Tauw

Note

Draft

Handled by MSc. P (Paul) Telkamp
Date November 25th, 2009
Reference N001-4615420PTK-V01

Quick evaluation pilot 3: UWWTP Kizilcahamam

- **Coarse screen / fine screen**

Coarse screen 4 cm
Fine screen 15 mm

Conclusion: In comparison to Dutch standards the fine screen is quite wide. In the Netherlands the standard for fine screens is 6 mm. In the past 15 mm fine screens have been applied in the Netherlands, but caused a lot of blockages of pumps and propulsors. If a fine screen of 15 mm is installed be sure that the following mechanical parts are not too sensitive to clogging. It is advised to install a 6 mm fine screen instead of a 15 mm fine screen.

- **Flow measurement**

Open channel flow measurement.

Conclusion: This measurement is OK and can easily calibrated. Disadvantage is the needed length of the channel.

- **Aerated grid removal**

Phase < year 2044

Number:	1
Surface	4.265 m^2
Length	5 m
Volume	21.32 m^3
Blower:	300 mbar, flow 0.9 m^3/min, N = 1,5 kW

Conclusion:
In the Netherlands aerated grid removal is not the most common way to remove sand from the wastewater. This is because biological P-removal is one of the most critical process of the Dutch waterwater installations (most installations are > 10.000 pe and have a discharge permit < 1 mg P/l).

Aerated grid chambers put oxygen into the wastewater just before the anaerobic tank and will affect the anaerobic conditions in this tank. This is not very effective. Also will the aerated grid chamber affect the amount of volatile fatty acids. The amount of volatile fatty acids will decrease in the grid removal chamber and that will affect the biological P-removal and N-removal process.

Aerated grid chambers can be used in situation when the influent contains a lot of fats/greases and biological P-removal in not a topic.

It seems that for Kizilcahamam the aerated grid removal is not the most appropriate method for grid removal.

Other types of grid removal:

- Horizontal-flow grid chambers (Dorr)
- Airlift grid removal
- Vortex (Jones and Attwood, more information in appendix 1)

- **Anaerobic tank**

Phase < year 2024, 2 streets

Number 2
Volume 432 m^3 (2 x 216 m^3)

<u>Conclusion</u>: The anaerobic tank is calculated differently from our guidelines because in the Netherlands we distinguish a dry weather and rain weather flow. At the last site visit the method of determination of the anaerobic tank by Illerbank was checked and feels OK.

Point of interest: In the planned situation the anaerobic tank is not covered. Based on the site visit at Kizilcahamam it appears that the wind is blowing from the UWWTP towards Kizilcahamam. This could mean that there is a possible chance of odour nuisance. Besides this the safety of the future operators could be at stake, because H_2S is formed in the anaerobic tank. It is advised to cover the anaerobic tank, extract the air and purify the air with a compost- or lavafilter.

Activated sludge tanks

Phase < year 2024, 2 streets

Number 2
Volume 3,900 m^3 (2 x 1,950 m^3)
Depth 5 m
Effluent demand for nitrogen is 15 mg/l

Conclusion: Based on a check in the Tauw calculation tool the volume and configuration choice is OK. Integrating the anaerobic tank with the activated sludge tank or integrating the settling tank with the activated sludge tank seems to be a logical improvement. See appendix 2 for some examples. In appendix 3 two build configurations of appendix 1 are visualised for the future location of UWWTP Kizilcahamam.

Aeration

Phase < year 2024, 2 streets

OC at 20°C	236.7 kg O_2/h (118.4 kg O_2/h per street)
OC at 12°C	193.2 kg O_2/h (96.6 kg O_2/h per street)

Conclusion: Based on a check in the Tauw calculation tool a lower OC is calculated for the summer and winter situation. The methods for calculating the oxygen demand are different. Due to the fact that the points of departure are not clear, it is not possible to compare the calculations. Based on this it is assumed that the (higher) calculated oxygen demand mentioned in the report delivered by Illerbank is correct.

Settling tanks

Phase < year 2024, 2 streets

Number	2
Diameter	16 m
Depth at the side	2.3 m

Conclusion: Diameter should be a bit larger (about 0.5 m) with a SVI of 150 ml/g. The depth at the side could be less than 2.3 m as the limitation is hydraulic. A depth of 1,5 m is OK.

Sludge treatment

Excess sludge production	685.5 kg MLSS/day
The MLSS concentration of the return sludge is	10 g/l

Assumptions made:

Mechanical thickening will reach MLSS concentration of 40 g/l.

The belt filter press will raise the MLSS concentration to 250 g/l.

Conclusion: According to Tauw calculation tool the design sludge production should be 1,300 kg MLSS/day (about twice as high). There is a difference in sludge age.

The design guideline for the MLSS load of mechanical thickener which is only loaded with excess sludge is 25 kg $MLSS.m^{-2}.d^{-1}$. Based on this guideline the needed surface is 52 m^2 (diameter 8 m). Guideline for the MLSS concentration reached with only excess sludge is 30 g/l (range 25 – 40 g/l).

