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ASSESSMENT OF IZMIR SEWAGE PROJECT AND ITS ENVIRONMENTAL IMPACTS

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ABSTRACT

Izmir Bay has been polluted by uncontrolled industrialisation, discharging of domestic and industrial wastewater, transportation, agricultural facilities, etc.. Izmir Sewage Project was drawn up and applied in order to control the pollution of Izmir Bay. This project consists of a Main Pipeline, Main and Secondary Collectors, Pump Stations, a Separate Sewage System, Water Intake Structures from the River and a Wastewater Treatment Plant. 98% of the studies on the sewage system between Konak and Cigli Wastewater Treatment Plant, which is the first step of the project, has been built. Project flowrate of the plant is 7 m^3/s and 2/3 of the total capacity has been completed. Another part of the project is Güzelbahce Wastewater Treatment Plant, which will treat the wastewater of the Southwest part of the Izmir City. According to this project, required revision studies were also done on the sewage collection system. Güzelbahce Wastewater Treatment Plant has signed a contract and they will have finished it in a year. In this paper, Izmir Sewage System and Cigli Wastewater Treatment Plants are introduced in detail, and some structures, which have to be built, are described. Environmental impacts of treatment plants on Izmir Bay and the surrounding region and usage of treatment plant effluent for some useful purposes like irrigation and process water are also discussed.

1. INTRODUCTION

Izmir City is one of the biggest cities in Turkey and it is a tourist region. Izmir has the biggest bay in Turkey, and it has been polluted by uncontrolled industrialisation, discharging of domestic and industrial wastewater, transportation, agricultural facilities, etc. All of the domestic and industrial wastewater produced in Izmir was discharged in the Izmir Bay. In order to control its pollution, Izmir Sewage Project was prepared and applied.

The first study on the Izmir Sewage Project was carried out by the team of Camp-Harris-Mesera (CHM) in 1971. This project consists of Main Pipeline, Main and Secondary Collectors, Pump Stations, Separate Sewage System, Water Intake System from River and Wastewater Treatment Plant. 98% of the studies on the sewage system between Konak and Cigli Wastewater Treatment Plant, which is the first step of the project, has been built.

In this paper, Izmir Sewage System and Cigli Wastewater Treatment Plants are introduced in detail, and some structures, which have to be built, are given and discussed.

2. DEFINITION OF THE IZMIR SEWAGE PROJECT

The Izmir Sewage Project is integrated projects, which include domestic and industrial wastewater sewage network systems, collectors, basic pipeline, pump stations, and a wastewater treatment plant.

The length of the basic pipeline is 65 km and final flowrate of the project is 32 m^3/s. Capacities of four pump stations, which are located on the basic pipe line, are given in Table 1 (IZSU, 1999).

Industries must treat their wastewater according to certain characteristics in order to discharge to the sewage system. If their wastewater characteristics are over the discharge limits, they must be use pre-treatment methods before discharging. Discharging limits to the sewage system, which are given in Table 2, are defined in “Discharging Regulations of IZSU”.

Table 1. Capacities of Pump Stations

Pump Station	Capacity (m^3/s)
GUMRUK Pump Station	6
BAYRAKLI Pump Station	20
KARSIYAKA Pump Station	24
CIGLI Pump Station	32

The Wastewater treatment plant is located at Çiğli and it is being built in 300 000 m^2 area. The Izmir City wastewater treatment plant includes pre-treatment units (inlet system, screens, grit removal tanks, Parshall Weir, water distribution system), primary sedimentation tanks, bio-phosphorus basins, aeration basins, final sedimentation tanks, and sludge treatment units. Project flowrate of the plant is 7 m^3/s and 2/3 of the total capacity has been completed. The flow scheme of the plant is given in Figure 1.

