Turkey, wastewater mgmnt (G2G/08/TR/7/2)

Evaluation Pilot 1 and Pilot 2

Site visit 25 May till 29 May 2009

September, 3rd, 2009

Responsibility

Title	Turkey, wastewater mgmnt (G2G/08/TR/7/2)
Client	EVD, Beneficiaries: Iller Bank / MoEF
Project Leader	Ir. E.J. (Hans) Jansen (Tauw), C. van Voorden (Ameco)
Author(s)	Ing. M.J.M. (Mike) van Boldrik and Ir. P. (Paul) Telkamp
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Signature	

Colophon

Tauw bv
Technology department
P.O. Box 133
7400 AC Deventer
The Netherlands
Telephone +31 (0)570 69 99 11
Fax number +31 (0)570 69 96 66

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1 Introduction

During the first site visits in Turkey several criteria for the selection of two pilot projects have been discussed, such as accessibility of the pilot region, energy efficiency technology in wastewater treatment, innovative technologies, selection of sensitive area of receiving waters, water scarcity, sludge disposal, area ownership and absence of sewerage systems.

With these criteria taken into account two pilot studies are chosen.

The following technical activities have been undertaken:
- Evaluation of design and consideration of alternative/innovative techniques
- Site visit(s): current state of operation, level of management, maintenance, financing

Apart from technical activities, institutional, organisational and financial issues have been discussed with the local stakeholders. These issues have been reported per pilot in section 2.1 and 2.2 of the report.

The results of pilot 1 and 2 are set out in this document.

Following the finalization of the first two pilot projects, the results and lessons learned will be evaluated and taken into account by the project team Illerbank/consortium. This document will help the team to select and how to carry out the pilots 3 and 4.

2 Points of departure

On 26th and 27th of May 2009 two pilot projects have been reviewed by the consortium in cooperation with the technical department of the Illerbank. Pilot 1, Kepez, is a medium sized installation. Pilot 2, Ermenek, is a small installation. The geographic location of both installations is different. Pilot 1 has a Mediterranean climate; pilot 2 is situated on high grounds with a more land climate environment.

2.1 Pilot 1: Kepez

Points of departure:
In next table the daily load on WWTP Kepez is given.

Table 1: daily load Kepez

Symbol	Description	Unit	Value
c	COD-load	kg/day	3.000
b	BOD-load	kg/day	1.238
S	SS-load	kg/day	2.067
n	N-Kj-load	kg/day	228
no	N-NO3-load	kg/day	0
p	P-tot-load	kg/day	83
Qmin	Minimum flow	m3/h	135
Qmax	Maximum flow	m3/h	254
Qmin hours	Minimum flow period	hour/day	15
Qav	Average flow	m3/day	3.762

Configuration type:
- Medium sized installation (35.000 p.e. (population equivalent))
- Installation for BOD/COD/N removal
- Biological basin with a depth of 3,5 metre
- Volume basin: 3.200 m^3
- Oxygen input with surface aerator
- Sludge gravity thickener followed by belt filter press

Findings:
- Choice of configuration is OK
- Possible risk on short circuit stream (inflow is close to outflow)
- Potential energy saving by constructing deeper tanks with fine bubble aeration
- Tauw design tool calculated a 25 % bigger biological volume
- Functional design has to be reviewed (on location)

Institutional/legislative issues:

- The Kepez WWTP has a discharge permit, which contains – amongst other – criteria for the frequency of inspections by the MoEF based on the volume of wastewater received.
- One verbal and one written warning have been received from MoEF for non-compliance with the permit conditions.

Organisation, management and finances:
The WWTP is currently operated by a private contractor and is supervised by municipal staff. The list of personnel working at the WWTP is given in the table below:

Table 2: Overview Kepez

Title	Number	Status
Plant manager (environmental engineer)	1	Municipality personnel
Electrical technician	1	Municipality personnel
Chemist	1	Private operator
Workers	7	Private operator
Total	**10**	

Although the number of staff is considered sufficient for a plant of this size, both the municipal staff and the personnel of the private contractor are inexperienced. The training provided by the construction contractor focused only on technical aspects, such as the operation of mechanical equipment.

The annual personnel costs at the Kepez WWTP are EUR 67,000, while the costs of electricity are approximately EUR 110,000. The plant treats 3000 m^3 of wastewater on a daily basis. This means that the operation costs, excluding repair and maintenance, are EUR 0,16/m^3. When investment and depreciation costs are also taken into account, the cost of treating one cubic meter of wastewater will be much higher.

For a small size municipality, this cost is quite significant and should be reflected to consumers so that enough revenue can be generated.

2.2 Pilot 2: Ermenek/Aycavik

Points of departure:

In next table the daily load on WWTP Ermenek is given.

Symbol	Description	Unit	Value
c	COD-load	kg/day	500
b	BOD-load	kg/day	300
S	SS-load	kg/day	360
n	N-Kj-load	kg/day	70
no	N-NO3-load	kg/day	0
p	P-tot-load	kg/day	0
Qmin	Minimum flow	m3/h	27
Qmax	Maximum flow	m3/h	88
Qmin hours	Minimum flow period	hour/day	15
Qav	Average flow	m3/day	1.008

Configuration type:

- Small installation (10.000 p.e.)
- Installation for BOD/COD removal
- Biological basin with a depth of 2 metre
- Volume basin: 950 m^3
- Oxygen input with aeration brushes
- Belt filter press

Findings

- Not clear if design is appropriate
- Low depth might cause problems during winter (temperature drop in tank)
- Potential energy saving by using other aerator system than brushes
- Functional design has to be reviewed (on location)

As the WWTP of Ermenek is quite a remote WWTP, it is chosen to visit a comparable WWTP that is closer to pilot 1: Kepez. The WWTP chosen is Ayvacik. This WWTP is representative for WWTP Ermenek. The WWTP Ayvacik was visited on the 29th of May 2009.

Institutional/legislative issues:

- The Aycavik WWTP does not have a discharge permit. The plant was taken over by the municipality in the beginning of 2009 when the municipality should have applied to the MoEF for an operation licence. Since then, the plant has been monitored by the Provincial Directorate of the MoEF. However, even though 5 months had passed, the application has not been submitted. The Directorate has not started its routine controls as a result.

The treatment performance of the plant has been observed to be very low. No precautions have yet been taken. There was no enforcement by the MoEF as the plant is not yet considered their responsibility.

- Samples for analysis are sent to Iller Bank by the municipality

Organisation, management and finances:
The WWTP is currently operated by the municipality. Only 2 personnel, an environmental engineer and a worker, are in charge of the UWWTP. According to the plant manager (environmental engineer), the ideal number is 4. The plant is therefore considered understaffed. The training provided by the construction contractor focused only on technical aspects, such as the operation of mechanical equipment.

