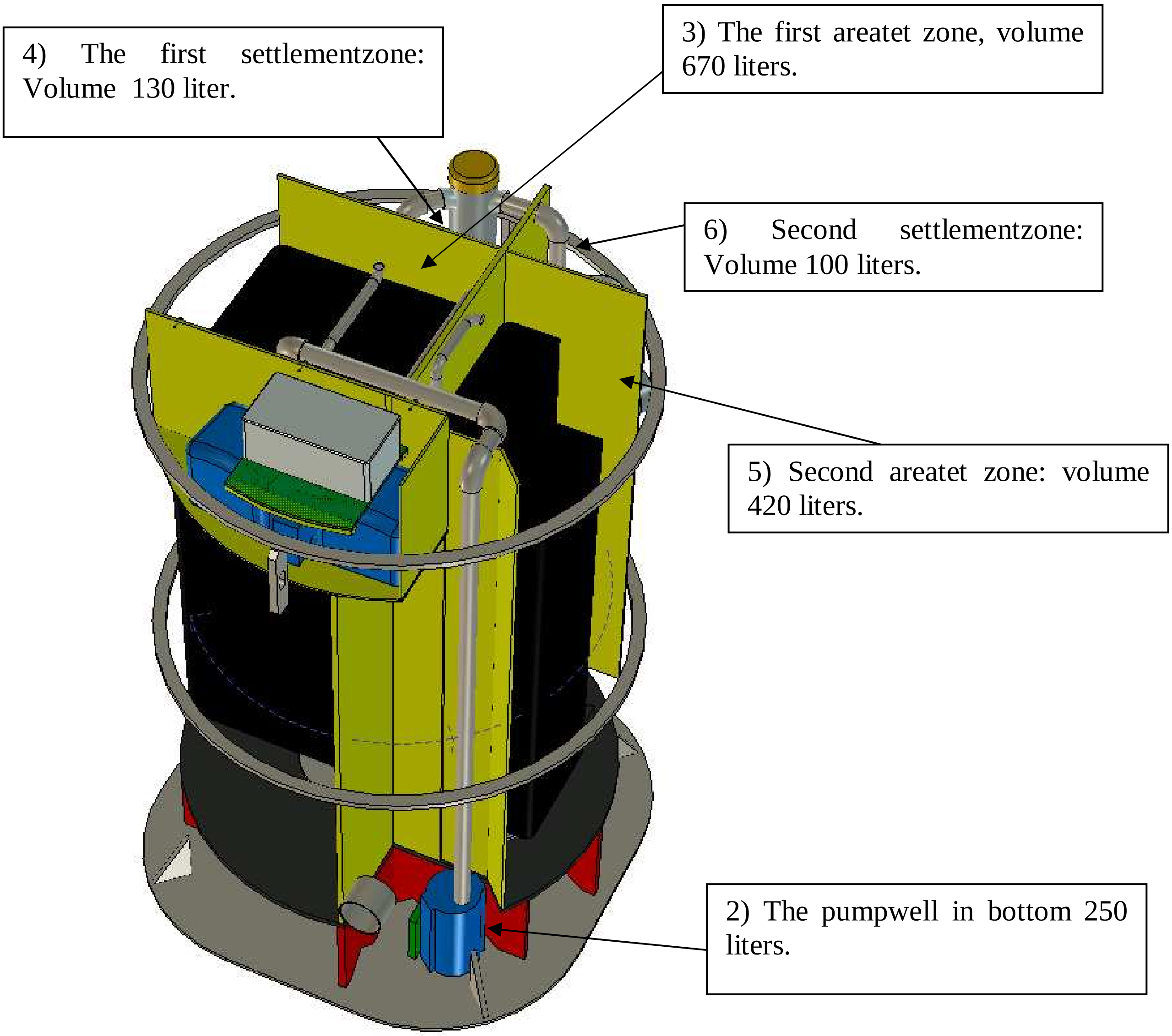
3 Product specifications

The BioKube range of AWTS (Aerated Wastewater Treatment System) is based on the technology of biological degrading of organic material via natural bacteria living on submerged aerated filters (SAF or submerged aerated filter).

The phosphorus removal kit was not in operation during the testing.

Durbility

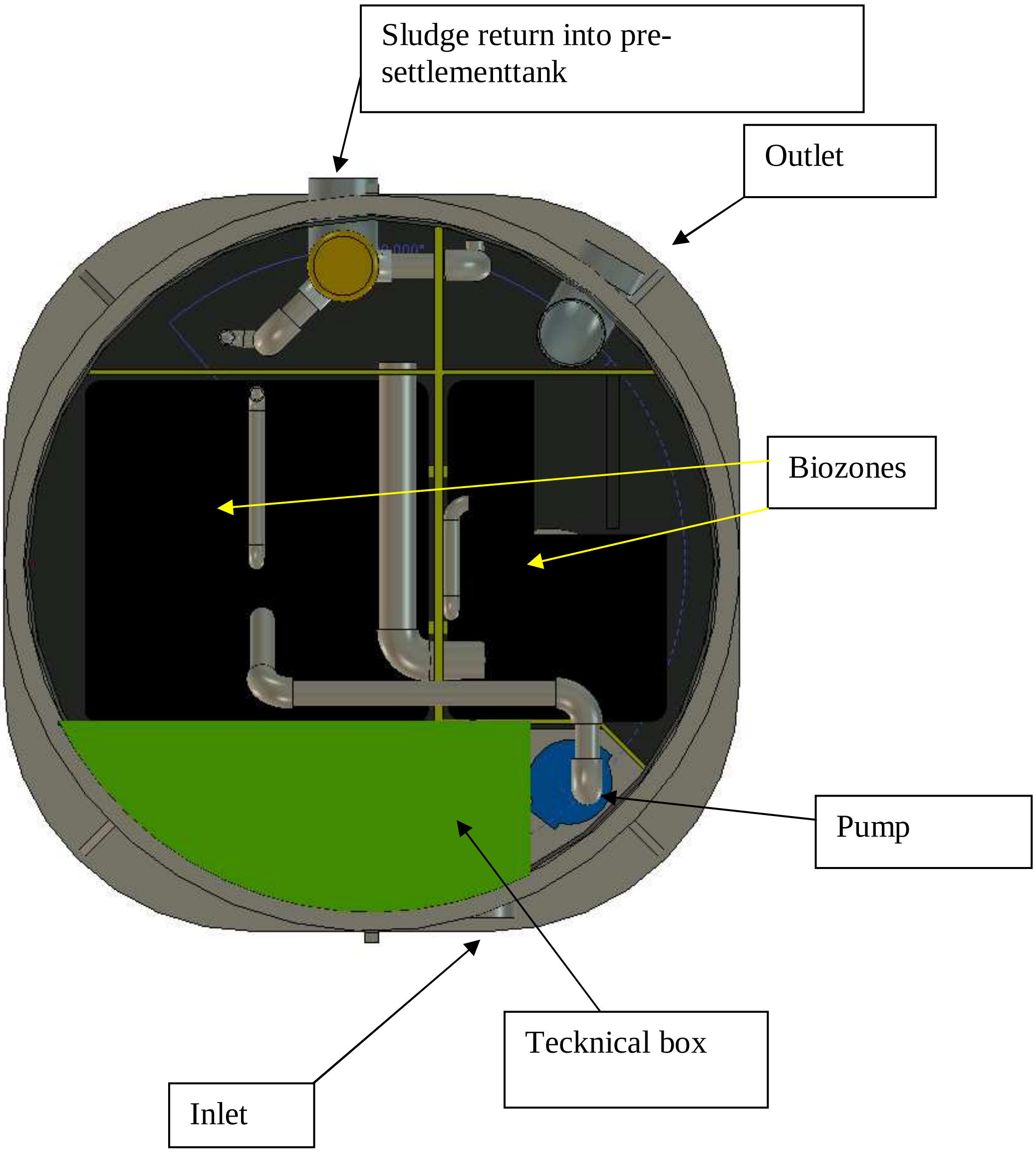
The BioKube range of AWTS mentioned in this report uses PP as base-material. According to the manufacturer, the properties are already known and the used materials comply with EN12566-3, section 6.5.7



<u>Technical drawing 1</u> : BioKube Venus 1850 (5 PE) Venus : internals

1. A separate pre-settlement-tank (septic tank /pre cleaning unit) is used (Sebico FAN 3000 liters) (not on the technical drawing)
2. The pre-cleaned wastewater is buffered at the bottom of the Venus 1850-system and pumped into the first cleaning camber at timed intervals.
3. The wastewater flows through the fist SAF (=Submerged Aerated Filter) (BioBlock) and
4. is led into a clarification chamber.
5. the water gravitates into the second SAF and
6. is led into the second clarification camber.

Finally, the cleaned wastewater is discharged .



<u>Technical drawing 2</u> : BioKube 1850 (5 PE) Venus : Top view

Sludge which settles in each cleaning section, is pumped back to the pre-settlement tank/septic tank several times a day by an airlift. From the pre-settlement tank the sludge should be removed periodically.

Control box

The air blowers and technical box is located in the a separate chamber above the volume-buffer (2).

Air blower 1 (cleaning chamber 1 (4) :

Model : BA40A
Elec : 230 VAC/50Hz ; 0,3A
Pressure : 0,13 kg/cm^2
Air volume : 42 L/min

Air blower 2 (cleaning chamber 2 (6) :

Model : BA30A
Elec : 230 VAC/50Hz ; 0,13 A
Pressure : 0,13 kg/cm^2
Air volume : 28 L/min

Timers :

Influent pump (2) pause : 15 min; run : 10 sec

Air blower 1 (4): continuous

Air blower 2 (6) : continuous

Airlift 1 (5) : pause : 15 min; run : 10 sec

Airlift 2 (7) : pause : 12 hours; run : 100 sec

Water pump : Pedrollo Vortes 375 W, 220 V

Magnet valve : Mivalt

Biofilter : Exponet 2 pcs Bioblok 100
2 pc bioblok 200

Diffuser : 2 pcs Gummijager GD 270

4 ITT Treatment efficiency

4.1 Test rig

The BioKube Venus 1850 (5 PE) Venus was set up in the Certipro® test facility on November 22 2007, in accordance with the installation instructions for the system (see photo 1). The Micro station was hydraulically loaded to 5 PE in accordance with EN 12566-3. This report includes the results of this test.

Photo 1 : left : BioKube Venus 1850 (5 PE) set up in Certipro® test facility
right : pre-settlement tank (septic tank)
left : BioKube Venus 1850 (5 PE)

Dimensional inspection

Tank 1 (FAN 3000 liters Sebico)

Dimension (cm)	Technical drawing	Value measured
Height	147	147
Length	255	255
Width	123	123
Dia In/out	10	10
Height out	127	127

Table 1: BioKube 5 FAN 3000 Sebico : dimensions

Tank 2 (BioKube Venus 1850 5(PE)):

Dimension (cm)	Technical drawing	Value measured
Diameter tank	110	110
Height tank (without cover)	183	183
Min. height volume buffer	25	183-157=26
In/Out/sludge return	11	11

Table 2: BioKube Venus 1850 (5 PE) dimensions

4.2 Test schedule

The initial 38-week type test was started up following a stabilization period of 1 month.

Sequence	Characteristic	Start	End
1	Biomass establishment	22/11/07	30/12/07
2	Nominal	30/12/07	13/02/08
3	Under loading 50 %	13/02/08	27/02/08
4	Nominal PBD	27/02/08	09/04/08
5	Low occupation stress 0%	09/04/08	23/04/08
6	Nominal	23/04/08	09/05/08
extra	Recovery	19/05/08	02/06/08
6	Nominal	02/06/08	25/06/08
7	Overloading 150%	25/06/08	09/07/08
8	Nominal PBD	09/07/08	20/08/08
9	Under loading 50%	20/08/08	03/09/08
10	Nominal PBD	03/09/08	18/10/08
7 extra	Overloading 150%	18/10/08	29/10/08

Table 3: Test schedule for the BioKube Venus 1850 (5 PE)

Abnormalities and deviations during test procedure

Sequence 1 : one sample hasn’t been taken due to malfunction of the automated sampling machine. Extra sample was taken during sequence 10

19/05/08 : observation : electrical power supply has been interrupted. The cause of this power cut was not within the BioKube system.

The system was given 14 days for biomass re-establishment after the power was reconnected at 19/05/08. The log-data shows the fault occurred from O9/05/08

01/07/08 : Sludge-return-valve was found to be defective and was replaced. It is not known when the malfunction occurred, last samples (as from 11/06/08) were rejected since these samples might be compromised due to the malfunction. Extra samples were taken during sequence 10.