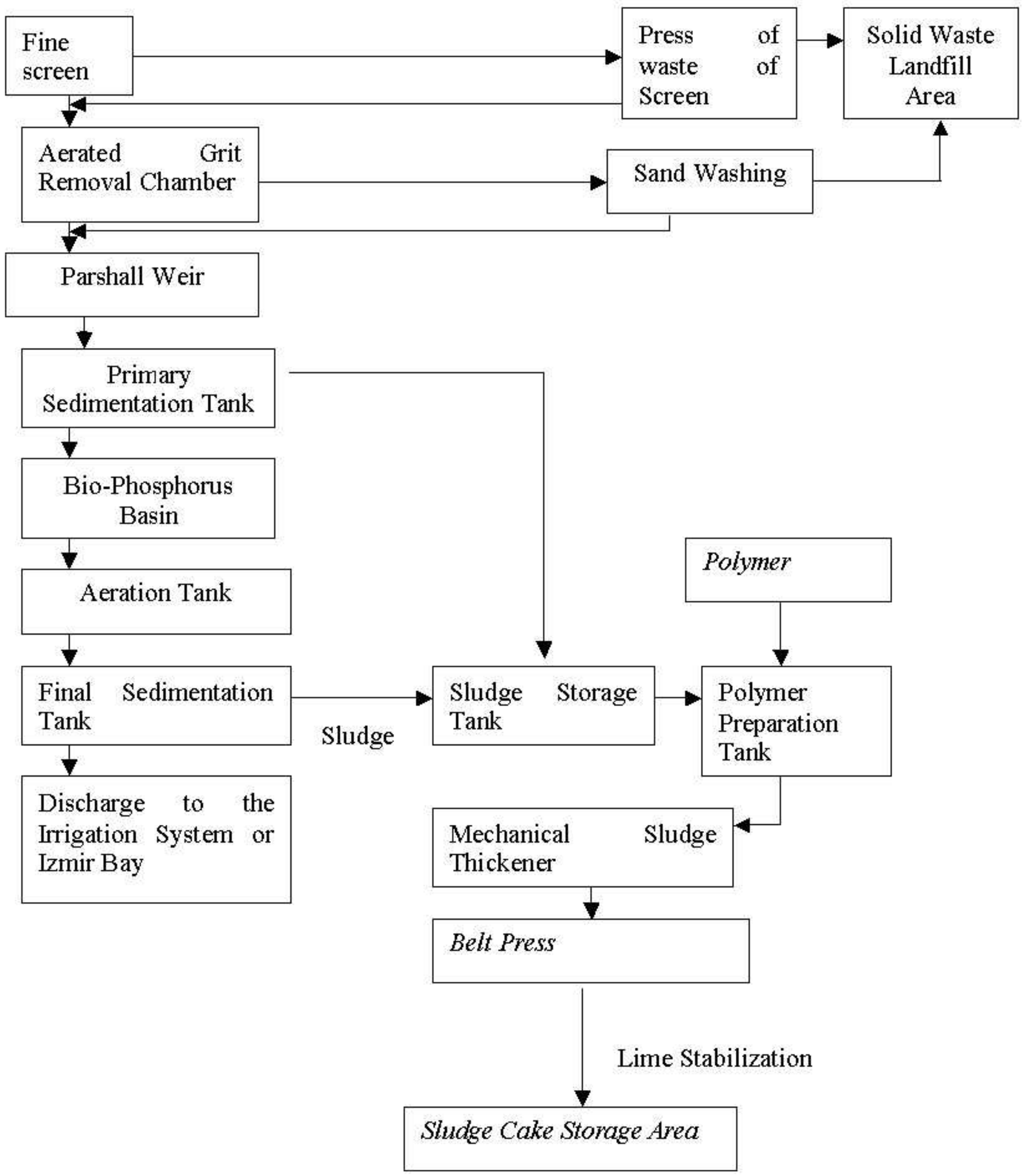

Figure 1. Izmir Wastewater Treatment Plant Flow Scheme

Table 2. Discharging Limits to the Sewage System (IZSU, 1991)