For the belt filter press the concentration reached is within a range of about 170 – 320 g/l. The design guideline for the MLSS concentration reached is 200 g/l. We don’t have design guidelines for a belt filter press on hand. In most cases a supplier is asked to deliver the appropriate size of the belt filter press.

General remark
There are a lot of buildings planned according to the drawing of UWWTP Kizilcahamam. It is recommended to combine the buildings as much as possible to one or two buildings. It is expected that this will decrease the investment costs.

Appendix 1

JONES & ATTWOOD

JETA GRIT TRAP

Introduction

Jones and Attwood are the market leader for the supply of grit traps. 20 years of experience and collaboration with Pista SA of Geneva Switzerland has led to a full and complete understanding solids in raw sewage.

Many factors will dictate the performance of a grit trap, most of which, if recognised can be accommodated by design.

Some variables to be encountered:-

Source of Grit
a) shape
b) size
c) specific weight

Sewerage System
d) age (grit in system)
e) quantity for removal
f) rate of arrival at plant
g) range of flows to be treated

Location
h) flow channel configuration
i) permissible water depths
j) head loss allowable
k) sewage temperature

a) Shape of Grit
Shape of the grit particles is a determining factor of the settlement rate. A sphere has a settlement rate of say 1.0 then an irregular shape has a settlement rate of 2.0 and a flat disc settles at a factor of 4.0X. Shales for example are very difficult to separate.

b) Size of Grit
Size of the grit particles is a determining factor of the settlement rate. In Stokes Law the resultant settlement velocity varies as the $(\text{diameter})^2$.

c) Specific Weight
Specific weight of the mineral material is a determining factor of the settlement rate. Settlement velocity varies directly to its specific weight.

d) Age
Grit in sewage will collect bacteria growth. Its size and resultant specific weight will therefore be affected. The greater the age the greater the effect can be.

e) Quantity for Removal
The sewerage system whether it be pumped, gravity of both, or if it be separate, partially separate or combined will have characteristics that produce a discharge pattern for grits. Minimum to maximum volumes can vary. The wider the variation, the less efficient the plant will be overall.

f) Rate of Arrival at Plant
Ideal conditions would exist for removal if the grit arrived at a constant rate. Most sewerage systems will store mineral deposits presenting a heavy influx during high flow periods when flushing takes place. The degree of flushing and time for transportation to the plant can easily affect the efficiency of the removal.

g) Range of Flows to be Treated
Most systems of grit removal are based on settlement by gravity through a pre-determined depth of liquid. As flow varies the velocity of flow varies, therefore specific rates of flow will satisfy only particular grit types and sizes. It follows therefore that a wide range of flow will reduce the overall efficiency of a given installation.

h) Flow Channel Configuration
The means of grit separation will be assisted if, upon arrival the grit has stratified to the lower levels of the incoming channel. A dramatic change in shape, size or direction of the channel in close proximity to the separator will induce mixing currents and destroy the layering, thus imposing absolute maximum performance on the system. Efficiency is therefore improved with good and carefully designed approach channels.

i) **Permissible Water Depths**
To become separated a grit particle has to descend in the body of liquid. A combination of forward flow energy and depth to the level of trapping determines the success of the trap. The more shallow the depth at a compatible forward flow velocity results in high efficiency.
The flow depth is a resultant of the downstream flow conditions combining with the characteristics of the grit chamber. Careful control and design of the channel system is most important.

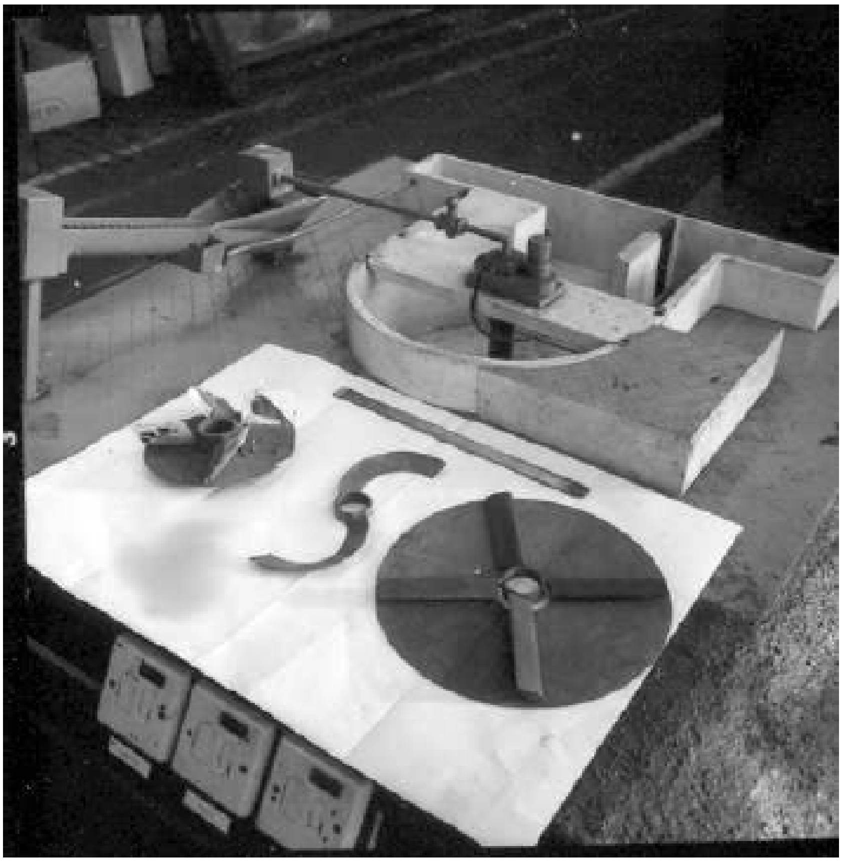
j) **Headloss Allowable**
The site selected for the grit removal will determine the quantity of head available to maintain sufficient hydraulic gradient, hence maintain suitable flow conditions.
In some instances it is necessary to correct the flow depth with the use of weirs etc. Introducing such devices may result in physical and hydraulic headlosses. The site limitations will determine if such an approach to design can be made or not. In any case the efficiency can become affected.