Annual personnel costs at the Aycavik WWTP are EUR 18,000, while the cost of electricity is approximately EUR 22,000. The plant treats 800m^3 wastewater daily. This means that the operation cost/excluding repair and maintenance) is EUR 0,14/m^3. When investment and depreciation costs were also taken into account, the cost of treating one cubic meter of wastewater would be much higher. For a small size municipality, this cost is quite significant and should be reflected to consumers so that enough revenue can be generated.

Aycavik Municipality has not taken any actions to cover the costs of the WWTP. The municipality should either increase the price of water or introduce a wastewater tariff. The sustainability of the plant will otherwise be jeopardized.

2.3 General findings

- Separate sewerage system is very efficient
- Design parameters for settling tank used by Illerbank are similar to Dutch standards
- Biological design by Illerbank is based on BOD removal, Dutch standard is N removal.
- In colder areas shallow tanks will have a negative influence on the efficiency of the treatment plant

3 Technical findings location visit pilot 1: Kepez

This chapter describes the findings of the visited pilot 2. Each part of the WWTP is discussed per paragraph.

3.1 Introduction
The WWTP Kepez was visited on the 28th of May 2009.

Figures WWTP Kepez:
- Hydraulic capacity 5.000 m^3/d
- The installation is build for 35.000 p.e.

At the current situation (day of visit) the hydraulic load is 3.000 m^3/d. The wastewater enters the installation in a gutter towards the screens.

3.2 Screens

<u>Purpose:</u> Sieving gross solids from the raw wastewater (influent)

<u>Findings:</u>
There are two screens placed (wide and small, see picture 3.1). The wide screen should be cleaned by hand whereas the small screen is cleaned automatically. The removed gross solids are transported to a container that is placed near the small screen. The construction and installation are OK.


Picture 3.1 Two screens + closer view of small screen

Possible improvements:

- None

3.3 Sand removal

Purpose: Removal of sand from wastewater by sedimentation

Findings:
Picture 3.2 and 3.3 show the construction and installation for the sand removal.

Picture 3.2 Sand removal construction (1)

The wastewater is slowly transported through the concrete construction where the sand can sedimentate. With the help of pumps fixed to a rolling construction the sand is pumped out of the basin into a channel (see picture 3.3, left part) which transports the sandy water towards the mechanical unit (see picture 4.3, right part). The sand-free wastewater will flow towards the influent receiving basin.

The surface load for sand removal in this kind of constructions should be around 30 -40 $m^3/m^2.h$.
Based on the total design flow of 5.000 m^3/d (= 208 m^3/h) the surface needed is 5,2 - 7 m^2.
The available surface for sand removal in case of Kepez is adequate.
Based on the sand seen in the container the sand removal seems to function well.

The slope of the channel (see picture 3.3, left part) doesn't seem to be OK as a lot of sand already settles in the channel.

Picture 3.3 Sand removal construction (2)

Possible improvements:

- Correct slope of channel in order to prevent sedimentation of sand in channel.

3.4 Influent receiving basin + pump basement

Purpose: Collecting the sand-free wastewater and transporting towards the distribution construction.

Findings:

Picture 3.4 shows the influent receiving basin and the cover of the influent receiving basin. The concrete, ladder and cover of the influent receiving basin are already quite harmed by hydrogen sulphide (H_2S).

To prevent this damage the concrete, ladder and cover should have a protection layer (coating). Installing a ladder and cover of stainless steel (or aluminium) is also a solution. To avoid dangerous situations it is recommended to install an extractor fan on the influent receiving basin. In this way all H_2S will be extracted from the influent receiving basin. As H_2S is poisonous the extracted H_2S should be treated.


Picture 3.4 Influent receiving basin + cover of influent receiving basin

The influent is transported by 3 pumps (2+ 1 back-up, see picture 3.5, left part) towards the distribution construction. The 3 pumps are situated in a dry well. Within this dry well there is already room reserved for the future expansion of the WWTP. In the pipeline between the pumps and the distribution construction a flowmeter is installed in a separate basin (see picture 4.5, right part). In the current situation the flowmeter is out of order due to a flooding of this basin. If the installation of the flowmeter is correct is not known as it could not be seen if there is enough straight pipeline installed before and after the flowmeter.


Picture 3.5 Influent pumps in dry well + flowmeter in separate basin

Possible improvements:
- Prevent further corrosion of influent receiving basin, ladder and cover of influent receiving basin by installing an extractor fan
- Repair flowmeter as soon as possible in order to know the hydraulic load of the WWTP

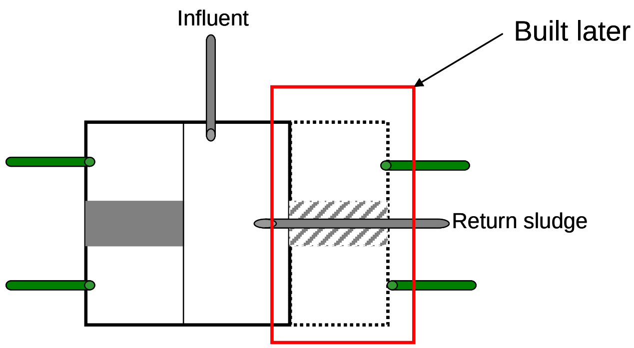
3.5 Distribution construction

Purpose: Distributing wastewater to the two existing streets and two future streets.

Findings:
Picture 3.6 shows the distribution construction from the outside and from a top view. The future expansion is already considered within the distribution construction. There are two streets in use and build at the moment. Two future streets are expected (streets not build yet). The distribution points for the future streets are those who are marked with a red cross in picture 3.6, right part.

Picture 3.6 Distribution construction

A few parts of the installation are already built for future expansion of the installation. If it is smart to already partly build the distribution construction for future purposes is the question, because the concrete and the slides will already be subject to weather influences and the wastewater. Especially in this case it seems more logical that the distribution for the future streets is built when the future streets are actually built (schematically shown in picture 3.7).



Picture 3.7 Distribution construction

The place of the inflow of the influent and the return sludge in relation to the distribution of the already built streets might be unequal. The return sludge is placed at the centre which seems quite OK in the current situation. When the other two streets will be connected in the future then it might not function very well, because there is a chance that (considering the direction of the flow of the return sludge) the current streets will have higher concentrations of return sludge than the new streets.
The place of the influent is suspicious as well, because it is close to 1 street. There is a considerable chance that this specific street will have a higher influent load than the other street. The direction of the flow of the return sludge will probably contribute to this higher loading of 1 street. It would be better to place the inflow of the influent and return sludge close to the bottom. This results in a better mixture of influent and return sludge and a more equally distribution.