8/07/08 : influent out of specs : test sequence re-done after sequence 10

4.3 Influent properties

The BioKube Venus 1850 (5 PE) was subjected to a daily hydraulic loading of 750 liters/day, dosed in accordance with the dosing schedule below (table 4). The influent was fed into the system by gravity in 25-litre batches. The dosages were uniformly distributed over a dosing period, the number of which was dependent upon the dosing period. The BioKube Venus 1850 (5 PE) was also subjected to a weekly bathwater test (peak flow discharge) . During the peak throughput of 40%, an additional quantity of 2*200 liters per 3 minutes of waste water was fed through the system.

time	***Percentage daily throughput***
3h00	30
3h00	15
6h00	0
2h00	40
3h00	15
7h00	0

Table 4: BioKube Venus 1850 (5 PE) dosage schedule

Raw household waste water was used during the test procedure. The influent properties listed below require to be achieved in order to be able to use the corresponding effluent results for evaluation:

BOD_5: 150 - 500 mg/l or COD: 300 - 1000 mg/l
Suspended solids: 200 - 700 mg/l
Kjel N: 25 - 100 mg/l of NH_4-N: 22 – 80 mg/l
P_T: 5 - 20 mg/l

4.4 Test results

Analysis results from the 24-hour effluent and according influent samples in accordance with the test schedule are listed below.

			WK 2	WK 3	WK 7	WK 7	WK 9	WK 10	WK 11	WK 12	WK 13	WK 15
INFLUENT	pH						6,74			0	7,36	7,75
	Sus. S.	mg/L	168	228	275	275	200	225	195	220	230	220
	Set. S.	mL/L					5	9,5	6,5	6,5	9,5	5,5
	NH4-N	mg N/L	55,6	65	58	58	71	78	65	77	64	69
	NO2	mg N/L								<0,1	<0,1	<0,1
	NO3	mg N/L								<0,5	<0,5	<0,5
	NOx									<0,5	<0,5	<0,5
	Pt	mg P/L	9,91		10,3	10,3	9,68	11,1	10,4	0	11	10,4
	Kj-N	mg N/L	82,2	100	78	78	75	90	81	0	87	86
	BOD	mg O2/L	257	257	340	340	270	320	315	275	370	370
	COD	mg O2/L	525	579	805	805	690	745	705	*	680	650
			Sequence 2 nominal load			Sequence 3 underloading		Sequence 4 Nominal load PBD				
			10/01/08	17/01/08	12/02/08	17/02/08	26/02/08	4/03/08	11/03/08	18/03/08	25/03/08	8/04/08
EFFLUENT	pH		7,8	7,72	7,46	7,72	7,8	7,95	7,83	7,88	7,79	7,69
	Sus. S.	mg/L	<4,3	18.71	10	5	6	4	6	28	7	3
	Set. S.	mL/L	<0,1	<5	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
	NH4-N	mg N/L	0,808	1.1	5,8	1,1	<0,1	0,2	0,3	0,1	0,1	4
	NO2	mg N/L	6,21	0.21	0,23	0,21	<0,1	0,1	<0,1	<0,1	<0,1	0,43
	NO3	mg N/L	12,5	14	15	14	12	11	12	11	13	17
	NOx		18.7	14	15	14	12	11	12	11	13	17,4
	Pt	mg P/L	0,398	8,58	8,01	8,58	8,38	7,67	8,15	8,7	8,4	8,51
	Kj-N	mg N/L	5,43	5.2	10	5,2	4,6	3,6	3,1	4,4	4	6,9
	BOD	mg O2/L	16,9	5	13	5	6	4	7	6	6	5
	COD	mg O2/L	95,4	19	94	65	64	72	74	85	69	67

* : no value determined

			WK 23	WK 24	WK 29	WK 31	WK 32	WK 33	WK 34
INFLUENT	pH		7,02	7,09	7,13	7,06	7,02	7,83	7,15
	Sus. S.	mg/L	225	340	290	695	220	225	190
	Set. S.	mL/L	7,5	11	7,5	17	7	11	10
	NH4-N	mg N/L	68	74	77	48	60	76	71
	NO2	mg N/L	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
	NO3	mg N/L	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
	NOx		<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
	Pt	mg P/L	11,6	13,2	11,3	16,5	10,4	13	11,5
	Kj-N	mg N/L	91	98	100	86	79	98	96
	BOD	mg O2/L	275	285	290	250	305	230	345
	COD	mg O2/L	710	845	900	1280	635	750	705
			Sequence 6 Nominal load		Sequence 8 Nominal load				
			3/06/08	10/06/08	15/07/08	29/07/08	5/08/08	12/08/08	19/08/08
EFFLUENT	pH		7,22	7,55	7,76	7,52	7,8	7,82	7,66
	Sus. S.	mg/L	20	4	25	22	14	7	8
	Set. S.	mL/L	0,6	<0,1	4	0,7	0,1	<0,1	<0,1
	NH4-N	mg N/L	2,4	0,2	34	0,1	0,1	<0,1	<0,1
	NO2	mg N/L	1,4	0,32	3,1	0,24	0,15	<0,1	<0,1
	NO3	mg N/L	21,9	22,4	9,15	17	16,6	20,8	24,5
	NOx		23,3	22,7	12,3	17,2	16,8	20,9	24,6
	Pt	mg P/L	9,6	9,27	10,7	10,6	8,71	8,79	9,25
	Kj-N	mg N/L	5,8	4	42	4,3	3,4	2,7	3
	BOD	mg O2/L	9	4	19	8	3	<3	3
	COD	mg O2/L	71	57	120	91	63	60	105

			WK 35	WK 36	WK 37	WK 39	WK 40	WK 41	WK 42	WK 43	WK 44
INFLUENT	pH		7,6	7,16	7,12	7,2	7,63	7,46	7,54	7,55	7,67
	Sus. S.	mg/L	235	370	280	275	195	550	245	390	340
	Set. S.	mL/L	10	10	7,5	10	12	10	12	12	0,1
	NH4-N	mg N/L	69	92	66	71	73	75	72	71	70
	NO2	mg N/L	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
	NO3	mg N/L	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
	NOx		<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
	Pt	mg P/L	11,6	14,7	11,8	11,7	10,6	16,2	11,5	12,9	11,5
	Kj-N	mg N/L	96	98	98	90	91	110	94	110	90
	BOD	mg O2/L	200	270	295	290	255	250	210	265	255
	COD	mg O2/L	585	900	740	705	530	1180	545	980	630
EFFLUENT			Sequence 9 Underloading		Sequence 10 Nominal load PBD					Sequence 10 Nominal load PBD	
			26/08/08	2/09/08	9/09/08	23/09/08	30/09/08	8/10/08		22/10/08	28/10/08
	pH		7,72	7,37	7,11	7,14	7,5	7,51	7.45	7,54	7,42
	Sus. S.	mg/L	10	57	38	7	4	6	6	4	7
	Set. S.	mL/L	0,1	1,9	0,9	<0,1	<0,1	<0,1	0,1	<0,1	<0,1
	NH4-N	mg N/L	<0,1	<0,1	<0,1	0,7	0,3	<0,1	0,3	0,4	0,4
	NO2	mg N/L	<0,1	<0,1	<0,1	0,52	0,32	<0,1	0,15	0,33	0,39
	NO3	mg N/L	20,6	24,7	32,9	27.5	27,6	25	22	23	40,00
	NOx		20,6	24,7	33	28	27,9	25	22	24	41
	Pt	mg P/L	11,5	11,1	12,5	10,8	10	10,2	10,4	8,12	10,5
	Kj-N	mg N/L	3	5,6	5,5	5,8	3,4	2,6	3,6	2,9	3,4
	BOD	mg O2/L	<3	7	10	11	4	3	4	4	4
	COD	mg O2/L	38	98	110	80	71	69	73	65	55

Table 5: BioKube Venus 1850 (5 PE): analytical data
Sus. S : Suspended solids Set. S. : settable solids
NOx = NO_2 + NO_3 Kj-N = Kjeldahl nitrogen
Pt : total phosphate

4.4.1 Evaluation of thet results

All chemical analysis were done under BELAC accreditation. BELAC is the Belgian accreditation body and member of EA (European Accreditation).

The treatment performance of the BioKube Venus 1850 (5 PE) Venus micro station was established by means of a sampling test consisting of 20 mixed samples taken (24 h) spread during the sequences with nominal lo ad (5 PT).

pH = 7,6
$SS_{nom\ average}$ = 11,9 mg/l
Settleable $solids_{nom\ average}$ = 0,4 ml/l
$NH4\text{-}N_{nom\ average}$ = 2,5 mg/l N
$NO_{x\ nom\ average}$ = 19,3 mg/l N
$P_{nom\ average}$ = 8,97 mg/l P
$KJ\text{-}N_{nom\ average}$ = 6,3 mg/l N
$BOD_{nom\ average}$ = 7,3 mg/l O_2
$COD_{nom\ average}$ = 81 mg/l O_2

The average of removal percentages obtain during the periods with nominal load are:

$BOD_{red\%}$ = 97 %
$COD_{red\%}$ = 89 %
$SS_{red\%}$ = 96 %
$NH4\text{-}N_{red\%}$ = 96 %

The removal percentages obtained during 50% charge sequences :

Parameter	sample 1	sample 2	sample 3	sample 3
$BOD_{red\%}$(mg/l)	99 %	98 %	>99 %	97 %
$COD_{red\%}$(mg/l)	92 %	91 %	94 %	89 %
$SS_{red\%}$(mg/l)	98 %	97 %	96 %	85 %
$P_{t\ red\%}$ (mg P/l)	17 %	13 %	1 %	24 %

Table 6 : individual removal percentages 50 %-charge

And 150 %-charge (overloading)

Parameter	sample 1	sample 2
$BOD_{red\%}$(mg/l)	98	98
$COD_{red\%}$(mg/l)	93	91
$SS_{red\%}$(mg/l)	99	98
$P_{t\ red\%}$ (mg P/l)	37	9

Table 7 : individual removal percentages 150 %-charge

4.4.2 Summary of interventions

As mentioned in chapter 4.2 “Test schedule”, there was an electrical power cut as from 09/05/08 up to 19/05/08. This power cut was not due to the BioKube system but was caused by the technical system of Certipro. The system was given 14 days recovery period.

01/07/2008 : BioKube placed a bumper over de outlet. This should prevent the excessive loss of sludge. The defective “sludge-return-valve” was replaced.

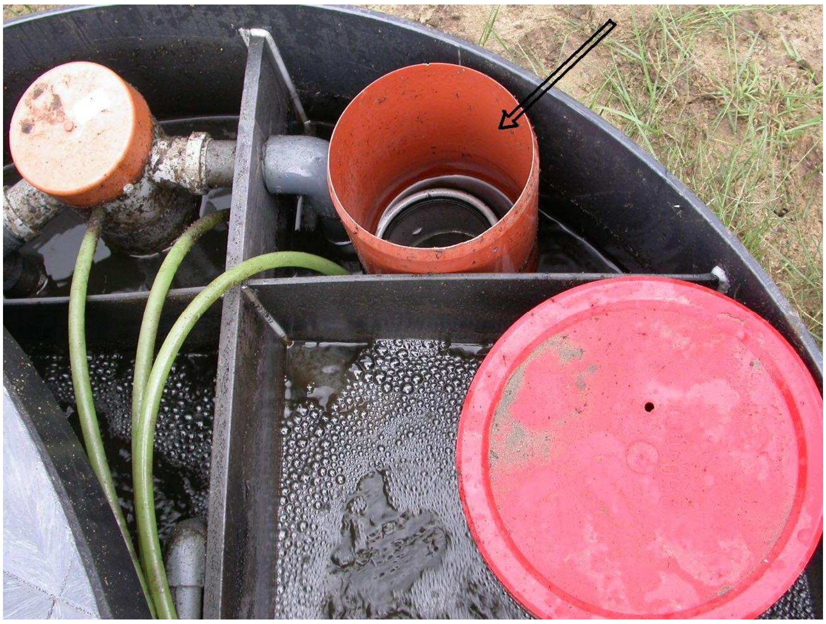


Photo 2 : detail : bumper over the outlet;

4.4.3 Electrical power consumption

The electrical power consumption during the test procedure was 442 kWh (from 23/11/2007 up to 29/10/2008). The average daily consumption was 1,35 kWh and the annual consumption for the Micro station will be approximately 473 kWh.

4.4.4 Sludge production

The BioKube Venus 1850 (5 PE) was started up without inoculation of activated sludge.
The sludge, which settles in each cleaning section, is pumped back to the pre-settlement tank/septic tank several times a day by an airlift.
Therefore, there was no sludge accumulation in botch cleaning sections. The total sludge mass of the Biofilm and the activated sludge in the reactor chambers is negligible to the sludge accumulation in the pre-settlement tank.
There was no sludge removed from the system during the test;

The final sludge concentrations in the pre-settlement tank was 1,6 g/l (19/11/2008).