k) **Sewage Treatment**
The variable factors which are to be considered in Stokes Law include temperature of the liquid. It follows therefore that a difference in efficiency will be found in extreme low to high variations of ambient/sewage temperatures. Particle separation under gravity is more rapid when temperature is high.

JETA GRIT TRAP TEST

Objective
To find the efficiency of grit removal/organics rejection of the Pista Grit Trap, and to design and test, if possible, a unit of even high efficiency.

Model Tests
It was decided that before we carry out full-scale tests 1/10 scale model tests should be carried out to enable
us to study the exact behaviour of the grit trap. Several arrangements of grit trap were made including (A) J&A's MKII design, (B) S&L type with a flat bed and (C) a new design with impeller blades mounted on a flat disc.



MKII Theory
The MKII design is based upon both the retention and constant velocity principle. The constant velocity being achieved by the use of paddles rotating in the same direction as the sewage. The shaping of the paddles creates an upward thrust in the centre of the tank causing the sewage to spiral on a horizontal axis as it revolves around the unit. Organic material remains in suspension whilst grit is allowed to settle. The spiralling of the flow also produces a vortex helping to push the grit down to the base of the hopper.

S & L Theory

The S&L Pista design also works in the principle of a forced vortex in conjunction with gravity that forces the grit to the chamber floor. The grit settles sufficiently in one revolution of the chambers contents so as not to be within the influence of the outlet of the Pista. The grit that settles to the bottom along with other material is propelled along the bottom towards the centre. The flow moves circumferentially and downward to the bottom, across the bottom still moving in a circle to the outside. As the settled solids move towards the centre, they pick up velocity because the area of the flow is decreasing. When the solids approach the middle, the rotating paddles increase the velocity to the point where lighter organics are lifted, and returned to the flow passing through the Pista. The grit moves on and drops into the centre storage hopper.

MKIII Theory

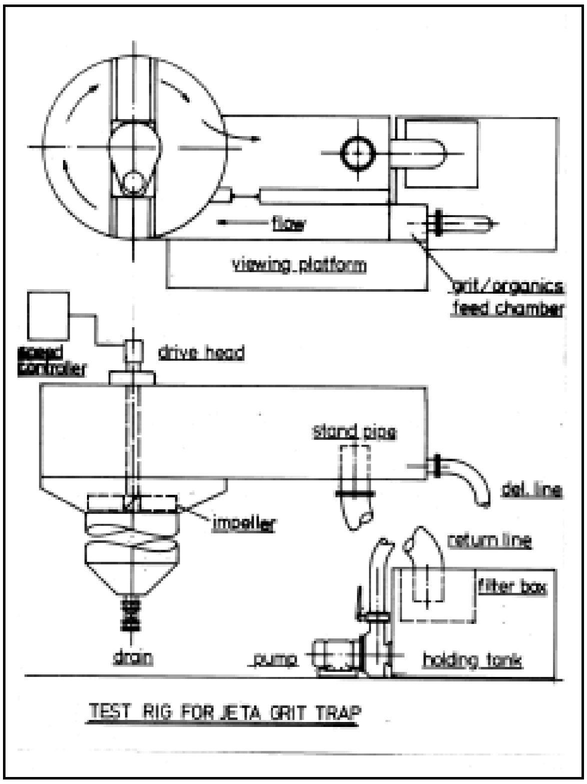
The Pista chamber is retained in shape and fitted with a disc with impeller blades mounted on the top face. The disc is positioned slightly above the grit collection hopper rotating slowly. The effect is such that it can be explained by breaking the tank volume up into two sections. The outer ring is only slightly affected by the impeller blades and allows the grit to settle by gravity. When the grit hits the conical section it moves spirally (under the influence of the inclined surface, gravity and the impeller blades) into the classification gap between the disc and the chamber. The heavy organics will also settle but are always rejected from the classification gap by the influence of the paddle blades. All the organics eventually find their way into the central zone and are lifted by the impeller blades on the disc, and then carried out by the flow through the outlet.