Parameter	IZSU Discharge Standards	Parameter	IZSU Discharge Standards
Temperature (◦C)	40	Pb (mg/L)	3
PH	6.5 – 10	Cd (mg/L)	2
SS (mg/L)	500	Total Cr (mg/L)	5
Oil and Grease (mg/L)	250	Hg (mg/L)	0.2
COD (mg/L)	4000	Cu (mg/L)	2
SO_4^{-2} (mg/L)	1000	Ni (mg/L)	5
Sulphur (mg/L)	2	Zn (mg/L)	10
Phenol (mg/L)	10	B (mg/L)	3
Free Chlorine (mg/L)	10	Sn (mg/L)	5
Arsenic (mg/L)	3	Oil (Tar – petroleum) (mg/L)	50
Total Cyanide (mg/L)	10	Surfactants	It is forbidden

Treated wastewater will be discharged to the sea using an open channel. Dimensions of the channel are 8 m width, 2 m depth, and 2.4 km length. And also it is planned that, treated wastewater also can be used for irrigation in the Menemen Plain if necessary later.

Wastewater flowrates are:

Average flowrate : 7 m^3/s (25 200 m^3/h, 605 000 m^3/d)
Maximum dry wheather flowrate : 9 m^3/s
Maximum peak flowrate :12 m^3/s

General characteristics of raw wastewater and required effluent values, which were considering when designing the treatment plant are given in Table 3 and 4, respectively (IZSU, 1999).

Table 3. Raw Wastewater Characteristics

Parameter	Value	
	Concentration (mg/L)	Load (t/d)
BOD_5	400	242
COD	600	363
TSS	500	302
TKN	60	36
TP	6	3.6
Temperature (summer)	22 ◦C	
Temperature (winter)	15 ◦C	
Conductivity	1200 μmho	

Table 4. Required Effluent Values

Parameter	Project Value	Preferred Value
Summer time and irrigation season (22 ◦C)		
BOD_5	< 20 mg/L	10 mg/L
COD	< 100 mg/L	75 mg/L
TSS	< 30 mg/L	15 mg/L
Winter time (15 ◦C)		
BOD_5	< 20 mg/L	15 mg/L
COD	< 100 mg/L	75 mg/L
TSS	< 30 mg/L	20 mg/L
TN	< 12 mg/L	10 mg/L
TP	< 1 mg/L	1 mg/L

Industrial wastewaters also come to the treatment plant. Therefore, the organic loads of wastewater are higher than proposed organic loadings of a big city.

The length of the main pipeline from Güzelbahce to the Çiğli Wastewater Treatment Plant is 65 km. Because of this very long pipeline, two wastewater treatment plants were planned, one of them is Çiğli Wastewater Treatment Plant and the other is Güzelbahce Wastewater Treatment Plant. Güzelbahce Wastewater Treatment Plant was planned for a population of 100.000 people. Effluent from the treatment plant will be discharged into the sea and it has a contract and they will have finished it in a year.

3. DEFICIENCIES OF THE IZMIR SEWAGE PROJECT

Izmir Çiğli Wastewater Treatment Plant started operating in 1999. Nowadays, two stages of the treatment plant are operating and the wastewater treatment capacity is about 5 m^3/s. This treatment plant was designed to reduced nutrients such as nitrogen and phosphorous. Although it was aimed to obtain best effluent quality, sludge handling and treatment units were not taken into consideration during the design stage. A schematic flow diagram of this treatment plant is given in Figure 1.