The total quantity of sludge produced during 363 days was 4, 8 kg (d.m.)
Sludge level pre-settlement tank : 30 cm, 32 cm, 35 cm (19/11/2008)

4.4.5 Fault detection system assessment

A fault detection system is present and concentrates mainly on the power supply to the compressors.

4.4.6 Installation and operating instructions

Installation and operating instructions are present.

4.4.7 General overvieuw of the scaling rules used by the manufacturer

Note : Detailed scaling rules can be found in annex 2

Daily amount of water in BioKube systems to achieve a given cleaning requirement

Outlet requirement / BioKube system	**BOD<10 NH4<5 (mg/litre)**	**BOD<20 NH4<20 (mg/litre)**	**BOD<25 (mg/litre)**	**BOD<30 (mg/litre)**	**BOD<40 (mg/litre)**
Pluto	N/A (will not fulfil demand)	N/A (will not fulfil demand)	750 litres. 5 PE	750 litres. 5 PE	1050 litres 7 PE
Venus 1850	750 litre 5 PE	1000 litre 7 PE	1500 litre 10 PE	1500 litre 10 PE	
Venus 2200	1500 litre 10 PE	2250 litre 15 PE	3000 litre 20PE	3000 litre 20 PE	
Mars 3000 2K	3000 litre 20 PE	3750 litre 25 PE	4500 litre 30PE	5250 litre 35PE	
Mars 3000 3K	4500 litre 30 PE	5250 litre 35 PE	6000 litre 40 PE	6750 litre 45 PE	
Mars 3000 4 K	6000 litre 40 PE	6750 litre 45 PE	7500 litre 50 PE	8000 litre 55 PE	

<u>Specification of 1 PE</u> (<u>P</u>ersonnel <u>E</u>quivalent)

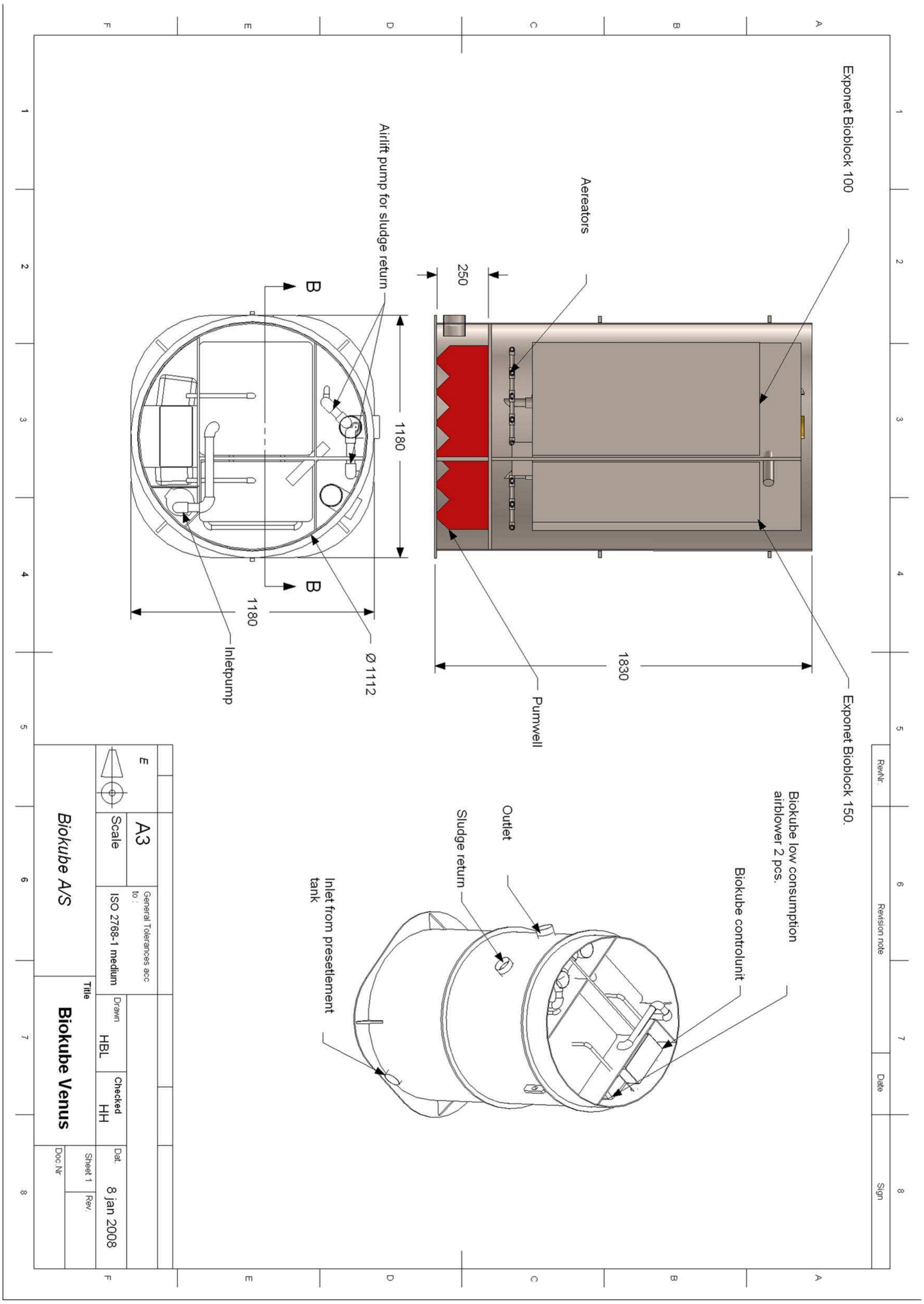
One PE equals:
Up to 60 gram BOD/day
Up to 200 litre water/day.

In table above the daily water consumption is 150 litre/day pr. PE.
If the amount of water is below or above 150 litre/day pr. PE then this fluctuation in incoming amount of water is handled by BioKubes patent of timed inflow.

Annex 1

Technical drawings

BioKube Venus 1850 (5 PE)


Exponet Bioblock 100
Aereators
Airlift pump for sludge return
250
B
1180
1180
B
Ø 1112
Inletpump
Pumwell
1830
Exponet Bioblock 150.
Biokube low consumption airblower 2 pcs.
Biokube controlunit
Outlet
Sludge return
Inlet from presetlement tank
RevNr.
Revision note
Date
Sign
E
A3
Scale
General Tolerances acc to :
ISO 2768-1 medium
Drawn
HBL
Checked
HH
Dat.
8 jan 2008
Sheet 1
Rev.
Doc.Nr
Biokube A/S
Title
Biokube Venus

Annex 2

Scaling rules used by the manufacturer

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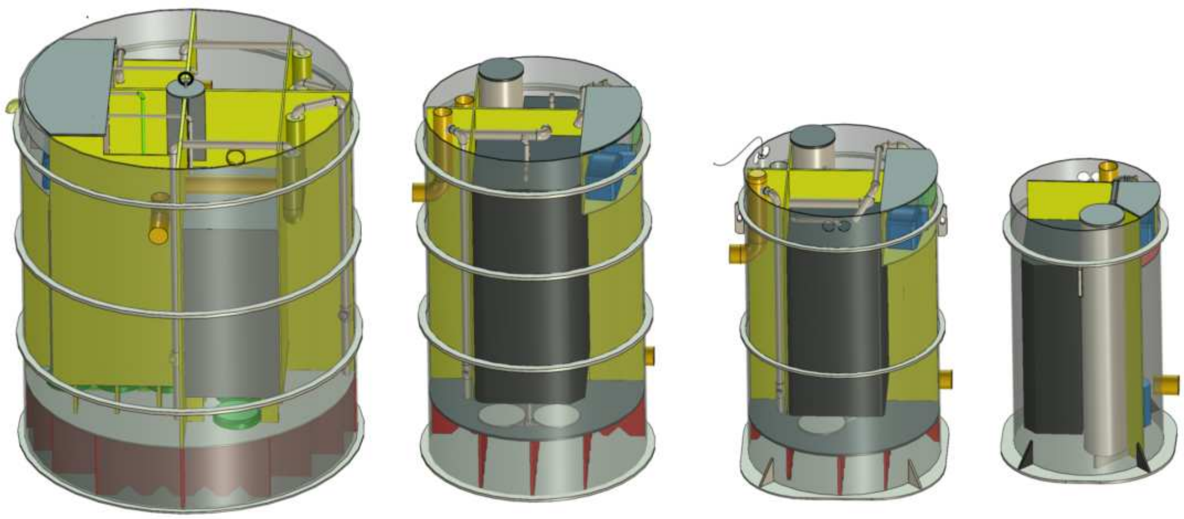
Treatment efficiency calculations
after CEN 12566-3 section 6.3 and section B.5 i)
based on CEN 12566-3 test from CERTIPRO

Manufactures Design calculations in regards to test and approval according to CEN 12566-3 for BioKube wastewater systems 5 – 50 PE

Mars 3000	Venus 2200	Venus 1850	Pluto
15 – 55 PE	10 – 25 PE	5 – 10 PE	5 - 7 PE



BioKubes design calculations in this document cover size calculations in two respects:

BioKube Venus 1850 is measured under CEN 12566-3 test specifications, to have a cleaning capability of BOD = 7.3 mg/l for 750 litre of wastewater pr. day.

a) It is calculated how much waste water each of the different BioKube systems Mars, Venus and Pluto (all of which are based on the same basic technology) will treat if the cleaning requirements are BOD < 10 mg/l. (Same cleaning requirements as measured Venus 1850, calculation on water amount only)

b) It is calculated how much water each of the different BioKube systems will treat if the cleaning requirements are BOD < 10 mg/l, BOD < 25 mg/l, BOD < 30 mg>l og BOD < 50 mg/l (larger amounts of water can be treated in a given system if the cleaning requirements are less stringent).

Table of content

Preface

BioKube wastewater treatment systems are designed and certified in accordance with the standards described in CEN 12566-3.

The measurements behind said certification were performed at CertiPro, Certification and Testing department of Vito, Boeretang 200, B-2400 Mol, Belgium.

The testing was preformed during the period 22/11/2007 to 29/10/2008.

The tests showed the following average cleaning results:

BOD_5 :	7.3 mg/l	(reduction 97 %)
COD	81 mg / l	(reduction 89 %)
NH4-N	2.5 mg/l	(reduction 96 %)
SS	11.9 mg/l	(reduction 96 %)

The measurements at CertiPro were preformed on a BioKube Venus 5 PE system. In this document nominated as BioKube 1850 to differentiate it from the different models.

Size calculations for different system sizes from 5 – 50 PE and with different cleaning demands on the outgoing water.

The test results from CertiPro and BioKubes documented and verified size calculations are used to calculate the amount of water (i.e. also number of PE) different BioKube systems can clean.

The amount of water (number of PE) a given system can clean depends on the outlet requirements in the area where the system is installed. The more stringent the outlet requirements, the smaller amount of water can be treated. And vice versa, the less stringent the outlet requirements, the larger amount of water a system can clean.

The amount of water a system can clean to a given outlet demand also depends on the content of the incoming sewage water to be treated. In this document it is assumed that the incoming sewage water is standard household sewage water as defined in CEN 12566-3 section B.3.2.:

BOD_5 150 mg/l to 500 mg/l, or COD 300 mg/l to 1.000 mg/l
SS 200 mg/l to 700 mg/l
KN 25 mg/l to 100 mg/l or HN4 – N 22 mg/l to 80 mg/l
P_{tot} 5 mg/l to 20 mg/l

The systems documented in this paper are:
BioKube Venus 1850. (In test at CertiPro nominated BioKube Venus 5 PE)
BioKube Venus 2200.
BioKube Mars 3000 / 2 chambers.
BioKube Mars 3000 / 3 chambers.
BioKube Mars 3000 / 4 chambers.
BioKube Pluto.

For the BioKube systems listed above, there is in this document for each system given figures on how much water each system will clean to the following outlet demands:
BOD_5 < 10 mg/l and NH4-N < 5 mg/l and SS < 15 mg/l
BOD_5 < 20 mg/l and NH4-N < 20 mg/l and SS < 20 mg/l
BOD_5 < 25 mg/l and SS < 30 mg/l
BOD_5 < 30 and SS < 30 mg/l
BOD_5 < 40 and SS < 50 mg/l
Given that incoming sewage water to be treated is standard household sewage water as defined above.

Regarding number of PE

These are based on incoming BOD of 60 g/day per person and 150 l of water per day.

If the amount of water differs per person then the difference in water is regulated via timed inflow into the system being changed at setup of the system. The amount of BOD pr. PE is still assumed to be 60 gram BOD pr person pr. day. This adjustment is part of BioKubes patent.