Model Test Results

The model test showed that only the MKIII theory stood firm. The other arrangements based on the vortex principle did not perform as they should, with the forced vortex actually inhibiting grit settlement, and only keeping a small percentage of solids in suspension. It was also noted that the speed of the MKIII impeller disc affected its' performance. The model tests were encouraging and it was decided to build a full-scale test rig.

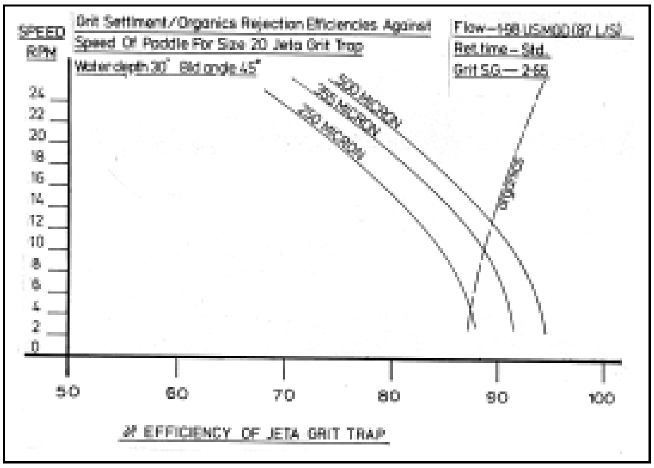
Equipment

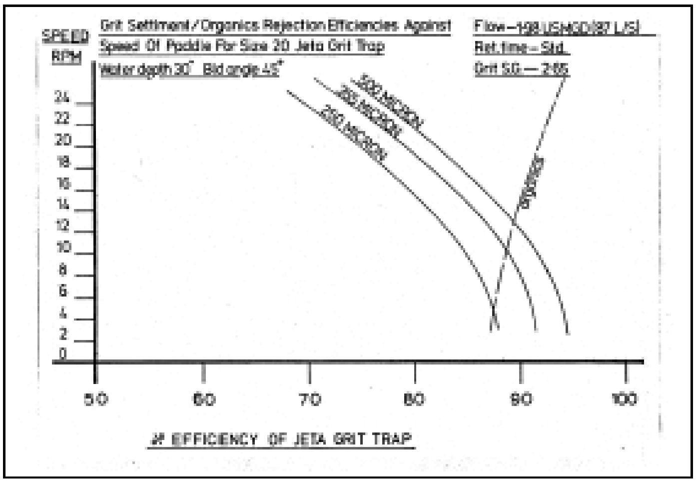
The test rig basically comprised of a 2.0m diameter Pista chamber fabricated in steel with an extended inlet and outlet section, mounted over a holding tank. The arrangement was connected by a 6" flex delivery line and a 12" return line. Circulation was provided by a Worthington Simpson Centrifugal Clean Water Pump with a butterfly valve on its' outlet to vary the delivery. A filter box was fitted to the holding tank to catch any grit/solids that passed through the grit trap. Various sizes of outlet weir were made to provide different retention conditions. A standpipe was also fitted over the 12" outlet. To promote calm conditions a variable speed controller was fitted to the drive head motor to test the disc/impeller at different speeds. The disc/impeller was fully adjustable up and down the drive tube and had 4 positions of blade angle.



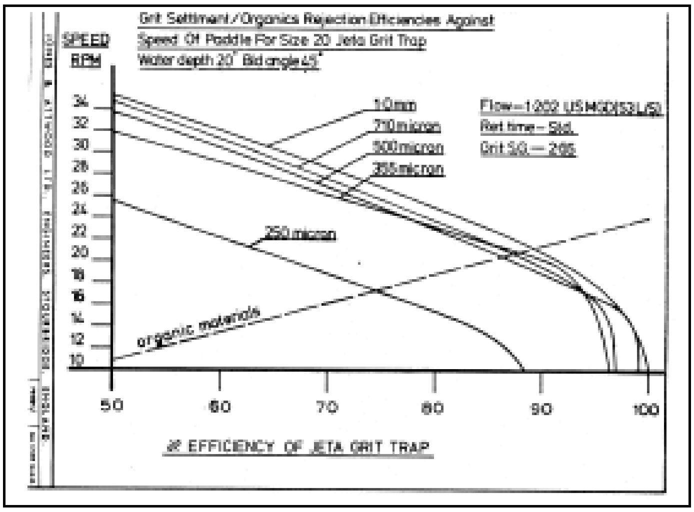
TEST RIG FOR JETA GRIT TRAP

Full Sale Tests
The tests were carried out using a sand graded into 212, 250, 355, 500, 710 micron and 1mm with a specific gravity of 2.65. The organics were simulated by thick brown paper towels. The speed of the impeller disc was varied from 0-30rpm and the blade angle from 30°-70° from the horizontal. Two flow levels were used 53 and 87 l/s with the water depth being varied from 4" to 30" by use of the overflow weirs. The sand and paper were introduced at the inlet in a wet condition. The percentage efficiency of removal being calculated by measuring the amount passing through the trap into the filter.