Future improvements:

- Change place of the inflow of influent and make sure that the influent and return sludge will be equally distributed to the different streets

3.6 Activated sludge tank and aeration

Purpose: COD/BOD/N removal process by activated sludge.

Findings:
Picture 3.8 shows the activated sludge tank and aeration.

Picture 3.8 Activated sludge tanks + one of the surface aerators

There are 2 surface aerators installed per street, so 4 aerators in total. During the visit 1 surface aerator per street was in use. The other surface aerator is switched off to save on operation costs. Based on the provided information this represents the normal operation of this plant.
The amount of aerators in function (one or two) depends on visual influent capacity and is not based on oxygen level measured in the tank. One street is fitted with 4 propulsors. All propulsors are continuously switched on.

The MLSS (Mixed Liquor Suspended Solids) level in the activated sludge tank was around 8 g/l. The design value is 4 g/l. So roughly there is about twice as much sludge in the activated sludge tank as designed for. Because of the high MLSS level more oxygen is needed for a proper functioning of the activated sludge. In the current situation the activated sludge tanks can't work properly because:

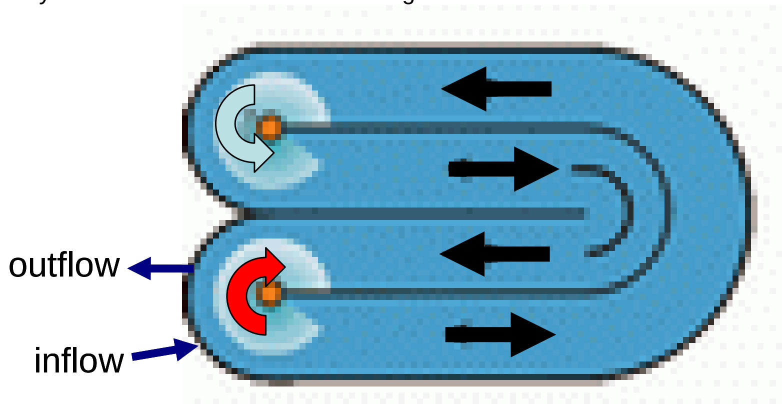
1. The MLSS level is twice as high as designed for. This results in more oxygen consumption by the sludge in relation to the design
2. Only one surface aerator per street is in use and is not based on oxygen demand

The combination of the above mentioned points result in a poor working of the WWTP. This thesis is supported by the visual sight of the activated sludge tanks (see picture 3.9) and settling tanks (see also paragraph 3.7). There is a lot of floating layer (mainly (anaerobic) sludge) found on the activated sludge tanks and settling tanks which is likely a result of lack of oxygen in the activated sludge tank. The expectation is that there are a lot of filamentous organisms present in the activated sludge tanks.

Picture 3.9 Floating layer on activated sludge tanks

Besides the above mentioned points, the inflow and the outflow of the activated sludge tanks are situated quite close to each other which may result in a short circuit stream.

In one street the surface aerator was turning the wrong way. In picture 3.10 this finding is schematically explained. The surface aerator marked with the red arrow (the one in use) is turning the opposite way. Especially in this situation there is considerable chance that a big part of the influent will directly flow to the outflow (short circuit stream). It is of course necessary to turn the direction of rotation. The blades of the surface aerator are specifically designed for a certain direction of rotation to have an optimal oxygen transfer. It could be that the blades of this specific wrong-turning aerator are designed to rotate in that way. This means that once the direction of the rotation is turned the blades will not function well. This results in bad oxygen transfer. If this is really the case could not be seen during the visit because the blades are submerged.



Picture 3.10 Schematic situation of one of the two streets

The walls of the activated sludge tanks are quite thick (see picture 3.11).

- Water retaining walls: approximately 45 cm thick → Dutch standard: 30 cm
- Inner walls: approximately 30 cm → Dutch standard: 20 cm

The reason for this is not known.
In general the design seems to be OK.

Picture 3.11 Thick walls of activated sludge tanks

Future improvements:

- Change direction of the surface aerator that is turning the opposite way. Make sure that the blades are built for this direction of rotation. If not the blades have to be replaced unfortunately. Otherwise you are loosing a lot of energy, because the oxygen transfer will be less
- Lower the MLSS level towards the design value of 4 g/l (and maintain this level) and switch on the second surface aerator in each street as well
- Steer the surface aerators by oxygen level in activated sludge tanks

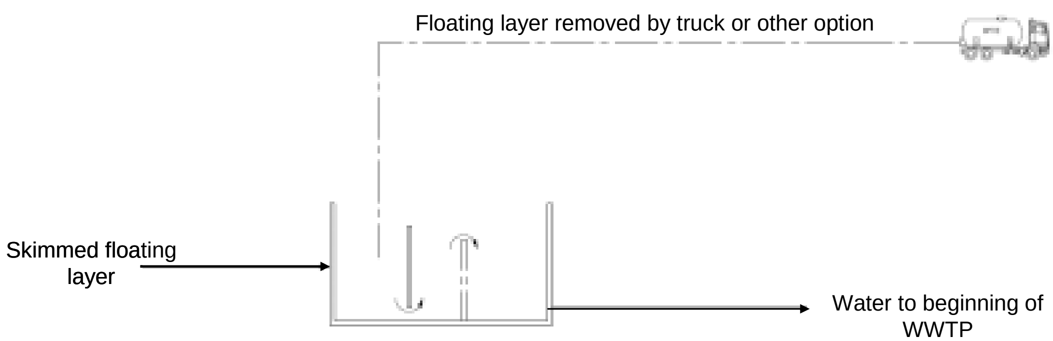
3.7 Settling tanks and return sludge

Purpose: separation of effluent and sludge which is returned to the activated sludge tanks.

Findings:
Picture 3.12 shows the two settling tanks.

Picture 3.12 Settling tanks

The settling tanks are fitted with continuously moving bridges (½ of the diameter of the settling tanks). Both settling tanks have a considerable amount of floating layer. The floating layer is skimmed into a floating layer removal device (see picture 3.12, right part). The floating layer is then returned to the beginning of the WWTP. This is not a desirable solution because the in this way the floating layer will stay in the system. The municipality mentioned that they don’t return the floating layer to the beginning of the WWTP. Occasionally the sludge is removed from the settling tanks and is transported elsewhere. A solution to easily remove the floating layer is to install a floating layer basin as schematically shown in picture 3.13.



Picture 3.13 Schematic view of possible solution for floating layers

The floating layer on the settling tanks is skimmed by the floating layer removal device. The skimmed floating layer is then transported towards a floating layer basin. Within this floating layer basin partitioning walls are placed. These partitioning walls ensure that the floating layer will stay in the first part and only the water will be returned to the beginning of the WWTP.