BioKube design calculation basis.

The size calculations for BioKube systems are based on the following material:

1. **Degrading ability pr m^2 of BioBlock filters**
   Se detailed graph on page 7 - 8.

2. **BioKube verification of cleaning ability for over 2.200 systems installed in Denmark.**
   BioKube design theory in tables on page 2 – 4 verifies in live field tests on 700 systems installed at individual houses in Denmark the theory behind BioKubes calculations.

3. **BioKube patent US 7,476,321 B2**
   This patent covers the basis of how the flow of water through a BioKube system is controlled.

4. **BioKube patent (pending) WO 2009/047230 A1**
   This patent covers the basic construction and hydraulic flow of BioKube 5 – 50 PE systems.

Built in overcapacity for increased stability.

All BioKube systems are put on the market with a built in “over capability” of approx 25 %. This built in over capability means there always will be a very stable performance from a BioKube systems and that a BioKube system does not have any problems with unexpected overload in the incoming water.

The BioKube systems, general overview of cleaning capability.

Table for daily amount of water in BioKube systems to achieve a given cleaning requirement

Outlet requirement / BioKube system	**BOD<10 NH4<5 (mg/litre)**	**BOD<20 NH4<20 (mg/litre)**	**BOD<25 (mg/litre)**	**BOD<30 (mg/litre)**	**BOD<40 (mg/litre)**
Pluto	N/A (will not fulfil demand)	N/A (will not fulfil demand)	750 litres. 5 PE Section 1.3	750 litres. 5 PE Section 1.3	1050 litres 7 PE Section 1.4
Venus 1850	750 litre 5 PE Section 2.1	1000 litre 7 PE Section 2.2	1500 litre 10 PE Section 2.3	1500 litre 10 PE Section 2.3	
Venus 2200	1500 litre 10 PE Section 3.1	2250 litre 15 PE Section 3.2	3000 litre 20PE Section 3.3	3000 litre 20 PE Section 3.3	
Mars 3000 2K	3000 litre 20 PE Section 4.1	3750 litre 25 PE Section 4.2	4500 litre 30PE Section 4.3	5250 litre 35PE Section 4.4	
Mars 3000 3K	4500 litre 30 PE Section 5.1	5250 litre 35 PE Section 5.2	6000 litre 40 PE Section 5.3	6750 litre 45 PE Section 5.4	
Mars 3000 4 K	6000 litre 40 PE Section 6.1	6750 litre 45 Section 6.2	7500 litre 50 Section 6.3	8000 litre 55 PE Section 6.4	

Specification of 1 PE (Personnel Equivalent)

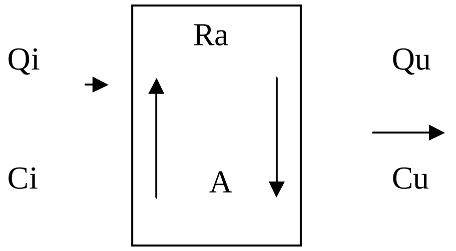
One PE equals:
Up to 60 gram BOD/day
Up to 200 litre water/day.

In table above the daily water consumption is 150 litre/day pr. PE.
If the amount of water is below or above 150 litre/day pr. PE then this fluctuation in incoming amount of water is handled by BioKubes patent of timed inflow.

BioKube design calculation basis

For BioKube Venus, Mars and Pluto systems.

<u>BASIC FORMULA FOR AERATED SUBMERGED FILTERTECHNOLOGI</u>



Qi = daily flow in
Ci = inlet concentration to each step
Qu= daily flow out
Cu = outlet concentration from each step
Ra= Surface performance submerged filter
A = Submerged filter area

$Qi \times Ci - Ra \times A = Qu \times Cu$ and: $Qi = Qu$

and:

$$A = \frac{Qi\,(Ci - Cu)}{Ra}$$

<u>ASSUMPTION, Ideal blended water:</u>

Ideal blended water in each cleaning step with O2 concentration of minimum 6 mg/l. The ideal blending of water in each cleaning chamber is archived by a combination of timed inflow (giving an even distribution over time of the incoming waste water) and the powerful and continues mixing of water in the aerated chambers by the raising air from the diffusers.

Section 1.1

BOD treatment / BOD Reduction Ratio.

The BOD treatment / reduction value is very depended of the concentration of BOD in the water.

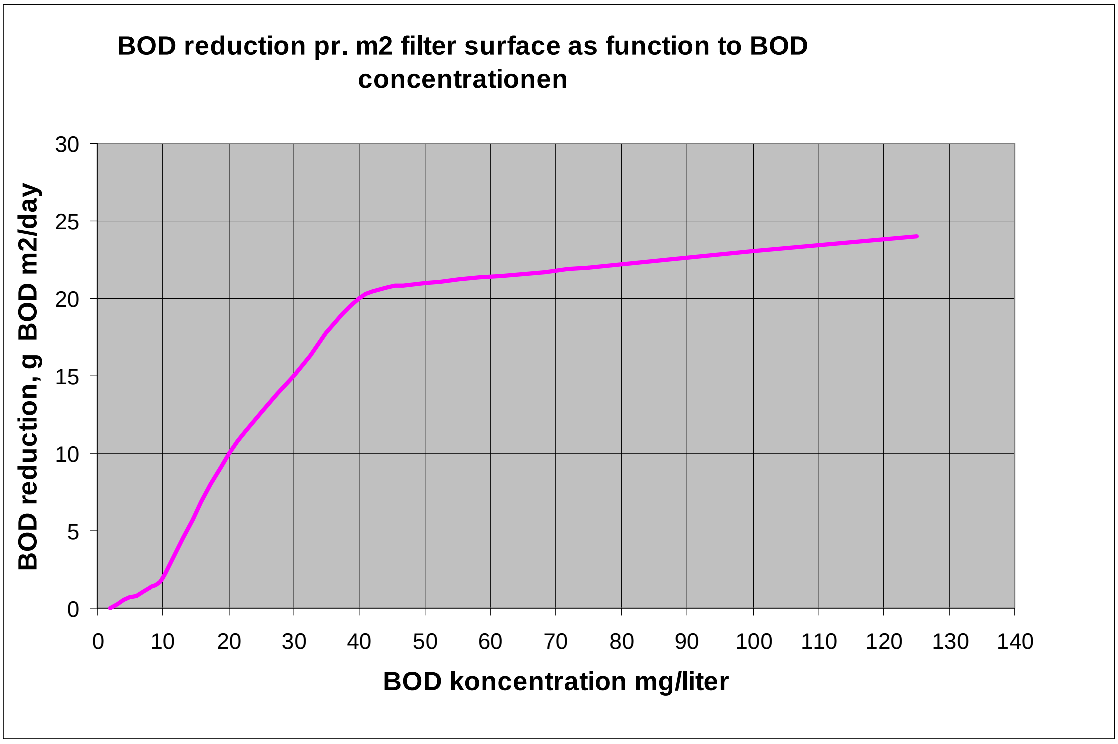


Table 1.

From table above the following basic reduction of BOD as a reduction pr. m^2 filter area from a given BOD concentration can be used.

	BOD 500-30 mg/litre (in chamber 1)	BOD 30- 10 mg/litre (in chamber 2 if applicable)
Reduction in gram of BOD day/m2 filter surface.	15	2

Section 1.2

NH4 Treatment / NH4 reduction ratio.

Assuming temperature > 5 Celsius.

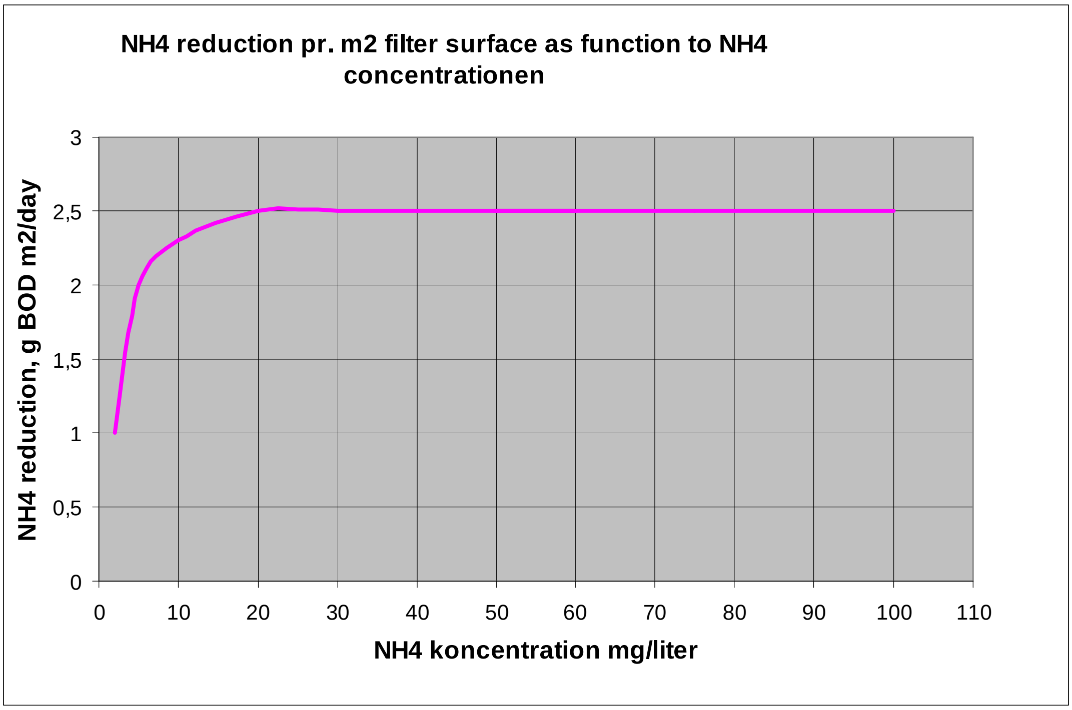


Table 2

From table above following numbers are the Biokube main figures in dimensioning systems.

Ra.	NH4: 80- 5 mg/litre
Filter surface performance Gram NH4 a day/m2 filter surface.	2

Suspended solids.

After each aerated biological cleaning step there is a settlement zone.

The maximum allowed up going water velocity is 1 m/hour. This ensures the sludge in the treated waste water will settle in the bottom of the system and will be cleaned out by the airlift pumps.

Equalized load to system.

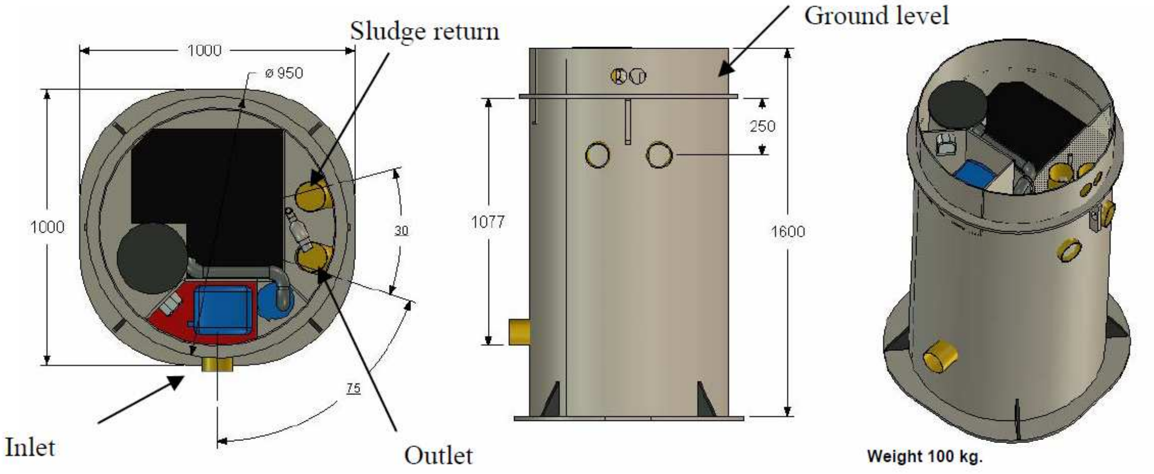
The buffer tank size in the BioKube system is 15-30% of daily load.

This assures the capability og efficient timed inflow.

Section 1.3

Pluto system 750 litre a day.

Cleaning level:
BOD<25 mg/litre,
COD<125 mg/litre,
SS <35 mg/litre).