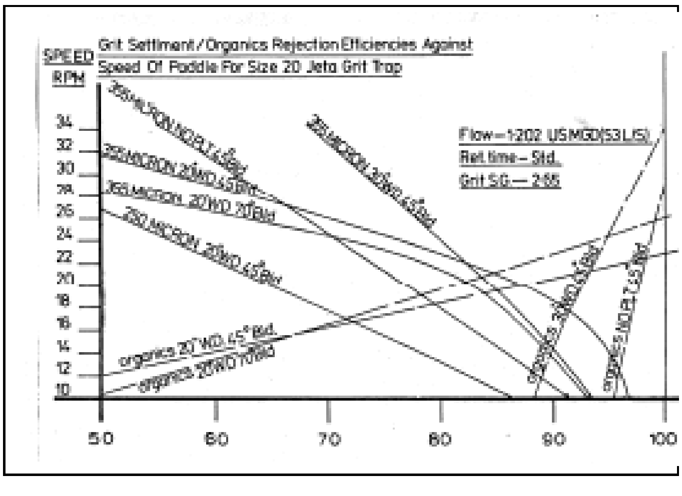




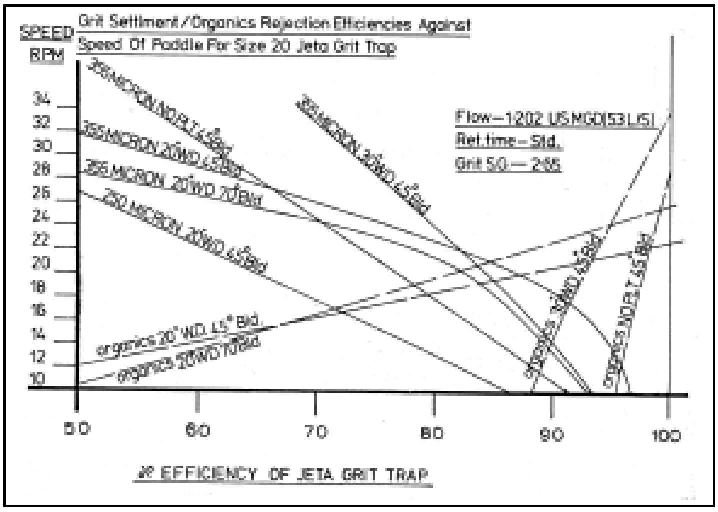
Grit Settiment/Organics Rejection Efficiencies Against
Speed Of Paddle For Size 20 Jeta Grit Trap
Water depth 30" Bld angle 45°
Flow—1·98 USMGD(87 L/S)
Ret.time—Std.
Grit S.G.—2·65
SPEED
RPM
500 MICRON
355 MICRON
250 MICRON
organics
24
22
20
18
16
14
12
10
8
6
4
2
0
50
60
70
80
90
100
% EFFICIENCY OF JETA GRIT TRAP



Grit Settiment/Organics Rejection Efficiencies Against
Speed Of Paddle For Size 20 Jeta Grit Trap
Water depth 20" Bld angle 45°
SPEED
RPM
1·0 mm
710 micron
500 micron
355 micron
250 micron
organic materials
Flow—1·202 USMGD(53 L/S)
Ret.time—Std.
Grit S.G.—2·65
34
32
30
28
26
24
22
20
18
16
14
12
10
50
60
70
80
90
100
% EFFICIENCY OF JETA GRIT TRAP



Grit Settiment/Organics Rejection Efficiencies Against
Speed Of Paddle For Size 20 Jeta Grit Trap
SPEED
RPM
Flow—1·202 USMGD(53 L/S)
Ret.time—Std.
Grit S.G.—2·65
organics 20" WD 45° Bld.
organics 20" WD 70° Bld
34
32
30
28
26
24
22
20
18
16
14
12
10
50
60
70
80
90
100

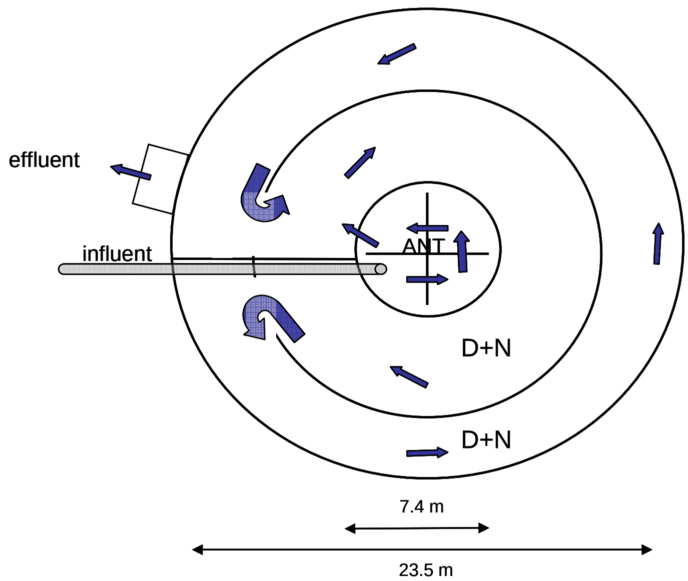


<u>Conclusions</u>

It can be seen from the graphs that the speed of impeller plays a big part in the efficiency of the unit. The slower the speed the better the settlement rate and correspondingly a loss in efficiency or organics rejection. The optimum speed would appear to be around 15rpm. But in a situation where fine screening takes place before grit removal, lower speeds would be acceptable. Flow, retention time and water level also are important factors of efficiency and may lead to the realisation of individual chamber design for differing hydraulic arrangements.