3.1. Sludge Disposal Methods

The most important problem of the treatment plant is sludge disposal. At the design stage, sludge stabilization and disposal units were not taken into consideration. The treatment plant was designed as consisting of only thickening and dewatering units; the stabilization step of sludge produced in primary and secondary sedimentation units was not concerned. However, stabilization must be applied to sludge before disposal in order to protect the environment. Hence, anaerobic sludge stabilization, which is preferred as a biological stabilization method all over the world, was recommended. Since, about three years are necessary to build and operate these units, the lime stabilization method was suggested until anaerobic digestion units are completed. Thus, the lime stabilization unit was built and operated. The lime stabilized sludge cake containing about 30% DS is stored in special cells, which are placed in the treatment plant area. Huge amounts of lime is used in order to stabilize dewatered sludge; so operational costs are high and the required area for storage is getting bigger and bigger. In addition, if required doses of lime are not applied to sludge, decomposition of organic material will start, pH will drop and depending on the environmental conditions pathogens will be reproduced. If required technical remediation is not applied during storage stage such as impermeability of landfill cell ground, cover of the windrows, sufficient drainage system of landfill cell, groundwater and soil pollution problems will occur. Other disadvantages of this operation are odor problems, flies and some esthetical problems around the landfill area and close settlement areas are disturbed.

Because Izmir is a big a developing city, there will also be a free and sufficient area problem for new treatment units and storage areas in the future. So, other alternatives for handling and disposal of sludge must be planned. One of the alternatives is anaerobic stabilization of sludge. Anaerobic digestion is among the oldest forms of biological waste and/or wastewater treatment. Anaerobic digestion has certain advantages over aerobic biological treatment processes. Firstly, less energy is required than aerobic systems because there is no need for oxygen and, secondly, methane gas is evolved. Digester gas is typically about 65% methane, heating value of digester gas is approximately 22 400 kJ/m^3, and it can be used as an energy source. In large plants, methane gas may be used as fuel for boiler and internal combustion engines, which are in turn used for pumping wastewater, operating blowers, and generating electricity. Because of rich nutrient content, anaerobically digested sludge can be used as conditioning material in soil, in forest areas and it can be stored on the earth directly. Biologically stabile and less amount of sludge production is another advantage of anaerobic digestion process (Metcalf, Eddy, 1992). Comparison of volume of produced sludge in different treatment processes is given in Figure 2.

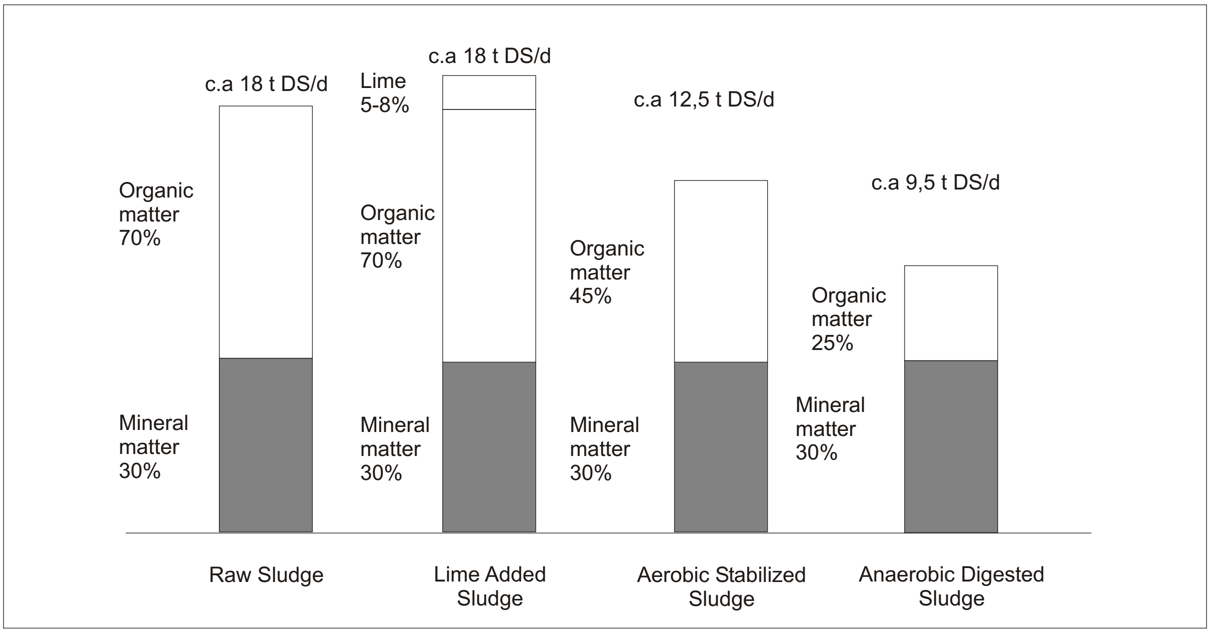

Figure 2. Comparison of Sludge Volumes Produced in Different Treatment Processes (Jatzkowski, 2000)