In the case that the floating layer on the settling tanks mainly consists of sludge it is also a possibility to install spray pumps on the bridge of the settling tanks to reduce the amount of floating layer. After spraying the microbiological material will settle. The spray installation only has to effect the scum layer and not the deeper sludge blanked. This technique is common use in The Netherlands.

At one settling tank the rubber flap is missing on the skimmer for the removal of the floating layer (see picture 3.14). This is not a huge problem but results in a less effective removal of the floating layer as part of the floating layer will pass.

Picture 3.14 Skimmer for removal of the floating layer

In order to effectively remove the current floating layer the water level in the settling tanks should be raised. This could be arranged by adjusting the valves in the return sludge basin (picture 3.15, right part). The height of the inflow of the return sludge in the return sludge basin is the same as the water level of the settling tanks.

It is expected that the floating layer is a results of the points mentioned in paragraph 3.6:

- The MLSS level is twice as high as designed for
- This results in more oxygen consumption by the sludge in relation to the design
- The oxygen demand is not measured and only stired based on expected consumption based on hydraulic influent load
- This can cause a lack of oxygen in the system
- This can cause bulking sludge (filamentous bacteria)

There seems to be a considerable amount of wash-out of sludge from the settling tanks as there is sludge found on the edge of the overflow (see picture 3.15, left part). This indicates that the settling process is disturbed. This disruption is a result of the high level of activated sludge (8 g/l of MLSS instead of the designed value of 4 g/l) and the lack of oxygen (O_2 < 1,5 mg/l) in the activated sludge tanks.


Picture 3.15 Edge of overflow of settling tanks + return sludge basin

Future improvements:

- Improvement of the skimming device. In the current situation sludge was not extracted
- Test sludge volume index (SVI). SVI should be around 120 – 150 ml/gram. This is achieved by oxygen steering of the activated sludge or by chemical dosing of aluminium

3.8 Sludge handling

Purpose: Discharge of excess sludge after dewatering by a belt filter press.

Findings:

The excess sludge is extracted by 2 pumps that are placed in a dry well (see picture 3.16, left part). Within this dry well there is already room reserved for the future expansion of the WWTP. The excess sludge is first pumped to a gravity thickener. The gravity thickener is completely filled with excess sludge and can not work properly anymore (see picture 3.16, right part).

Picture 3.16 Excess sludge pumps + sludge gravity thickener

Based on given information this accumulating of sludge is a result of problems with the thickened sludge transporting pumps (see picture 3.17, left part). The pumps seem to have a lack of capacity, because they are not/hardly able to transport the thickened sludge to the belt filter press (picture 3.17, right part). The type of pumps that are installed, are appropriate to deal with thickened sludge.

Reviewing this situation the following possible causes can be given why the thickened sludge pumps malfunction:

- The pipeline between the gravity thickener and the thickened sludge pumps is around 50 metre. This is quite a long distance for thickened sludge (high viscosity)
- A guideline is that the thickened sludge pumps should be as close as possible to the gravity thickeners because the compressional force is higher than de suction force
- The diameter of the used pipeline is suspicious. It would be better to use a larger diameter
- The capacity of the pumps (1,5 kW each) is limited for this situation. A guideline is that the thickened sludge pumps should always be dimensioned with a bit more capacity then theoretically needed. This guideline is based on experience in the Netherlands. In many cases the gravity thickeners have a better functioning in practice than was expected according to the design
- There are about 4 bends in the long pipeline. The amount of bends should be as low as possible
- The thickened sludge pumps are operated discontinuously. This means that the thickened sludge is buffered within the long pipeline where it might form a cake. This cake is difficult to transport and can block the pipeline

De current problems with the sludge handling are expected to be partly caused by the above mentioned possible causes, but also as a result of the operation of the WWTP. Instead of the design MLSS level of 4 g/l, the WWTP is operated at 8 g/l. This means that the sludge gravity thickener will also be loaded with a higher concentration than originally designed for. As a result the thickened sludge will also have a higher concentration. The high MLSS concentration in the system is working like a chain reaction in the whole plant.

Picture 3.17 Thickened sludge transporting pumps + belt filter press

The belt filter press is normally only used for a couple of hours a week. PE is used to improve the dewatering. The dewatered sludge is transported by a belt towards a trailer which stands outside (see picture 3.18). The handling of the dewatered sludge is governed by different regulations in Turkey as summarised in annex 1 of this report. Therefore, it is recommendable to make analysis of the sludge and act accordingly.

Figure 3.18 Dewatered sludge on trailer

Future improvements:
- Install the sludge pumps near the thickener
- Make sure the sludge in the thickener contains has a dry solid between 2 – 4 % DS
- Dry solid analyses can be measured easily on the location for direct process input
- After pumping sludge from the thickener towards the belt press always clean the pipelines with water to prevent blocking of system

3.9 Chlorination in effluent

Purpose: Disinfecting effluent

Findings:
Picture 3.19 shows the chloric gas bottles together with a part of the chlorination unit.

Picture 3.19 Chloric gas bottles + part of chlorination unit

The effluent is chlorinated with chloric gas. It is not obliged to chlorinate the effluent, only when the effluent is discharged nearby swimming water ore drinking water, chlorination is a option. The use of chloric gas involves potential risks for the operators of the WWTP. Especially in this case because the chloric gas bottles are not secured and can easily tip over. This is a serious risk.

Possible improvements:

- Make sure that chloric gas bottles are secured (e.g. clamp that is fixed to the wall) to prevent casualties
- Improvement of the process management on the WWTP can lead to a reduction of the amount of chloric gas needed (reducing outflow of micro organisms from the system). For each situation a balance has to be made if the use of chloric gas is useful (discharge on swimming water, possible direct contact on humans)

4 Technical findings location visit pilot 2: Ermenek →Ayvacik

This chapter describes the findings of the visited pilot 2. Each part of the WWTP is discussed per paragraph.

4.1 Introduction

As the WWTP of Ermenek is quite a remote WWTP, it is chosen to visit a comparable WWTP that is closer to pilot 1: Kepez. The WWTP chosen is Ayvacik. This WWTP is representative for WWTP Ermenek. The WWTP Ayvacik was visited on the 29th of May 2009.

Figures WWTP Ayvacik:

- Hydraulic capacity 1.000 m^3/d
- The installation was build for 10.000 p.e.

4.2 Sewerage collecting system

Purpose: Transport of wastewater towards WWTP

Findings:

In the current situation the wastewater of the municipality is collected in the sewerage system and is discharged with one pipe. This pipe is not directly connected to the WWTP. Instead of that the collecting pipe is discharged on a natural creek. This discharge point is about 1 km away from the WWTP. The (waste)water from the creek is pumped towards the WWTP (about 800 - 1.000 m^3/day). This is not a sustainable situation.