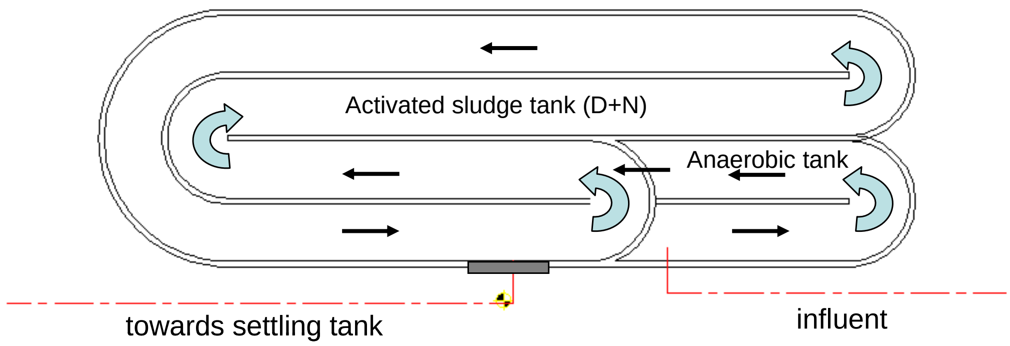
Appendix 2 Examples of different build configurations

- **Example 1: Integrating anaerobic tank with activated sludge tank in a circular reactor**

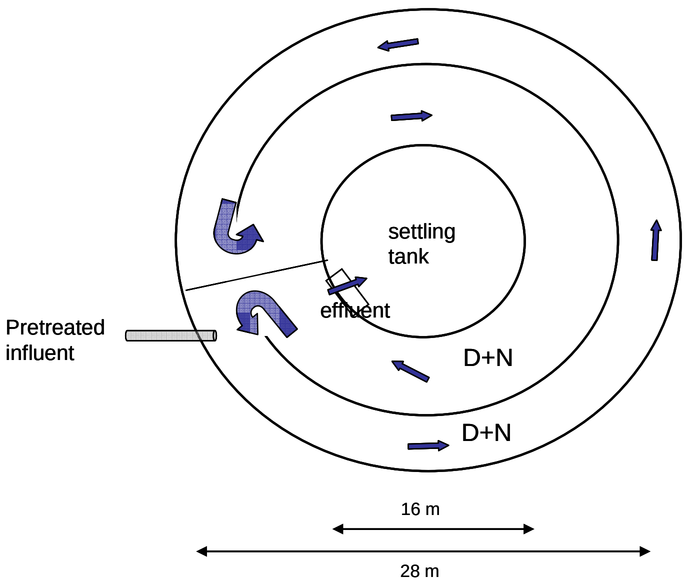


Based on the volumes and a depth of 5 m the total surface needed for the anaerobic tank + activated sludge tank is 433 m^2. This results in a diameter of 23.5 m. The diameter of the anaerobic tank should be 7.4 m. The remaining surface is for the activated sludge tank.

- **Example 2: Integrating anaerobic tank with activated sludge tank in a caroussel**

