

# EXAMINATION OF THE PROBLEMS EXPERIENCED IN URBAN AND INDUSTRIAL WASTEWATER TREATMENT FACILITIES AND CONSTRUCTED WETLANDS AND IDENTIFICATION OF CIRCUMSTANCES IN THE CASE OF THE YOZGAT PROVINCE OF TURKEY

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## ABSTRACT

In this study, the state of wastewater treatment facilities in the Yozgat province of Turkey was explored, and upon collection of samples from the facility outlets, problems encountered in the facilities were evaluated on the basis of the results of sample analysis, and solutions were proposed. To this end, five urban wastewater treatment facilities, five industrial wastewater treatment facilities and thirty constructed wetlands were examined. It was found that the samples received from five industrial wastewater treatment facilities operating in different sectors had values below the standards which specified in the Water Pollution Control Regulation of Turkey (WPCR). In the analysis performed in constructed wetlands located in towns with different population sizes, it was ascertained that they stood idle because of erroneous construction, wrong selection of plants, devastation of plants by animals and the absence of maintenance staff.

## KEYWORDS:

Yozgat, Wastewater, Domestic, Industrial, Constructed wetland, Operational problems

## INTRODUCTION

Along with urban and industrial development, water consumption and wastewater levels go up with each passing day, and urban wastewaters are some of the most important problems of rapid urbanization [1,2,3]. In the world, the water volume is 1.4 billion km<sup>3</sup>. 97.5% of the water across the world is in the form of saltwater in oceans and seas. Groundwater and surface water resources make up approximately 1% of the total water resources in the world. Groundwater resources meet 25–40% of drinking water needs. In this context, it is discerned that freshwater resources which can be used for satisfying human needs are limited [4]. In Turkey, the per capita annual

water volume is 1,519 m<sup>3</sup>. This situation demonstrates that Turkey is a country suffering from water scarcity. It is predicted that Turkey's population will reach 100 million in 2030, and the per capita annual water volume will fall down to 1,120 m<sup>3</sup>. Turkey stays in the course of becoming a water poor country with its increasing population and growing cities if the necessary measures are not taken soon [5]. The most crucial problems of the 21<sup>st</sup> century are energy scarcity and environmental pollution, and it is highly likely that the number of people confronting these problems will exceed 9 billion in 2050 [6]. The increase in living standards and urbanization will turn up the pressure on water resources besides population growth [7]. With each passing day, scarce freshwater resources get even more polluted because of waste from houses and industries and of uncontrolled agricultural practices. Besides these circumstances leading to pollution, the need for clean freshwater grows even further if droughts associated with climate change are also taken into consideration. The pollution of surface water gives rise to infectious diseases, as well. This is why collection and treatment of wastewater are quite significant. In the USA, the first sewage system was set to be built in Chicago after twelve years following the construction of the sewage system of Hamburg which was initiated in 1840 [8]. Today, water pollution is quite a crucial problem in developing countries [9]. Wastewater treatment facilities protect water resources and human health by reducing the amount of carbon, foodstuffs and pathogens discharged to water sources [10].

Wastewater treatment facilities have offered the opportunity to reuse the wastewater which stems from a variety of usages of water. The first wastewater treatment facility in the world was built in 1842. Wastewater treatment techniques and technology have been developed as of 1842 onwards until today [11]. Hence, the power consumption of treatment facilities fell down whilst their efficiency went up. Along with the increase in environmental pollution and water shortage, the reuse of water by

means of wastewater treatment facilities became even more important [12,13]. Through physical or biological wastewater treatment facilities, it is difficult to eliminate micropollutants which emerge along with industrialization such as microplastics, insecticides, hormones and antibiotics. Moreover, nutrients such as nitrogen and phosphorus cannot be sufficiently eliminated through these systems. This is why it was observed that there were high concentrations of these pollutants in several rivers and lakes which were used as receiving bodies [14]. For management of micropollutants and nutrients, systematic and sustainable solutions are needed. In this sense, recycling of wastewater is a promising solution for reduction of pollution in rivers and lakes [14]. Several studies in the literature have also cited that sewage water heat energy that is sometimes usable in terms of heating and cooling and heat pump systems may be used for this purpose [15].