Currently there are problems with the WWTP as a result of discharge of dairy industry. According to the municipality the WWTP is not working properly from spring till autumn due to the dairy wastewater discharge. This wastewater is not pre-treated at the moment. The high BOD-loads are disturbing the process of the WWTP. It is not clear if the discharge of the dairy industry was included in the design of the WWTP. Possibly the discharge of the dairy industry is not constant during the day, but involves shock loads which can harm the activated sludge quite intensively. Especially for small WWTP's as Ayvacik the effects can be quite immense.

Possible improvements:

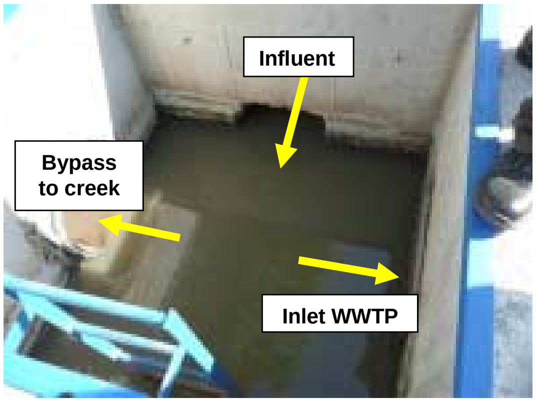
- Establish direct connection of sewerage collection system with WWTP
- Pretreatment of wastewater of dairy industry at source (on location of dairy industry) before discharge to sewerage system

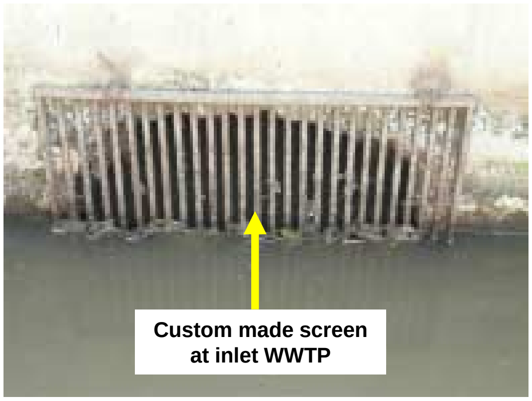
- Another possible improvement could be that the dairy industry buffers/equalization their wastewater during the day and gradually discharges this wastewater during the night. During the night the wastewater of households will be at its minimum as people are asleep. Theoretically this means that the WWTP has some extra capacity. The discharge of dairy wastewater during the night might optimize de use of the capacity of the WWTP and gives less disturbance to the activated sludge

4.3 Influent collection and distribution

Purpose: Inlet towards the WWTP and bypass function when flow exceeds inlet capacity of WWTP.

Findings:
Picture 4.1 (left part) shows the situation of the influent collection and distribution. There is a custom made screen placed in the inlet towards the treatment plant (picture 4.1, right part). This screen was not part of the original design. This screen has a small width (about 1,5 - 2 cm). This screen was placed by the municipality as a result of many blockages in the pipeline towards the screens (paragraph 4.4). The installation of the custom made screen is effective for the prevention of blockages, but it also stops the inflow of gross solids towards the treatment plant. In this situation the gross solids will not be collected, but will flow towards the creek. Due to filthiness of the custom made screen the amount of influent flowing towards the WWTP might be lower than originally designed for as water will choose the way of the lowest resistance. In this case there is a reasonable indication that the wastewater will flow directly to the creek. For a good functioning of the influent distribution the custom made screen should be removed.





Picture 4.1 Situation influent collection and distribution + custom made screen

Possible improvements:

- Remove custom made screen and regularly clean pipe between influent collection and screens to prevent blockages. Wash-out of gross solids towards the creek is not a sustainable solution. A possible better solution is to replace existing pipe with a pipe that has a larger diameter
- The bypass should only be used when the WWTP is working on its maximum capacity. In the current situation the bypass is continuously in use or the WWTP is working on its maximum capacity for 24 hours per day (?). Both situations are not desirable

4.4 Screens

Purpose: Sieving gross solids from the raw wastewater (influent)

Findings:
The original two screens (wide and small, see picture 4.2) should be cleaned by hand when gross solids block the screens. The gross solids can then easily be collected and transported towards a landfill. In the current situation this is never done because it is not necessary as all gross solids will not enter the WWTP as a result of the installation of the custom made screen at the influent collection.

Picture 4.2 Two screens

Possible improvements:

- None, besides the removal of the custom made screen at the influent collection (see paragraph 4.3)

4.5 Sand removal

Purpose: Removal of sand from wastewater by sedimentation.

Findings:
Picture 4.3 shows the construction and installation for the sand removal.

Picture 4.3 Sand removal construction

The construction of the sand removal seems OK. The wastewater is slowly transported through the concrete construction where the sand can sedimentate. With the help of a pump and a rolling construction the sand is pumped out of the basin into a channel which transports the sandy water towards the mechanical unit (see picture 4.3, right part). The sand-free wastewater will flow towards the influent receiving basin. The surface load for sand removal should be around 30 – 40 $m^3/m^2.h$. Based on the total flow of 1.000 m^3/d (= 42 m^3/h) the surface needed is 1 - 1,5 m^2. This surface is available for sand removal, so this seems to be OK.
The amount of sand seen on location was quite low to nil. It is not known if the sand is properly removed in the mechanical unit as the cover of the unit could not be removed easily as it was tightened by screws.
The expectation is that most of the sand in the influent will already deposit in the creek and will not flow towards the WWTP.

Possible improvements:

- None

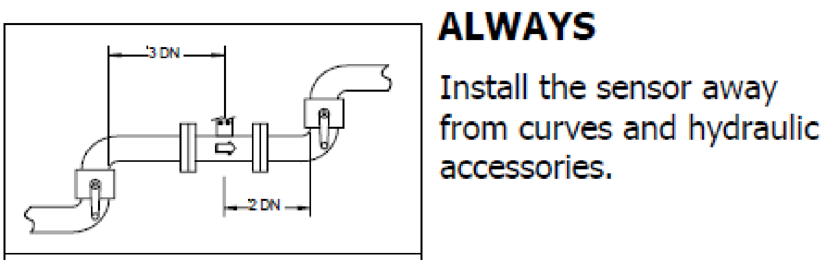
4.6 Pump basin and dry basin with valves

Purpose: Boosting the wastewater from the pump basin towards the activated sludge tank.

Findings:
Picture 4.4 (left part) shows the pump basin. There are 3 pumps (2 + 1 back-up) installed in the pump basin (wet placing). These pumps will transport the water towards the activated sludge tanks. The pipelines towards the activated sludge tank are partly installed within a dry basin. In this dry basin the pipelines from the pumps merge to one pipe. Valves are installed to be able to stop the flow towards the activated sludge tank and bypass the wastewater to the creek. The flow measurement is installed in the central pipe towards the activated sludge tank (see picture 4.4, right part).