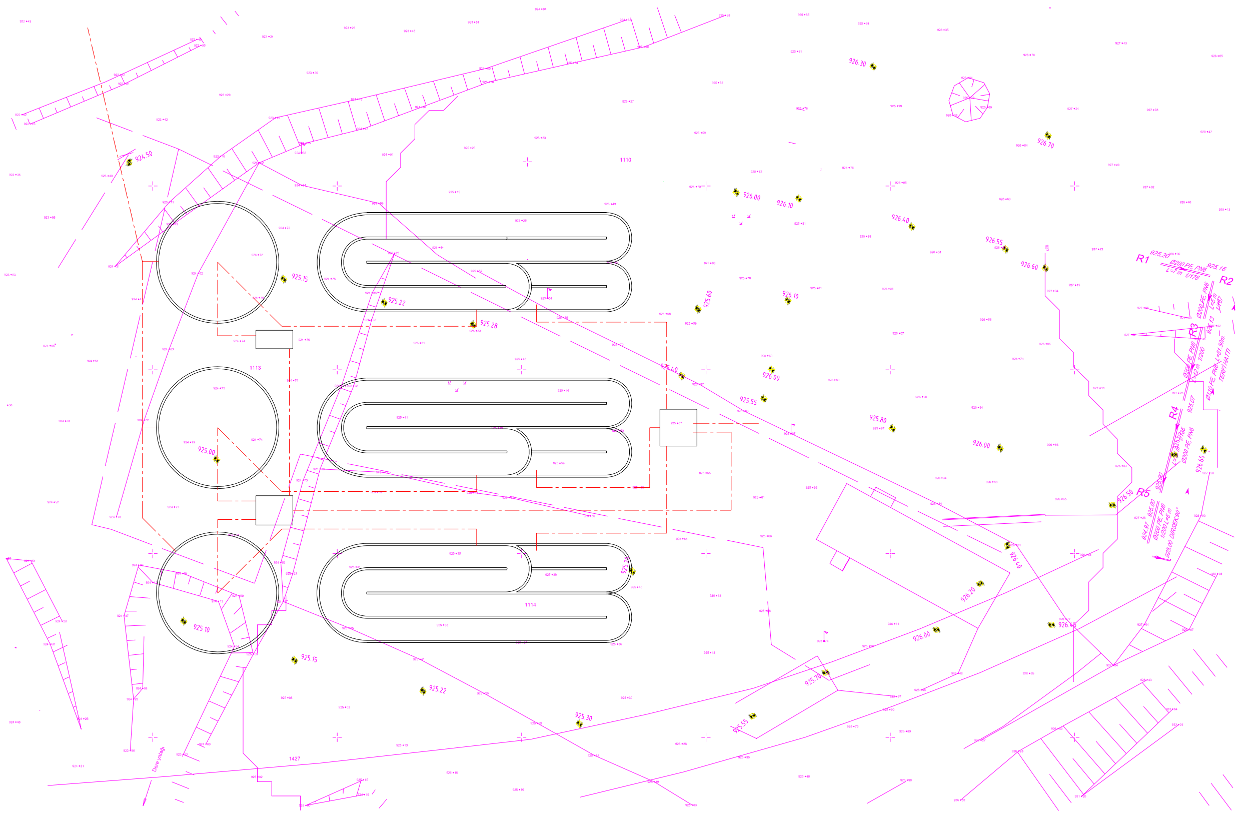


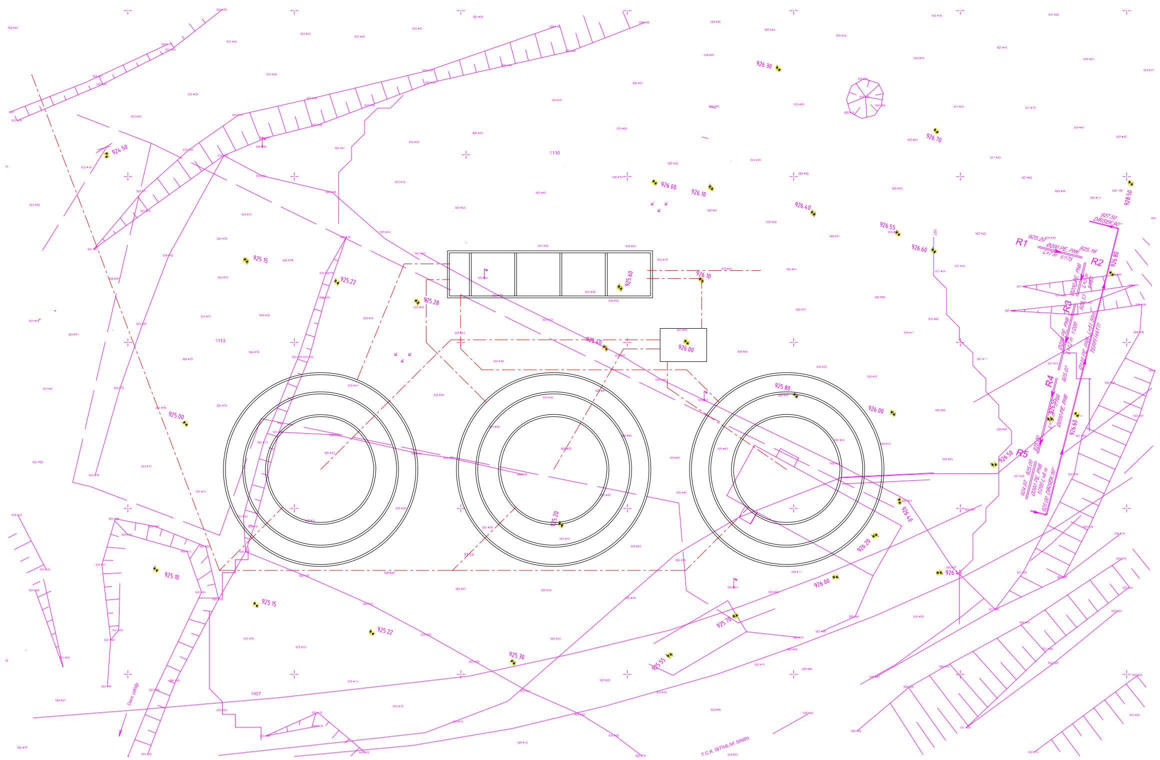
- **Example 3: Integrating settling tank with activated sludge tank in a circular reactor**



Based on the volumes and a depth of 5 m the surface needed for the activated sludge tank 390 m^2. The surface needed for the settling tank is 201 m^2. This results in a total diameter of 28 m. The diameter of the anaerobic tank should be 16 m. The remaining surface is for the activated sludge tank. The settling tank will keep its original depth.
A point of interest is the width of the activated sludge tank in relation to the propulsors. The width of the outer two circles is 3 m while the depth is 5 m. Be sure that the propulsors can be installed properly to ensure a good rate of flow.