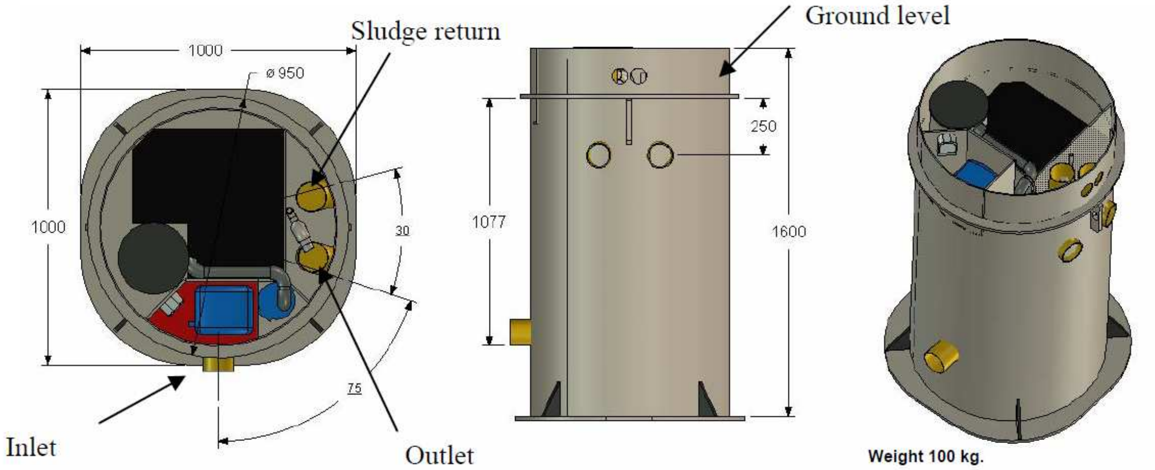


Ingoing water. BOD mg/litre	**Outgoing water. BOD mg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	203	15	14
30	25	3,75	2	**2**
		Filter Surface needed for BOD reduction to 10 mg/litre		**16**
		Filter surface present in Pluto (BioBlock 100).		**32,0**
		Because of the extra filter surface (32-16) =16 m2 the lower theoretical limit for BOD5 in a Pluto is 5-7 mg/litre.		

Section 1.4

Pluto system 1050 litre a day.

Cleaning level:
BOD<40 mg/litre,
COD<150 mg/litre,
SS <50 mg/litre).

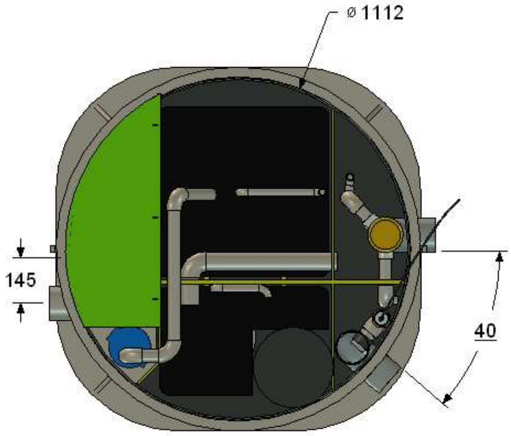


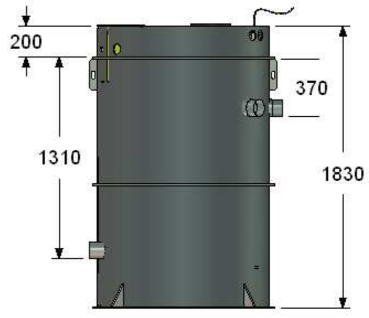
Ingoing water. BOD mg/litre	**Outgoing water. BOD mg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	40	273	15	18
		Filter Surface needed for BOD reduction to 40 mg/litre		**18**
		Filter surface present in Pluto (BioBlock 100).		**32,0**
		Because of the extra filter surface (32-18) =14 m2 the lower theoretical limit for BOD5 in a Pluto is 5-10 mg/litre.		

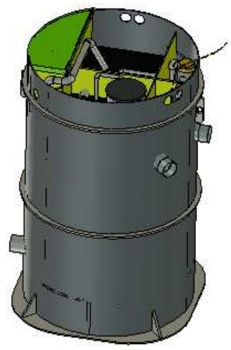
Section 2.1

<u>Venus 1850 system 750 litre a day.</u>

Cleaning level:
BOD<10 mg/litre,
COD<75 mg/litre,
NH4<5 mg/litre,
SS <15 mg/litre).





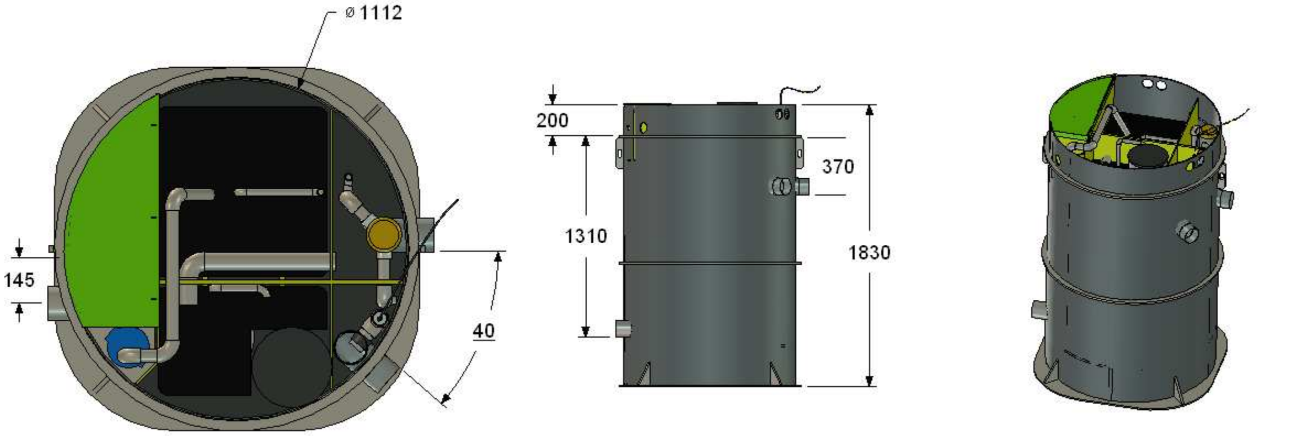


Ingoing water. BOD mg/litre	**Outgoing water. BOD mg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	203	15	14
30	10	15	2	**7,5**
		Filter Surface needed for BOD reduction to 10 mg/litre		**21,5**
		Filter surface present in Venus 1850 (1. chamber Bioblok 100).		**32,0**
		Because of the extra filter surface (32-21,5) = 10,5 m2 the theoretical lower limit for BOD5 in a Venus 1850 is 5-7 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	5	41	2	20,5
		Filter Surface needed for NH4 reduction to 5 mg/litre.		20,5
		Filter surface present in Venus 1850. (2. chamber – Bioblock 200).		32
		Because of the extra surface is (32-20,5) = 9,5 m2, the theoretical lower limit for NH4 in a Venus 1850 is close to 1-2 mg/litre.		

Section 2.2

Venus 1850 system 1000 litre a day.

Cleaning level:
BOD<20 mg/litre,
COD<100 mg/litre,
NH4<10 mg/litre,
SS <35 mg/litre).

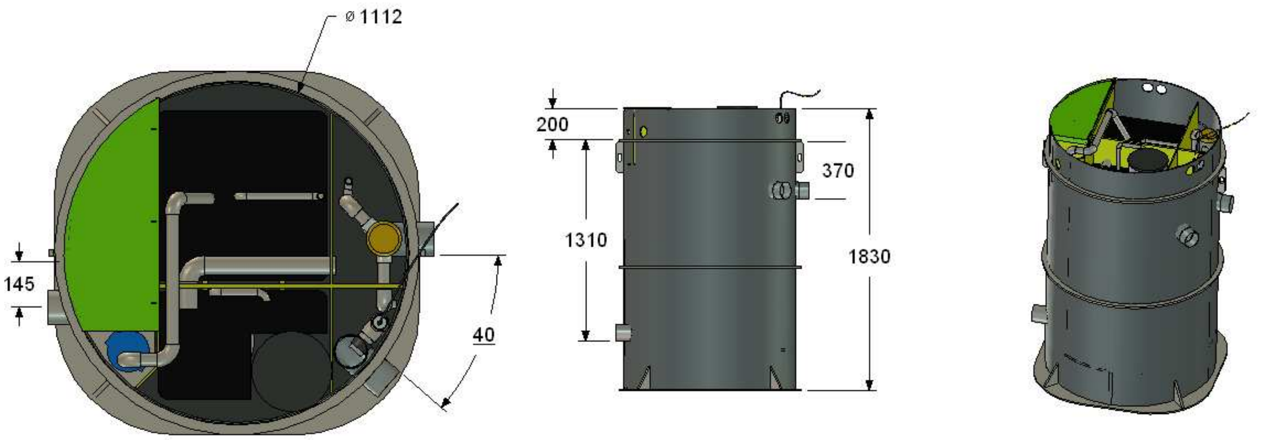


Ingoing water. BOD mg/litre	**Outgoing water. BOD mg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	270	15	18
30	20	10	2	5
		Filter Surface needed for BOD reduction to 20 mg/litre		23
		Filter surface present in Venus 1850 (1. chamber Bioblok 100).		32,0
		Because of the extra filter surface (32-23) = 9 m2 the theoretical lower limit for BOD5 in a Venus 1850 is 10-15 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	10	50	2	25
		Filter Surface needed for NH4 reduction to 10 mg/litre.		25
		Filter surface present in Venus 1850. (2. chamber – Bioblock 200).		32
		Because of the extra surface is (32-25) = 7 m2 the theoretical lower limit for NH4 in a Venus 1850 is 5-10 mg/litre.		

Section 2.3

<u>Venus 1850 system 1500 litre a day.</u>

Cleaning level:
BOD<25 mg/litre,
COD<125 mg/litre,
NH4<30 mg/litre,
SS <35 mg/litre).

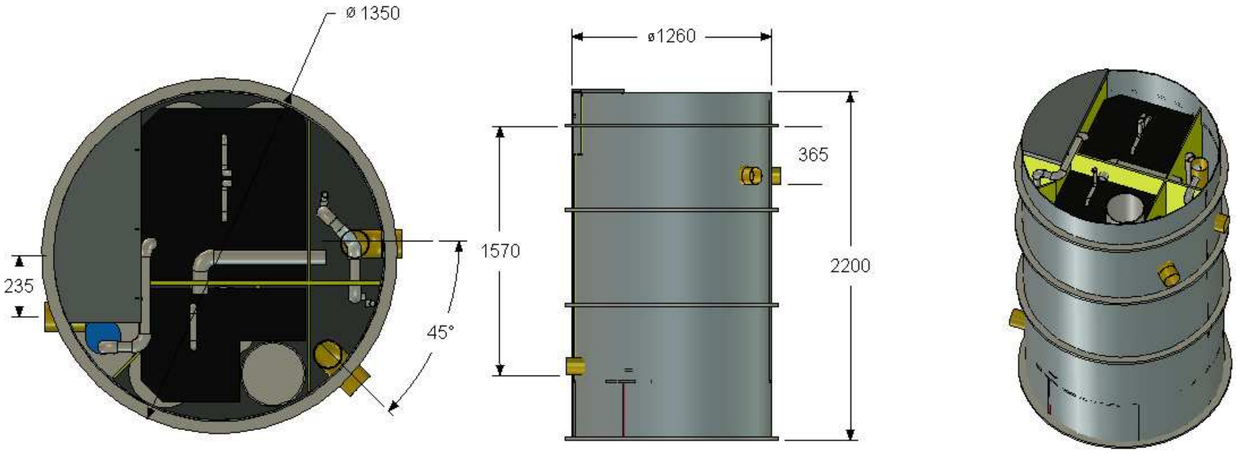


Ingoing water. BOD mg/litre	**Outgoing water. BOD mg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	405	15	27
30	25	7,5	2	3,8
		Filter Surface needed for BOD reduction to 30 mg/litre		31
		Filter surface present in Venus 1850 (1. chamber Bioblok 100).		32,0
		The demand for BOD5 in a Venus 1850 is already fulfilled in the 1st chamber. In the 2. chamber the BOD will be reduced down to 10-15 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	30	45	2	22,5
		Filter Surface needed for NH4 reduction to 30 mg/litre.		22,5
		Filter surface present in Venus 1850. (2. chamber – Bioblock 200).		32
		Because of the extra surface is (32-22,5) = 9,5 m2 the theoretical lower limit for NH4 in a Venus 1850 is 15-20 mg/litre.		

Section 3.1

<u>Venus 2200 system 1500 litre a day.</u>

Cleaning level:
BOD<10 mg/litre,
COD<75 mg/litre,
NH4<5 mg/litre,
SS<15 mg/litre).