Activated sludge systems have occupied a key place in treatment of urban and industrial wastewater on the world scale, and they have successfully been used for around a century [16]. However, problems encountered in activated sludge systems tempted designers to embark on new pursuits. Aerobic granular sludge systems were developed for assuring sustainable water management and more productive employment of resources [17].

When wastewater treatment facilities are built, a variety of problems based on the project, construction or operation are likely to be experienced. In this study, existing problems were identified by examining urban and industrial wastewater treatment facilities and constructed wetlands, and solutions were proposed. In the examinations, besides observations, samples were collected from the outgoing water from the facilities, and the results obtained from the analyses of the samples were compared to sector-specific discharge standards stipulated in WPCR.

## MATERIALS AND METHODS

The province of Yozgat is located in the Central Anatolia Region of Turkey. In terms of land area, it is the fifteenth largest province of Turkey. It has an arid/semi-arid continental climate [18]. The province's population is 424,981 as per 2018 data, and 105,167 people out of the total population live in the provincial center [19]. In the context of this study, five urban wastewater treatment facilities, five industrial wastewater treatment facilities and thirty constructed wetlands were examined. Among all these facilities, samples were collected from the outgoing water originating from two urban wastewater treatment facilities, three constructed wetlands and five industrial wastewater treatment facilities, and these samples were analyzed. Information on these facilities is briefly presented below.

**Urban Wastewater Treatment Facilities** In the Yozgat province, there are five urban wastewater treatment facilities, namely, Biological Wastewater Treatment Facility of Yozgat Municipality, Biological Wastewater Treatment Facility of Yerköy Municipality, Biological Wastewater Treatment Facility of Bozok University, Biological Wastewater Treatment Facility of Şefaati Municipality and Biological Wastewater Treatment Facility of Saraykent Municipality.

**1. Biological Wastewater Treatment Facility of Yozgat Municipality.** On average, the mass flow rate of the facility is 19,000 m<sup>3</sup>/day, and the capacity of the facility is 25,000 m<sup>3</sup>/day. The facility is made up of a coarse grid, fine grid, primary clarifier, sand trap, aeration basin, condensation trap, final sedimentation pond and decanter. The treated wastewater is discharged to the Balta Özü Stream. On average, one and a half tons of sludge is obtained in the facility per day. The resulting sludge is conditioned by using polyelectrolyte and disposed of in the regular storage area for solid waste.

**2. Biological Wastewater Treatment Facility of Bozok University.** The facility launched its operations in 2016. On average, the mass flow rate of the wastewater coming into the facility is 590 m<sup>3</sup>/day, and the capacity of the facility is 8,900 PE (Population Equivalent). The project of the facility is based on the classic activated sludge system. It is made up of a coarse grid, fine grid, sand trap, aeration basin, final sedimentation pond and decanter. Dehydrated sludge is sent to the regular storage field for solid waste.

**3. Biological Wastewater Treatment Facility of Yerköy Municipality.** The facility was built in 2015 by İller Bankası (Turkish Bank of the Provinces). It comprises two phases. The maximum mass flow rate of the first phase is 11,214 m<sup>3</sup>/day (52,000 PE), and the maximum mass flow rate of the second phase is 16,248 m<sup>3</sup>/day (78,000 PE). The initial investment cost for the facility totaled 3,368,000 US Dollars. It is made up of a coarse grid, fine grid, sand trap, biological treatment, final sedimentation pond and decanter. The treated water is discharged to the Derince Stream. However, the facility is still not operational.