Appendix 3 Visualisation of two build configurations for Kizilcahamam





R1
925.20
Ø200 PE, PN6
L=7 m 1/175
925.16
R2
927.50
DİRSEK:90°
928.50
926.80
R3
Ø200 PE, PN6
L=12 m 1/200
Ø110 PE, PN6 L=51.50m
TERFİ HATTI
925.07
R4
926.55
Ø200 PE, PN6
926.60
925.00
R5
926.50
924.97
925.00
Ø200 PE, PN6
1/200 L=6 m
925.00 DİRSEK:90°

Tauw

Note

Draft

Handled by Msc. P (Paul) Telkamp
Date January 6th, 2010
Reference N002-4615420PTK-V01

Comments/questions of Illerbank with reference to N001-4615420PTK-V01 (date November 25th, 2009)

In November 2009 a quick evaluation report was made for pilot 3, the UWWTP Kizilcahamam. Based on this evaluation report (reference N001-4615420PTK-V01) the Illerbank mailed some comments/questions. In this note the comments/questions placed by Illerbank in relation to pilot 3 are presented including the response of Tauw.

- **Coarse screen / fine screen**

Reaction Illerbank: We agree with shortening the distances between the bars. Three screens can be installed as one coarse screen, two fine screens.

Reaction Tauw: -

- **Flow measurement**

Reaction Illerbank: We agree with your contribution

Reaction Tauw: -

- **Aerated grid removal**

Reaction Illerbank: We'll take you're your suggestion into account and in ATV- Aerated Grit Removal Standard there is a similar comment as well. However, in ATV Standard, to decrease the amount of air is sufficient, instead of installing grit chambers without air. Is your comment related with forming anaerobic conditions in sewerage network system? (Because our network systems are designed not to flow with full pipes.)

Reaction Tauw: Our comment is not specific related to the sewerage network. Of coarse there is already a chance that the amount of volatile fatty acids will probably already slightly decrease due to transport in the network system (non pressurized sewers). This is a result of the air that is present in the network system. The contact with the air can not be prevented with non pressurized sewerage networks. This small loss of volatile fatty acids in the non pressurized sewers is just something that has to be accepted. Nevertheless the wastewater at the end of the sewer network will be mainly anaerobic. By applying an aerated grid removal we force air into the wastewater which will further decrease the amount of volatile fatty acids just before the wastewater will enter the anaerobic tank. If this contact with air can be avoided this will positively affect the biological P-removal. Decreasing the amount of air will probably be sufficient (as you mentioned), but in practice this will probably be quite difficult to control as the wastewater flow isn't constant during the day.

- **Anaerobic tank**

No comments/questions placed by Illerbank

- **Activated sludge tanks**

Reaction Illerbank: At First, in your calculations which sludge age did you use? Secondly, In the studies carried out during your last site visit with Tauw Calculation Tool, it is concluded that the volume of the one aeration tank should be bigger. But we see, in your comments that the volume is OK. What do you think about this situation?

Reaction Tauw: The used sludge age at 12 °C is 15 days and at 20 °C it is 9.8 days. This differs a lot from the sludge ages mentioned in the project report you have provided. In this specific report the calculated sludge ages (paragraph 8.4) are at 12 °C is 31.6 days and at 20 °C it is 18.2 days. These sludge ages seem quite high. In table 2 on page 21 of the ATV-report 'Dimensioning of Single-Stage Activated Sludge Plants (May 2000) an overview is presented with sludge ages. Based on the V_D/V_{AT} ratio applicable for UWWTP Kizilcahamam the sludge age should be around 15 days at a temperature of 12 °C. As it is quite difficult for us to understand all the calculations made in the project report as it is all written in Turkish, we suggest that you check these calculations with the ATV-standard. If you have checked the calculations and there is still a big difference between the sludge ages used by us and the ones you obtain we can further investigate this.

It is correct that during the last site visit it was concluded that the volume of the activated sludge tank should be bigger. When we wrote the quick evaluation report and checked the design in the Tauw Calculation Tool once more we discovered that a summer load was mentioned in the winter period and the winter load was mentioned in the summer period. So these were accidentally switched. This resulted in a higher volume of the activated sludge tanks than needed. After correcting this the volume of the activated sludge tanks were in the same range as mentioned in the project report.

- **Aeration**

Reaction Illerbank: In Quick evaluation report, you mention that " the oxygen calculation methods are different(see pg: 3) ". Can you send us formulas and methods of calculation?

Reaction Tauw: We calculate the OC with the method of Von der Emde. This method is based on the BOD and N-Kj oxygen demand. I have some information about this, but this is all in Dutch. We suggest showing the formulas and explaining this method further during the next visit (18-22 January 2010).

- **Settling tanks**

No comments/questions placed by Illerbank

- **Sludge treatment**

Reaction Illerbank: Can you send the formulas and calculation methods of determination of excess sludge production to make clear the reason of differences?

Reaction Tauw: As the excess sludge production is related to the sludge age it is most likely that this difference is caused by the difference in sludge ages (see section activated sludge tanks). Therefore we recommended checking the calculation of the sludge ages first with the ATV-standard.