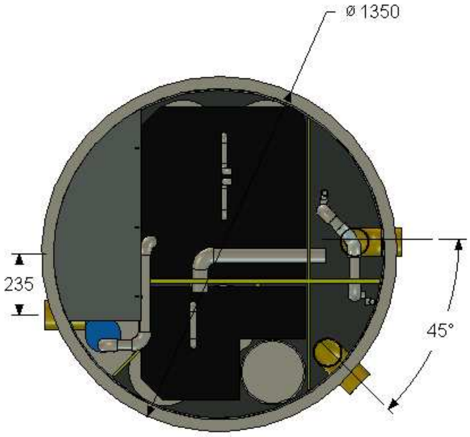


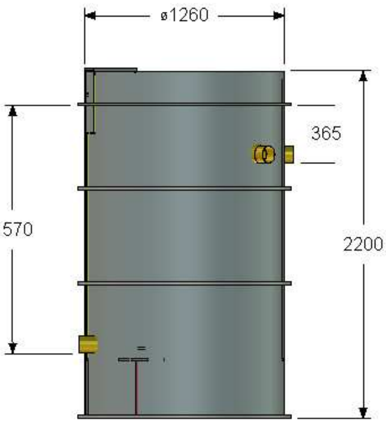
Ingoing water. BOD mg/litre	Outgoing water. BOD mg/litre	BOD load gram/day	BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)	submerged filter surface needed. (m2)
300	30	405	15	27
30	10	30	2	15
		Filter Surface needed for BOD reduction to 10 mg/litre		42
		Filter surface present in Venus 2200 (1. chamber Bioblok 100).		60
		Because of the extra filter surface (60-42) = 18 m2 the theoretical lower limit for BOD5 in a Venus 2200 is 5-7 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	5	83	2	41
		Filter Surface needed for NH4 reduction to 5 mg/litre.		41
		Filter surface present in Venus 2200. (2. chamber – Bioblock 200).		60
		Because of the extra surface is (60-41) = 19 m2 the theoretical lower limit for NH4 in a Venus 2200 is 1-2 mg/litre.		

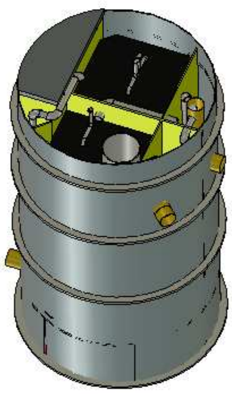
Section 3.2

<u>Venus 2200 system 2250 litre a day.</u>

Cleaning level:
BOD<20 mg/litre,
COD<100 mg/litre,
NH4<10 mg/litre,
SS <35 mg/litre).





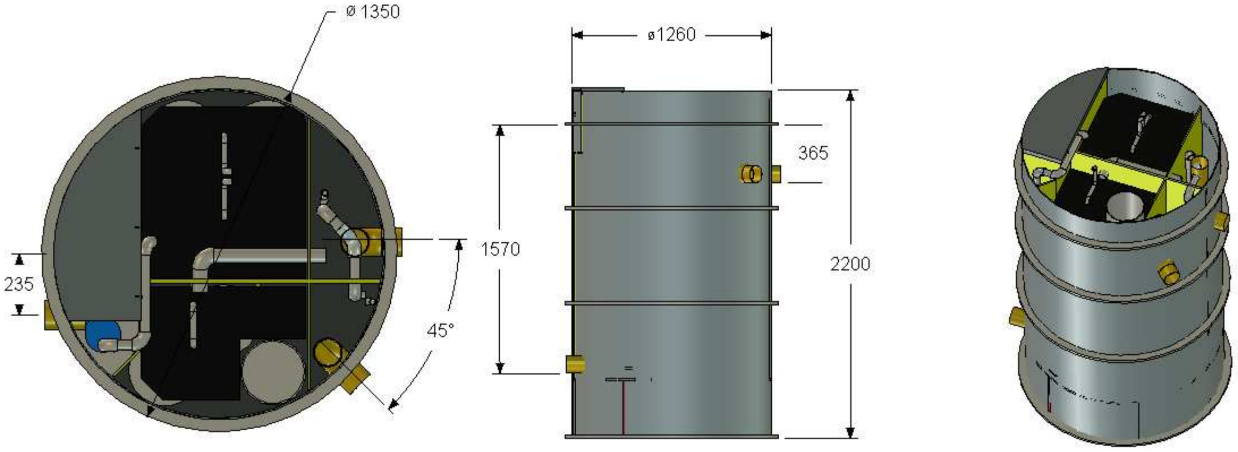


Ingoing water. BOD mg/litre	**Outgoing water. BOD mg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	607	15	41
30	20	22,5	2	11
		Filter Surface needed for BOD reduction to 20 mg/litre		52
		Filter surface present in Venus 2200 (1. chamber Bioblok 100).		60
		Because of the extra filter surface (60-52) = 8 m2 the theoretical lower limit for BOD5 in a Venus 2200 is 10-15 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	10	113	2	56
		Filter Surface needed for NH4 reduction to 10 mg/litre.		56
		Filter surface present in Venus 2250. (2. chamber – Bioblock 200).		60
		Because of the extra surface is (60-56) = 4 m2 the theoretical lower limit for NH4 in a Venus 2250 is 8 - 10 mg/litre.		

Section 3.3

Venus 2200 system 3000 litre a day.

Cleaning level:
BOD<25 mg/litre,
COD<125 mg/litre,
NH4<30 mg/litre,
SS<35 mg/litre).

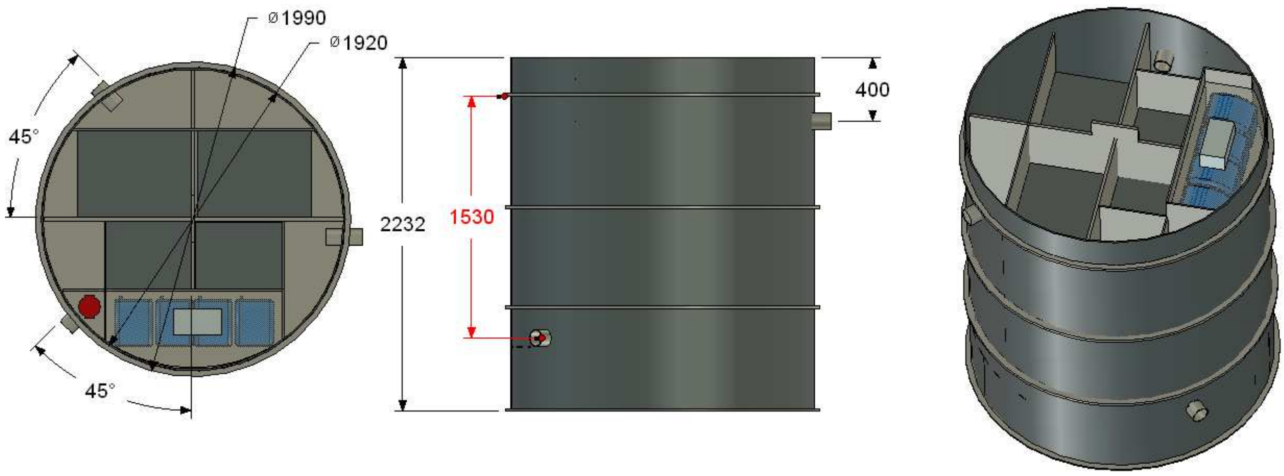


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	810	15	54
30	25	15	2	7,5
		Filter Surface needed for BOD reduction to 30 mg/litre		61,5
		Filter surface present in Venus 2200 (1. and 2. chamber Bioblok 100 and 200).		120
		Because of the extra filter surface (120-61,5) = 58,6 m2 the theoretical lower limit for BOD5 in a Venus 2200 is 15-20 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	30	90	2	45
		Filter Surface needed for NH4 reduction to 30 mg/litre.		45
		Filter surface present in Venus 2200 for nitrification (2. chamber – Bioblock 200).		55
		Because of the extra surface is (55 - 45) = 10 m2 the theoretical lower limit for NH4 in a Venus 2200 is 20-25 mg/litre.		

Section 4.1

Mars 3000 2K system, 3000 litre a day.

Cleaning level:
BOD<25 mg/litre,
COD<125 mg/litre,
SS<35 mg/litre).

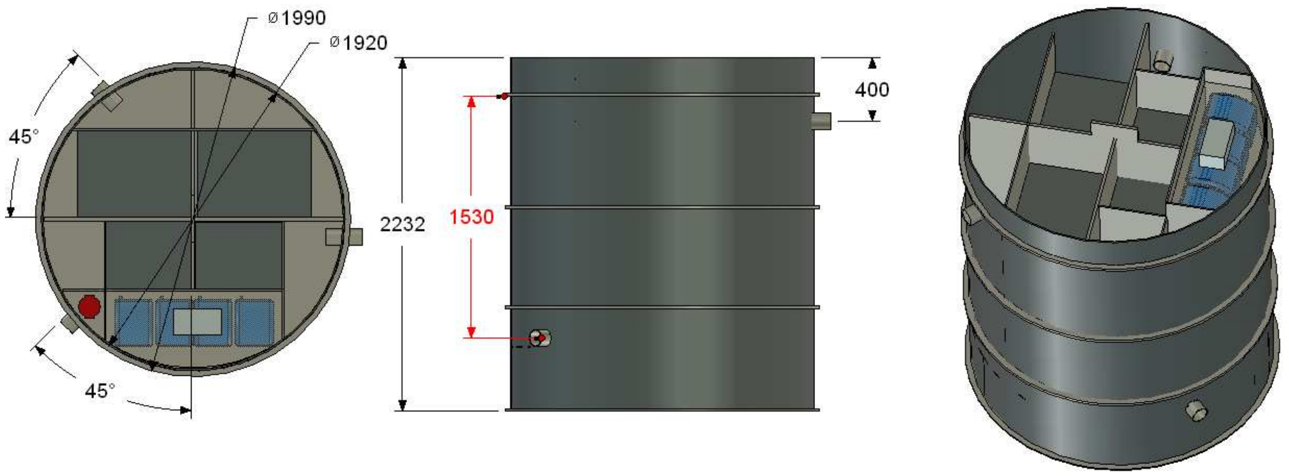


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	810	15	54
30	25	15	2	7,5
		Filter Surface needed for BOD reduction to 25 mg/litre		61,5
		Filter surface present in Mars 3000-2K (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-61,5) = 88 m2 the theoretical lower limit for BOD5 in a Mars 3000 2K is 5-7 mg/litre.		

Section 4.2

<u>Mars 3000 2K system, 3750 litre a day.</u>

Cleaning level:
BOD<25 mg/litre,
COD<125 mg/litre,
SS<35 mg/litre).

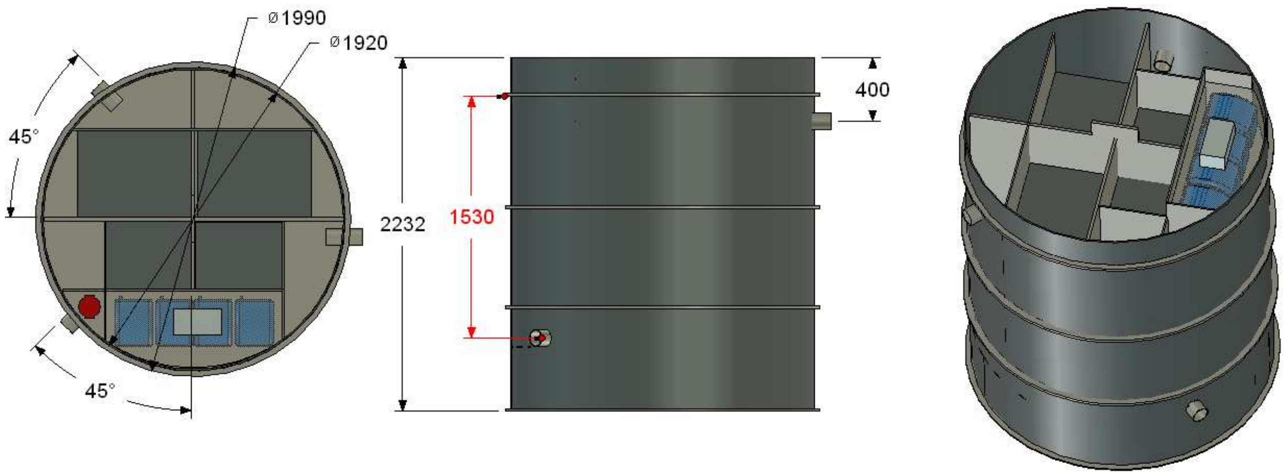


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	1012	15	67
30	25	18,7	2	9,35
		Filter Surface needed for BOD reduction to 25 mg/litre		76
		Filter surface present in Mars 3000-2K (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-76) = 73 m2 the theoretical lower limit for BOD5 in a Mars 3000 2K is 5-7 mg/litre.		

Section 4.3

Mars 3000 2K system, 4500 litre a day.