Picture 4.4 Pump basin + flow measurement in dry basin

The placement of the flow measurement is a point of interest. The flowmeter is an electromagnetic flowmeter (ISOIL, model ML110). The flowmeter is installed right after a sharp bend and also right before another sharp bend. In the case of an electromagnetic flowmeter there is a certain amount of straight pipeline needed before and after the flowmeter in order to have a good profile of the flow to ensure a reliable flow measurement. Picture 4.5 shows the installation guideline for this specific flowmeter. The inflow area should be a straight pipeline of at least 3 times the diameter of the pipeline, the outflow area should be a straight pipeline of a least 2 times the diameter of the pipeline (measured from the centre of the flowmeter). As seen in picture 4.4 (right part) the required straight pipeline is not installed. This means that the reliability of the flowmeter is at stake.



Picture 4.5 Installation guideline for ISOIL ML110

Possible improvements:

- Replacement of flowmeter according to installation guideline

4.7 Activated sludge tank and aeration

Purpose: COD/BOD removal process by activated sludge.

Findings:

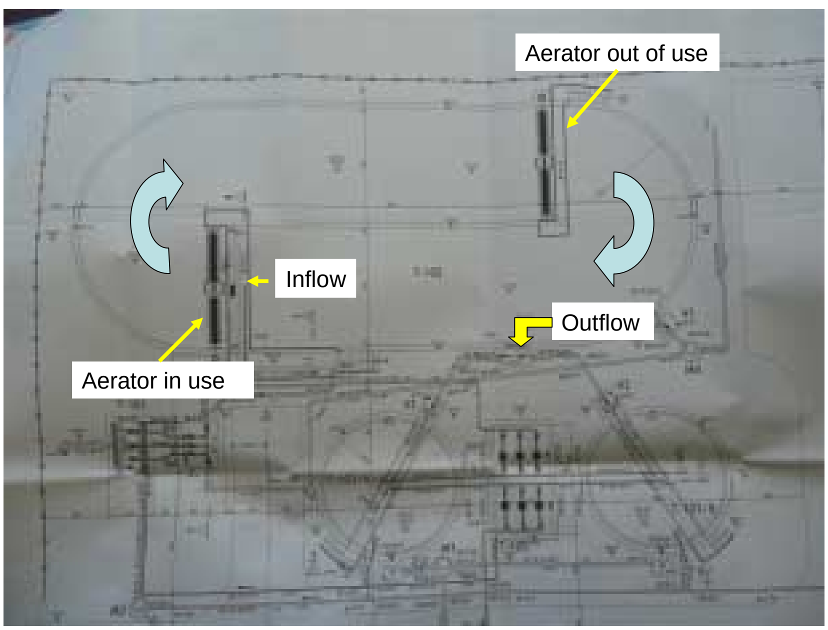
Picture 4.6 shows the activated sludge tank and aeration. There are two aeration brushes installed. The activated sludge tank is also fitted with two propulsors which are always switched on.

Picture 4.6 Activated sludge tank

At the moment we visited this plant only 1 aeration brush was in use. The other brush is switched off to save on operation costs. Based on the provided information this represents the normal operation of this plant. The MLSS level in the activated sludge tank was around 7 – 8 g/l. The design value is 4 g/l. So roughly there is about twice as much sludge in the activated sludge tank as designed for. Because of the high MLSS level more oxygen is needed for a proper functioning of the activated sludge. In the current situation the activated sludge tank can't work properly because:

1. The MLSS level is twice as high as designed for. This results in more oxygen consumption by the sludge in relation to the design
2. Only one aeration brush is in use and is not based on oxygen demand
3. The combination with (possible shock) loads from the dairy industry

The combination of the above mentioned points result in a malfunctioning of the WWTP. This thesis is well-founded by the visual sight of the settling tanks and the effluent (see also paragraph 4.8). There is a lot of floating layer (mainly sludge) found on the settling tanks which is likely a result of lack of oxygen in the activated sludge tank. The expectation is that there are a lot of filamentous organisms present. The turbidity of the effluent also indicates a non-proper functioning of the activated sludge. Picture 4.7 shows the drawing of the design of this WWTP.



Picture 4.7 Drawing of design

In the current situation the wastewater is only aerated at the beginning of the activated sludge tank. To prevent floating layers in the settling tanks it is important to aerate the wastewater close to the outflow. The second aerator should be switched on as well. In this specific case floating layers on the settling tanks will still be possible even when both aerators are switched on because of the discharge of the dairy industry, but it will definitely optimize the functioning of the WWTP. When both aerators are on, both propulsors can likely be switched off to maintain a good rate of flow (about 0,3 m/s). This can be quite easily checked in practice.

In general the design seems to be OK depending, although it is unknown if the amount of BOD from the dairy industry is included in the design.

Possible improvements:

- Lower the MLSS level towards the design value of 4 g/l (and maintain this level) and switch on the second aeration brush as well. As dairy industry wastewater is discharged at the moment the need for the second aeration brush seems inevitable
- Steer the aeration brushes by oxygen level in activated sludge tanks

4.8 Settling tanks and return sludge

Purpose: separation of effluent and sludge which is returned to the activated sludge tank.

Findings:

Picture 4.8 shows one of the two settling tanks.

Picture 4.8 One of two settling tanks

The settling tanks are fitted with a fixed bridge. Both settling tanks have a considerable amount of floating layer. The floating layer is not automatically removed and should be removed by hand. A strange thing is that only 1 settling tank is fitted with a floating layer removal device (see picture 4.9). On the other settling tank this device is missing.

Picture 4.9 Floating layer removal device

The place of this device seems quite inconvenient, because it is more or less placed right below the bridge. It seems logical that the device should be right next to the bridge and not under the bridge. The edge of the floating layer removal device is quite high which makes it difficult to easily skim the floating layer into the device. This device should be lowered a bit or the water level in the settling tank should be a bit higher in order to easily skim the floating layer into the device. Because there is no floating layer removal device at the other settling tank, removal of floating layer there is quite a labour intensive job. The floating layer should be removed frequently. Because of the algae growing on/in the floating layer it seems like this hasn't been done for a while. It is expected that the floating layer is a results of the points mentioned in paragraph 4.7.

The effluent/sludge separation should work properly within these settling tanks. In the current situation it is expected that the settling process is disturbed. This expectation is based on the fact that the settling tanks have to cope with a MLSS level of 8 g/l instead of the design value of 4 g/l.

The sludge return pumps (and also the excess sludge pumps) are situated between the two settling tanks (see picture 4.10). There are 3 return sludge pumps installed (2 + 1 back-up).