Another alternative operation for disposal of sludge is composting, which is one of the widely used stabilization methods. Treatment plant sludge can be composted alone or along with municipal solid wastes (co-composting process). There is Municipal Solid Waste Composting Plant in Menemen close to Wastewater Treatment Plant. According to the capacity of this composting plant, a part of sludge can be composted there. Sludge can also be composted in the treatment plant area using windrow composting technology. There is a sufficient free area for windrow composting operation. Composted material can be used for reclamation of soil. The soil properties of the treatment plant area can be improved by using this material for landscape purposes.

3.2. Treated Wastewater

Limitation of water sources is also an important problem for Izmir City as it is all over the world. There are no infinite water sources of drinking water quality; therefore other water sources should be used for other purposes instead of drinking water. Reuse and reclaimed of treated effluents are widely used all over the world in order to save fresh water sources. It can be used in industry (cooling water, process water, boiler feed, etc.), non-potable urban uses (fire protection, air conditioning, toilet flushing), agricultures irrigation, groundwater recharge, landscape irrigation (parks, golf courses, school yards, etc.).

At present, effluent of the Izmir Wastewater Treatment Plant is discharged into Izmir Bay. Instead of this, it may be reused for beneficial purposes, which are given above. For example: treated wastewater can be used for irrigation in the Menemen Plain. In order to use effluent for agricultural irrigation in Menemen, some studies were carried out by the Administration of Water and Sewage of Izmir Municipality (İZSU), State Hydraulic Works (DSİ), Ege University Faculty of Agricultural and Dokuz Eylül University Environmental Engineering Department. In addition to these studies, a report on usage of effluent of treatment plant for irrigation was prepared by Dokuz Eylül University Environmental Engineering Department. In this report, analyses of effluent quality and irrigation criteria in Turkish Regulations were given and usage of this effluent in the Menemen Plain was discussed (DEU, 1998). Studies on agricultural irrigation have been carried out by some Institutions.

Also, Çiğli Atatürk Industrial District is near to Izmir Wastewater Treatment Plant. In this district, water supply sources are becoming limited and salinity of groundwater is increasing because of over use. Water demand for industrial purposes of this area can be supplied from treatment plant effluent. If effluent of the treatment plant is not good enough quality for some industries, additional treatment steps can be added before using. Studies should be done on usage of treatment plant effluent for industrial or other purposes in this region.

4. RESULTS AND DISCUSSION

Izmir is one of the most beautiful coastal cities of the Aegean Region. Izmir Metropolitan and its surroundings have a high tourism potential because of natural beauties, historical places and beaches. Some precautions must be taken into consideration to protect environmental sources. The most important pollutant source is wastewater coming from settlement areas and industries for Izmir Bay. Some recommendations to prevent in particular water pollution are summarized below:

- Sewage system should be completed and all wastewater produced in settlement areas and industries transported to the Izmir Wastewater Treatment Plant and direct discharges of raw wastewater to İzmir Bay must be prevented,
- The deficiencies of the Izmir Wastewater Treatment Plant should be removed urgently
- The treatment plant should be operated efficiently,
- Sludge stabilization units must be built and operated without delay,
- Reuse of treated water should be evaluated and supply usage of this effluent properly,
- The Güzelbahçe Wastewater Treatment Plant should be completed in a short period,
- Industrial discharges to sewage system must be controlled by IZSU and pre-treatment of industrial wastewater before discharge to the sewage system must be done if necessary,
- Precautions given in IZSU Regulations, Water Pollution Control Regulation, Environmental Law and other related regulations should be applied.

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