Cleaning level:
BOD<25 mg/litre,
COD<125 mg/litre,
SS<35 mg/litre).

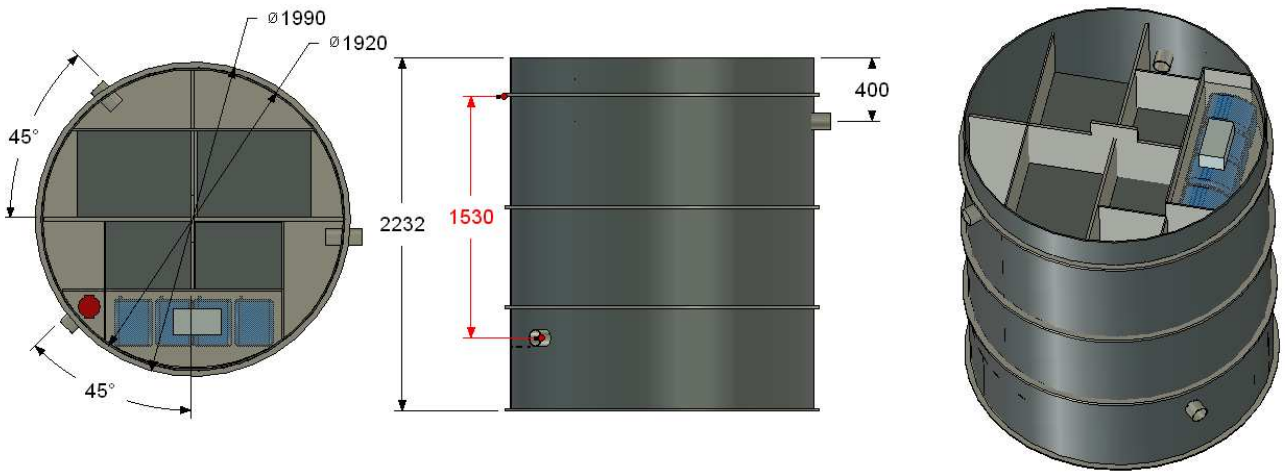


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	1215	15	81
30	25	22,5	2	11,25
		Filter Surface needed for BOD reduction to 25 mg/litre		93
		Filter surface present in Mars 3000-2K (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-93) = 57 m2 the theoretical lower limit for BOD5 in a Mars 3000 2K is 5-7 mg/litre.		

Section 4.4

<u>Mars 3000 2K system, 5250 litre a day.</u>

Cleaning level:
BOD<30 mg/litre,
COD<125 mg/litre,
SS<35 mg/litre).

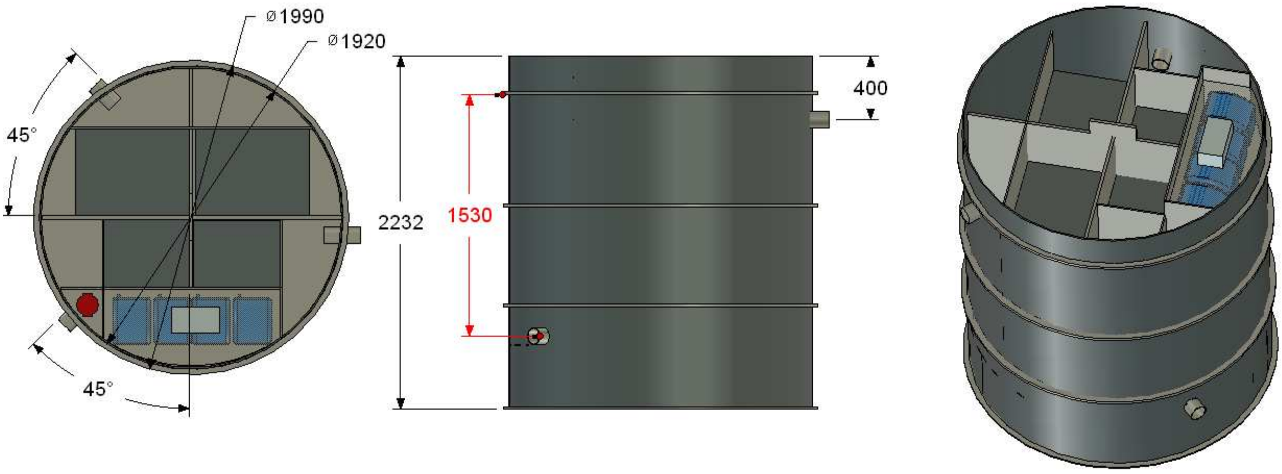


Ingoing water. BOD mg/litre	Outgoing water. BODmg/litre	BOD load gram/day	BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)	submerged filter surface needed. (m2)
300	30	1417	15	94
		Filter Surface needed for BOD reduction to 30 mg/litre		94
		Filter surface present in Mars 3000-2K (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-94)) = 56 m2 the theoretical lower limit for BOD5 in a Mars 3000 2K is 5-7 mg/litre.		

Section 5.1

<u>Mars 3000 3K system, 4500 litre a day.</u>

Cleaning level:
BOD<10 mg/litre,
NH4<5 mg/litre
COD<75 mg/litre,
SS<15 mg/litre).

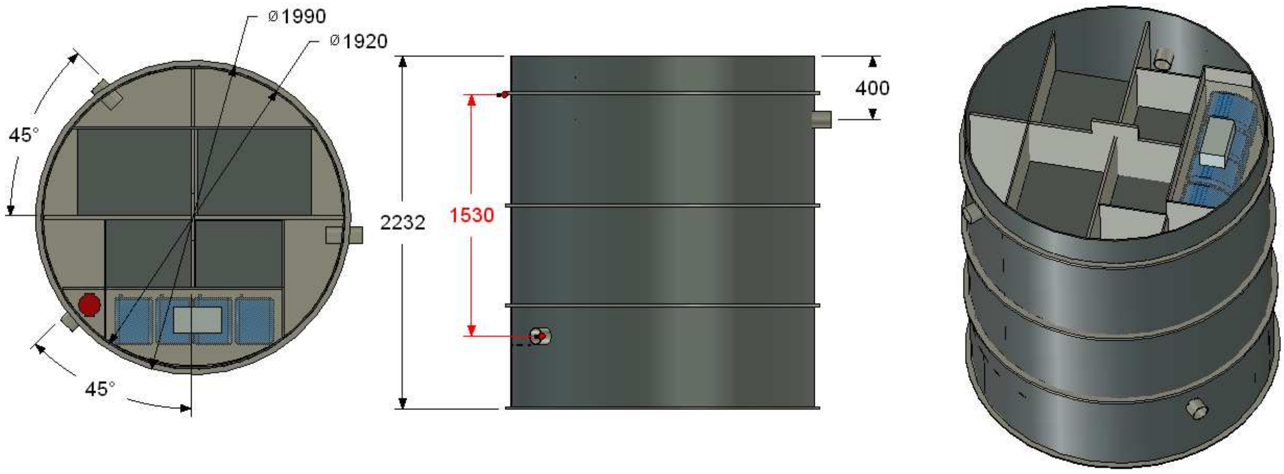


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	1215	15	81
30	10	90	2	45
		Filter Surface needed for BOD reduction to 30 mg/litre		126
		Filter surface present (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-126) =24 m2 the theoretical lower limit for BOD5 in a Mars 3000 3K is 1 - 2 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	5	247	2	123
		Filter Surface needed for NH4 reduction to 30 mg/litre.		123
		Filter surface present in Mars 3000 3K for nitrification (3. chamber – Bioblock 200).		100
		Because of the extra surface from chamber 1 and 2 theoretical the lower limit for NH4 in a Mars 3000 3K is 1-2 mg/litre.		

Section 5.2

Mars 3000 3K system, 5250 litre a day.

Cleaning level:
BOD<20 mg/litre,
NH4<20 mg/litre
COD<100 mg/litre,
SS<35 mg/litre).

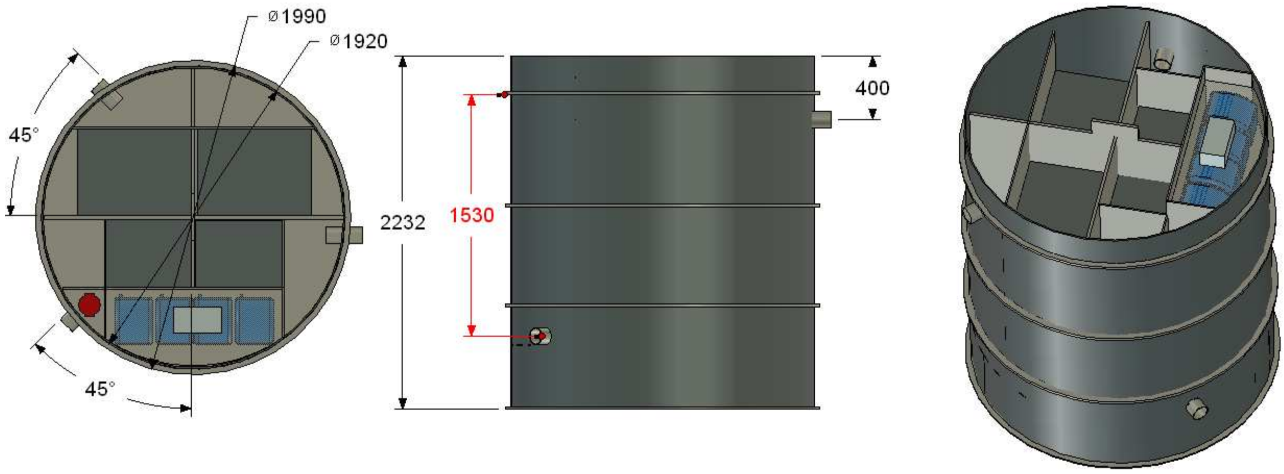


Ingoing water. BOD mg/litre	Outgoing water. BODmg/litre	BOD load gram/day	BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)	submerged filter surface needed. (m2)
300	30	1417	15	94
30	20	52	2	26
		Filter Surface needed for BOD reduction to 30 mg/litre		120
		Filter surface present (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-120) = 30 m2 the theoretical lower limit for BOD5 in a Mars 3000 3K is 10-15 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	10	262	2	131
		Filter Surface needed for NH4 reduction to 30 mg/litre.		131
		Filter surface present in Mars 3000 3K for nitrification (3. chamber – Bioblock 200).		100
		Because of the extra surface from chamber 1 and 2 the theoretical limit for NH4 in a Mars 3000 3K is 5-7 mg/litre.		

Section 5.3

<u>Mars 3000 3K system, 6000 litre a day.</u>

Cleaning level:
BOD<25 mg/litre,
NH4<30 mg/litre
COD<125 mg/litre,
SS<35 mg/litre).

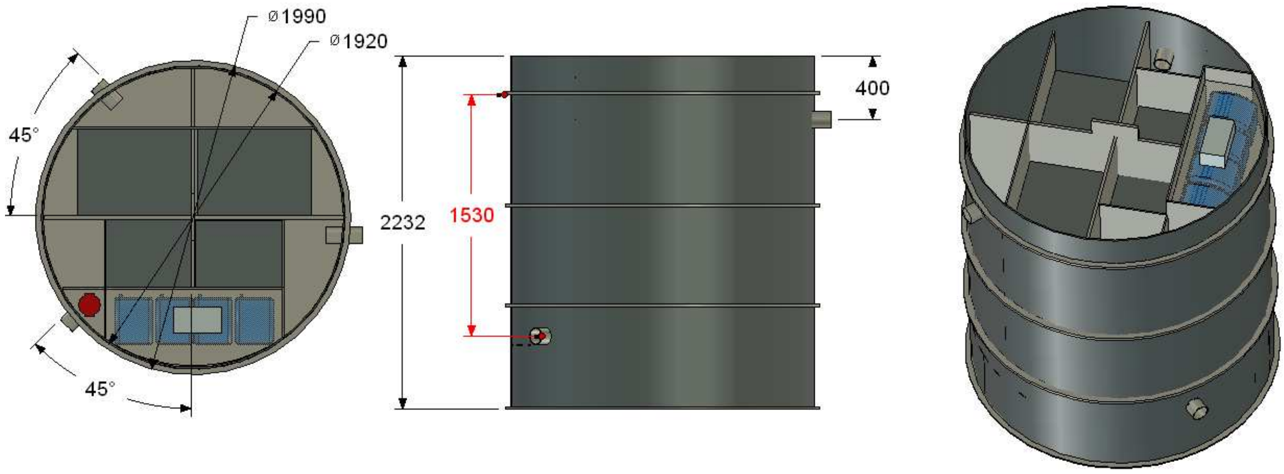


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	1620	15	108
30	25	30	2	15
		Filter Surface needed for BOD reduction to 25 mg/litre		123
		Filter surface present (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-123) = 27 m2 the theoretical lower limit for BOD5 in a Mars 3000 3K is 15-20 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	30	180	2	90
		Filter Surface needed for NH4 reduction to 30 mg/litre.		90
		Filter surface present in Mars 3000 3K for nitrification (3. chamber – Bioblock 200).		100
		Because of the extra filter surface 100-90 = 10 m2 and the ekstra surface from chamber 1 and 2 the theoretical lower limit for NH4 in a Mars 3000 3K is 10-20 mg/litre.		