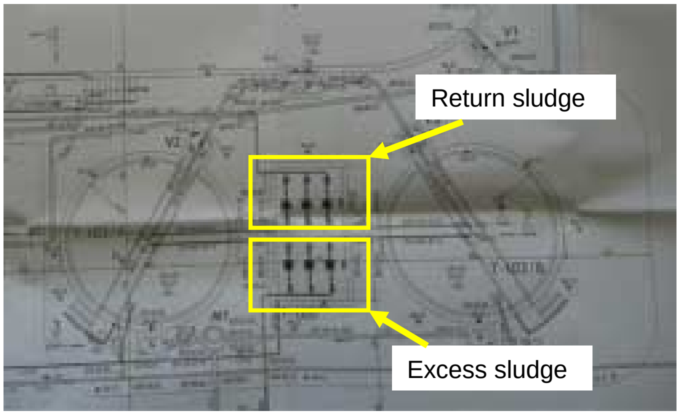


Figure 4.10 Location of sludge pumps + example of sludge pump

Possible improvements:

- Installation of sludge removal device in the other settling tank
- Adjust the existing floating layer removal device in order to easily skim the floating layer
- Test sludge volume index (SVI). SVI should be around 120 - 150 ml/gram. This is achieved by oxygen steering of the activated sludge or by chemical dosing of aluminium

4.9 Sludge handling

Purpose: Discharge of excess sludge after dewatering by a belt filter press.

Findings:

The excess sludge is transported by 3 pumps (2 + 1 back-up) towards the belt filter press where the sludge is dewatered (see figure 4.10 and 4.11). PE is dosed to the sludge for a better dewatering.

Figure 4.11 The 3 excess sludge pumps + the belt filter press

The dewatered sludge is transported by a belt towards a trailer which stands outside (see picture 4.12). The handling of the dewatered sludge is governed by different regulations in Turkey as summarised in annex 1 of this report. Therefore, it is recommendable to make analysis of the sludge and act accordingly.

Figure 4.12 Dewatered sludge on trailer

The belt filter press is normally only used for a couple of hours a week. A belt filter press in combination with the PE-dosing is a relative high investment. Possibly there are better solutions for sludge dewatering such as dewatering of the excess sludge of the treatment plant of Kepez. These possibilities will be further investigated at pilot 3 and 4.

Possible improvements:

- Make sure the sludge in the thickener contains has a dry solid between 2 - 4 % DS.
- Dry solid analyses can be measured easily on the location for direct process input
- After pumping sludge from the thickener towards the belt press always clean the pipes with water to prevent blocking of system

4.10 Chlorination in effluent

Purpose: Disinfecting effluent

Findings:
Picture 4.13 shows the chlorination unit together with the creek where the effluent is discharged.

Picture 4.13 Chlorination unit + creek

The effluent is chlorinated with chloric gas. It is not obliged to chlorinate the effluent, only when the effluent is discharged nearby swimming water ore drinking water, chlorination is a option. The use of chloric gas involves potential risks for the operators of the WWTP.

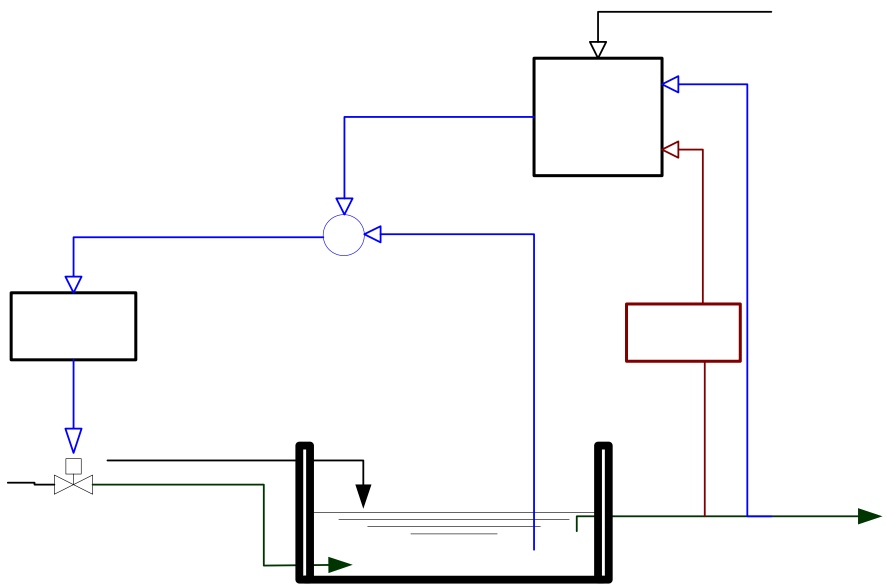
Possible improvements:

- Make sure that chloric gas bottles are secured (e.g. clamp that is fixed to the wall) to prevent casualties
- Improvement of the process management on the WWTP can lead to a reduction of the amount of chloric gas needed (reducing outflow of micro organisms from the system). For each situation a balance has to be made if the use of chloric gas is useful (discharge on swimming water, possible direct contact on humans).

5 General technical recommendations and next project steps

5.1 General technical recommendations

- Analyse the influent and effluent of the WWTP more frequently
  As well for Kepez as Ayvacik it is not known what the actual efficiency of the WWTP is. The characteristics of the influent and effluent are not analysed or analysed very little. For example, the influent of the WWTP Kepez has only been analyzed 4 times since its operation. It is very important to know the efficiency of a WWTP.
- Oxygen input
  At both visited WWTP's it was seen that half of the aeration devices were switched off. This was done, because this decreases the energy costs. Of course this will decrease the energy costs but it will also decrease the efficiency of the WWTP considerably. It would be wise to install an online oxygen measurement that controls the oxygen input (see next recommendation).
- Installation of more online measurements
  Besides on online flow measurement, there are no online measurements installed. This makes it difficult to operate a WWTP. Especially an online oxygen measurement in the activated sludge tank is important. The surface aerators should be controlled by this online oxygen measurement. In this way you make sure that the amount of oxygen input is related to the current load of the WWTP. For example for Kepez this would mean that if the load drops than one surface aerator is automatically switched off and when the load increases the second surface aerator is switched on again. You don't waste any oxygen (=energy) in this way.
  In general more online measurements result in less time needed for operators. A good balance in online measurements could be considered.