Section 5.4

<u>Mars 3000 3K system, 6750 litre a day.</u>

Cleaning level:
BOD<30 mg/litre,
NH4<30 mg/litre
COD<125 mg/litre,
SS<35 mg/litre).

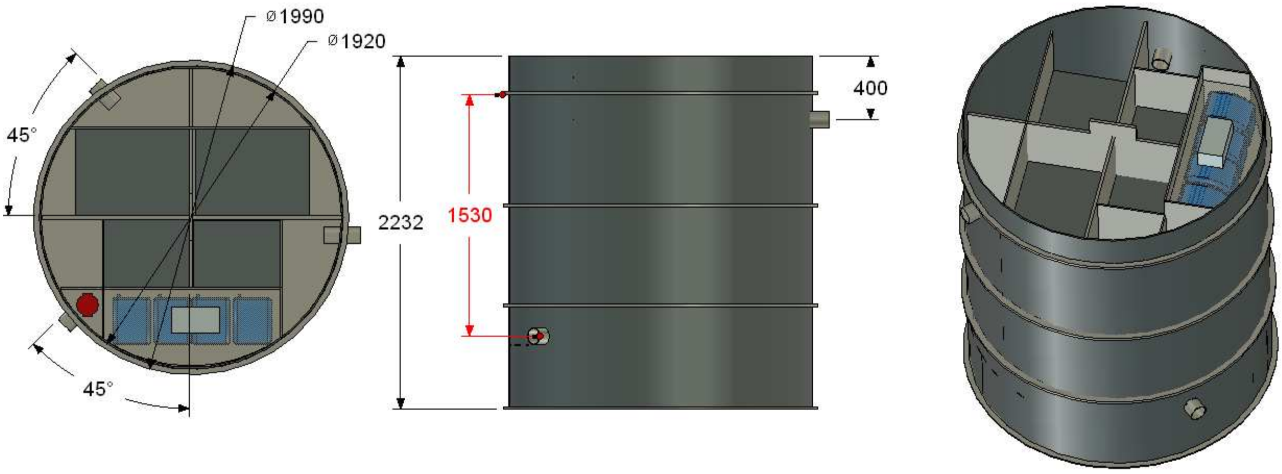


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	1822	15	121
		Filter Surface needed for BOD reduction to 30 mg/litre		121
		Filter surface present (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface (150-121) = 29 m2 the theoretical lower limit for BOD5 in a Mars 3000 3K is 15-20 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	30	200	2	100
		Filter Surface needed for NH4 reduction to 30 mg/litre.		100
		Filter surface present in Mars 3000 3K for nitrification (3. chamber – Bioblock 200).		100
		Because of the extra filter surface in chamber 1 and 2, 29 m2, the theoretical limit for Mars 3000 3K is 10-20 mg/litre.		

Section 6.1

Mars 3000 4K system, 6000 litre a day.

Cleaning level:
BOD<10 mg/litre,
NH4<5 mg/litre
COD<75 mg/litre,
SS<15 mg/litre).

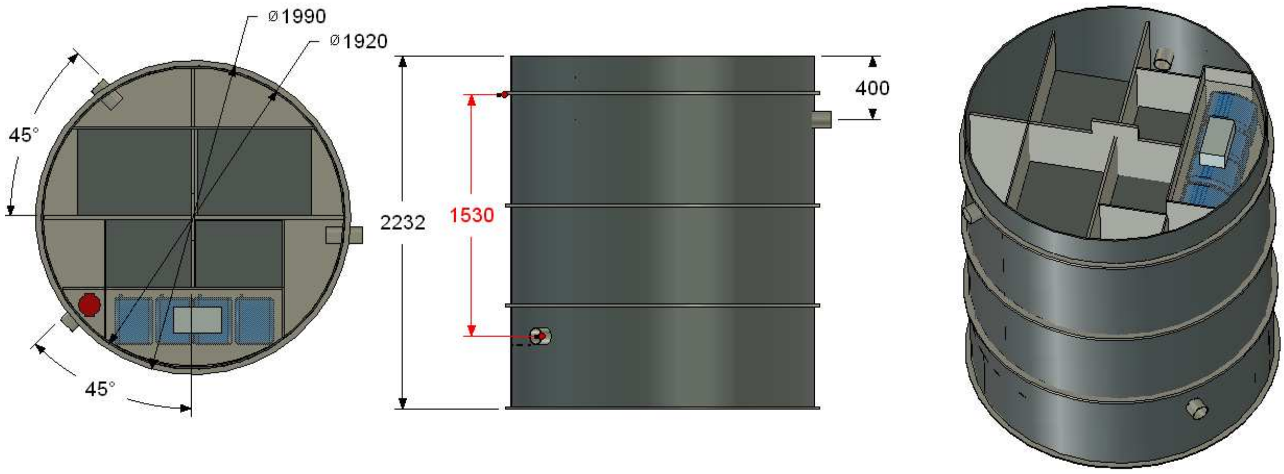


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	1620	15	108
30	10	120	2	60
		Filter Surface needed for BOD reduction to 30 mg/litre		168
		Filter surface present (1. and 2. chamber Bioblok 100 and 200).		150
		Because of the extra filter surface from chamber 3 and 4 the 35 m2 the theoretical limit for BOD5 in a Mars 3000 3K is 5-7 mg/litre.		
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	5	330	2	165
		Filter Surface needed for NH4 reduction to 30 mg/litre.		165
		Filter surface present in Mars 3000 4K for nitrification (3. chamber – Bioblock 200).		200
		Because of the extra filter surface 200-165 = 35 m2, the theoretical lower limit for NH4 in a Mars 3000 4K is 1-2 mg/litre.		

Section 6.2

Mars 3000 4K system, 6750 litre a day.

Cleaning level:
BOD<20 mg/litre,
NH4<20 mg/litre
COD<100 mg/litre,
SS<35 mg/litre).

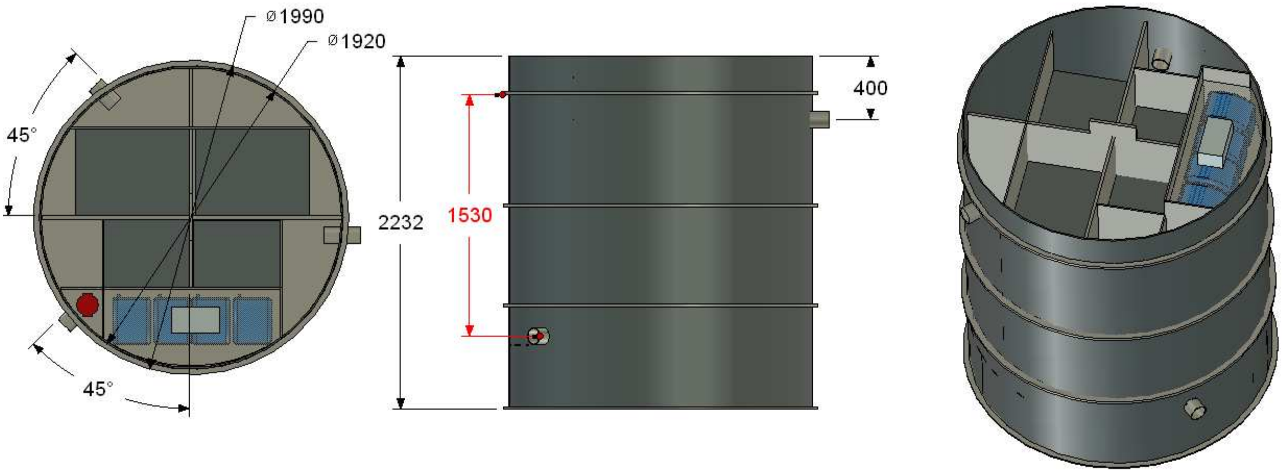


Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	1822	17	107
30	20	67	2	34
		Filter Surface needed for BOD reduction to 30 mg/litre		141
		Filter surface present (chamber 1. 2. Bioblok 100 and 200).		150
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	20	270	2	135
		Filter Surface needed for NH4 reduction to 30 mg/litre.		135
		Filter surface present in Mars 3000 4K for nitrification (3. chamber and 4. chamber all Bioblock 200).		200
		Because of the extra filter surface 200-135 = 65 m2 the theoretical lower limit for NH4 in a Mars 3000 4K is 10-15 mg/litre.		

Section 6.3

Mars 3000 4K system, 7500 litre a day.

Cleaning level:
BOD<25 mg/litre,
NH4<30 mg/litre
COD<125 mg/litre,
SS<35 mg/litre).

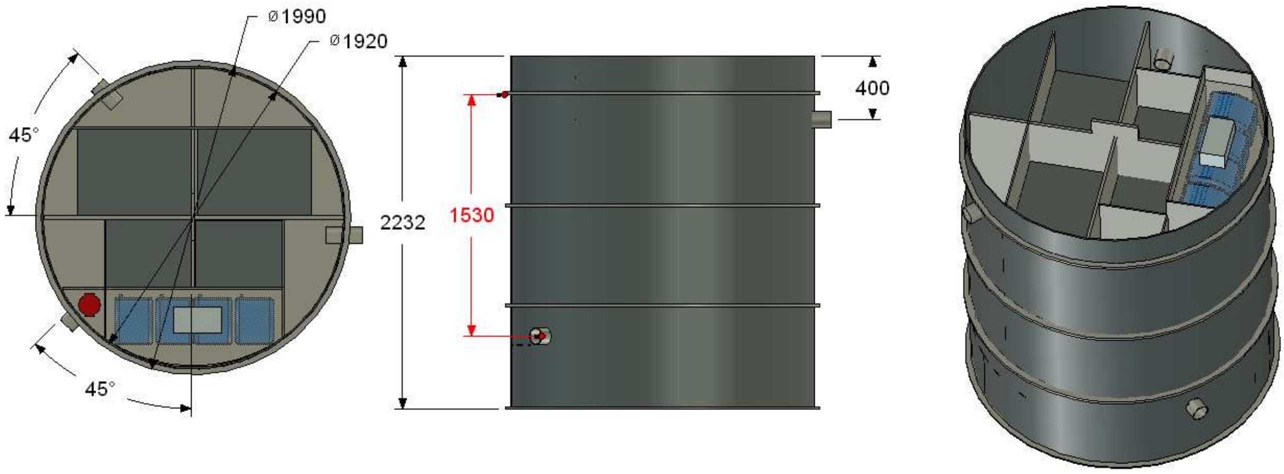


Ingoing water. BOD mg/litre	**Outgoing water. BOD mg/litre**	**BOD load Gram / day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	2025	17	119
30	25	37	2	19
		Filter Surface needed for BOD reduction to 25mg/litre		148
		Filter surface present (chamber 1. and 2, Bioblok 100 and 200).		150
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	30	225	2	130
		Filter Surface needed for NH4 reduction to 30 mg/litre.		130
		Filter surface present in Mars 3000 4K for nitrification		200
		Because of the extra filter surface 200-130 = 70 m2, the theoretical lower limit for NH4 in a Mars 3000 4K is 20-25 mg/litre.		

Section 6.4

<u>Mars 3000 4K system, 8000 litre a day.</u>

Cleaning level:
BOD<25 mg/litre,
NH4<30 mg/litre
COD<125 mg/litre,
SS<35 mg/litre).



Ingoing water. BOD mg/litre	**Outgoing water. BODmg/litre**	**BOD load gram/day**	**BOD reduction, Gram BOD m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
300	30	2160	17	127
30	25	40	2	20
		Filter Surface needed for BOD reduction to 25mg/litre		148
		Filter surface present (chamber 1. and 2, Bioblok 100 and 200).		150
Ingoing water. NH4 mg/litre	**Outgoing water. NH4 mg/litre**	**NH4 load gram/day**	**NH4 reduction, gram NH4 m2/day (table 1). (filter surface performance)**	**submerged filter surface needed. (m2)**
60	30	240	2	120
		Filter Surface needed for NH4 reduction to 30 mg/litre.		120
		Filter surface present in Mars 3000 4K for nitrification		
		Because of the extra filter surface 200-120 = 80 m2, the theoretical lower limit for NH4 in a Mars 3000 4K is 20-25 mg/litre.		