- Necessity chlorination in effluent
  Based on the current operation of the WWTP's it is necessary to chlorinate the effluent. The current operation is poor which results in a bad effluent quality. If the treatment process is properly controlled with among other things the mentioned oxygen measurement, chlorination seems unnecessary. Building costs and operational costs will decrease considerably. Another accompanied advantage is that working with the hazardous chloric gas is not needed anymore.
- Training of operators by contractor
  If understood correctly the contractor of the WWTP has to train the operators of the WWTP within one year after completion of the WWTP. After one year Illerbank checks if the WWTP is operating OK. If it is OK Illerbank hands over the responsibility of the WWTP to the municipality. About this education and this handing over some questions arise. The feeling is that the education done by the contractor is only technical (how to switch things on and off) and not technological. The feeling is that the municipality doesn't operate the WWTP poorly on purpose, but just because they do not know how to operate the WWTP from a technological point of view. More attention should be paid to this kind of training. Furthermore it is not known what the Illerbank checks exactly before handing over the WWTP to the municipality. With a handing over you would expect a protocol where it is written down what to check. In this way defects (like a wrong-turning aerator) are observed in time and can be corrected.

- Safety
  The safety of the operators of the WWTP could be better. For instance, picture 5.1 shows the situation at the excess sludge pumps at WWTP Kepez. There is no second chain installed while the connectors are installed at the poles. There is serious risk that someone can drop several metres. The costs of a second chain are negligible compared to the total building costs. An even better solution would be to have a stiff completely welded construction.

Picture 5.1 Situation at Kepez

Furthermore no safety work switches are installed. Picture 5.2 shows an example of a safety work switch. Installing a safety work switch at a pump or another electric device ensures that there is no electric current flowing anymore. This ensures safe working conditions when maintenance is performed.

Picture 5.2 Example of safety work switch

Another safety measure that has not been seen are safety cords in the activated sludge tanks. Safety cords are installed a few metres before surface aerators and propulsors. The function of the safety cords is that if someone accidentally falls into an activated sludge tank he or she pulls the safety cord. By pulling the safety cord the propulsors and surface aerators are stopped to prevent physical injuries.

It is understandable that safety regulations do not have a high priority at the moment, but in many cases the extra costs are low to nil in relation to the total building costs and ensure a safer working surrounding.

- Measures for future expansion
  In the case of Kepez a lot of parts have already been built for future expansion. This might seem a wise thing to do but on the other hand it increases the building costs. The already installed components are already subject to weather influences and the wastewater and probably need to be renewed when the expansion of the WWTP is really executed. This seems like a waste of capital costs. Besides this the technique for WWTP's could change considerably. So you might end up with a WWTP that is out of date.
- Electro technical
  All components of the treatment plant are to be served on and off manually. The operation and control of the machinery can be more efficient, more easy and energy saving by using simple controllers and timers. There is no need for using complicated hardware or software. With smart process control- equipment and adjustments the high workload of the operators will be reduced.(They are available 24 hours a day). The automatic operation of the systems will also reduce the energy use of the Plant. The level measurements can be better than they are now. Using better quality measuring equipment and applying extra level switches will prevent flooding or running dry the pumps.

Summary:

Installation of more online measurements would stimulate a better operation of the WWTP. The balance between the amount of online measurements in relation to the installation costs and operational costs should be reviewed per specific WWTP. Installing on online oxygen measurement and controlling the amount of oxygen input with this measurement seems logical to do. In this way the efficiency will increase considerably. The dosing of chloric gas is not needed when the operation of the WWTP is properly controlled. In this way the complete chloric dosing installation (such as building for chloric gas and special gutter) would be unnecessary and saves a lot of money on buildings costs and operation costs. Getting rid of the hazardous chloric gas is also a big improvement for the safety of the operators of the WWTP. For a good operation of the WWTP the operators should be educated from a technological point of view.

5.2 Next project steps

- Improvement of process steering on wastewater treatment plants
- Possible use of Tauw calculation tool for future WWTP calculations?
- Decision tool for configuration choices
- Overview possible aeration devices with amount of oxygen per kW
- Overview of appropriate wastewater techniques
- Frame construction for aeration devices
- Reuse possibilities for effluent and air purification possibilities

Appendix 1

Legal and Regulatory Issues for Sludge Management

Annex: Legal and Regulatory Issues for Sludge Management

The Municipal Wastewater Treatment Regulation (MWTR) bans the disposal of all types of solid waste and sludges from treatment plants and septic tanks to the receiving bodies listed in Item 5(f). The Solid Waste Control Regulation (SWCR) refers to sludge disposal. The Hazardous Waste Control Regulation (HWCR) also controls the disposal of sludges. The list of hazardous wastes is given in the Annex 7 of the HWCR. In this list, confirmed hazardous wastes are classified as 'A' wastes, while possible hazardous wastes are designated 'M'.

The list includes 20 sections: Sections 1-12 and 17-19 refer to the source (that is, the type of industry), Sections 6-7 refer to the associated industrial process, Sections 13-15 refer to the materials, Section 16 refers to miscellaneous provisions, and Section 20 refers to domestic wastes. In these sections waste water treatment sludges are classified as 'A' or 'M', according to the process. Category 'A' sludges are automatically classified as hazardous waste, while the sludges in Category 'M' must be checked according to the limit values given in Annex 6 of the regulation.
Reuse, recover and recycling of wastes are recommended. The appropriate methods for sludge disposal complying with these regulations are given below.

Re-use of sludge on land as a soil conditioner

Item 5(g) of the MWTR states that sludge from municipal waste water treatment plants can be re-used under the appropriate conditions, and that the use and/or disposal of sludge on land should be in compliance with the Soil Pollution Control Regulation (SPCR). The SPCR defines the conditions, restrictions and bans applicable to stabilized sludges from municipal waste water treatment plants. Management of this sludge is also specified in the relevant permit. For us in agricultural applications, sludge should be analyzed and checked with the limits given in Annex 1-B of the SPCR, and the soil to be applied should be analyzed and checked with the limits given in Annex 1-A(a) of the SPCR.

Use of sludge as supplementary fuel

According to the decree on the General Rules for the Use of Wastes as Supplementary Fuel, sludges of waste water treatment plants can be used as supplementary fuel at cement plants. However, it should be processed accordingly depending on the type of the sludge, that is, whether it is classified hazardous or not according to the HWCR. A trial incineration must be done, and the emission results must be in compliance with the Regulation on Air Pollution Control Sourced by Industrial Facilities and the decree.

Disposal to sanitary landfill

Sludges can be disposed to sanitary landfills, but prior to initial disposal a leachate analysis must be done according to Annex 11-A of the HWCR. If the leachate analysis demonstrates that the sludge is within the limits of hazardous waste, the sludge can be disposed to the special landfill in compliance with Items of 23, 32, 34 and 35 of the HCWR, once permission is granted by the Ministry. If it is not hazardous, then the sludge can be disposed to a sanitary landfill as a mono-fill (separate compartment) complying with the SWCR. If it is inert, then sludge can be disposed to a sanitary landfill or on impermeable soil with the approval of the Ministry. In addition, Item 28 of SWCR limits the water content of the sludge to 65%, and to 75% with special conditions.