**4. Biological Wastewater Treatment Facility of Şefaati Municipality.** The facility was built in 2014 by the Municipality of Şefaati with the donation granted by the Ministry of Environment and Urbanization of Turkey. The maximum mass flow rate of the facility which has a surface aerator is 2,400 m<sup>3</sup>/day (10,000 PE). It is made up of a coarse grid, fine grid, sand trap, aeration basin and final sedimentation pond. The treated water is discharged to the Delice Creek. The resulting sludge is dehydrated

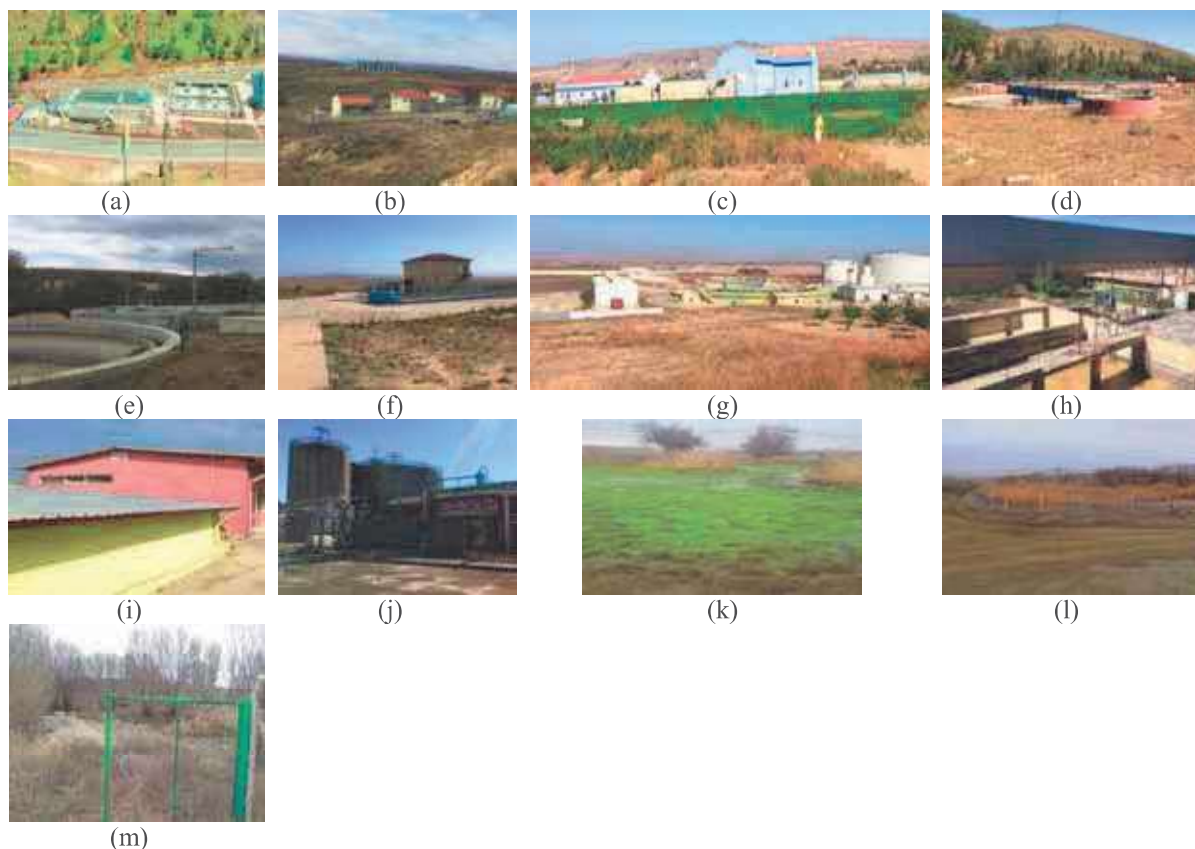
with a plate filter press and disposed of in the irregular storage area of the municipality.

**5. Biological Wastewater Treatment Facility of Saraykent Municipality.** The facility was built in 2012 by the Municipality of Saraykent with the donation granted by the Ministry of Environment and Urbanization of Turkey. The maximum mass flow rate of the facility is 2,400 m<sup>3</sup>/day (10,000 PE). It is made up of a coarse grid, fine grid, elevation center, sand trap, aeration basin and final sedimentation pond. The treated water is discharged to the Kaynaçan Stream. The resulting sludge is dehydrated with a plate filter press and disposed of in the irregular storage area of the municipality.

**Industrial Wastewater Treatment Facilities.** By means of industrial development, industrial wastewaters became an important pollution source, the environment is being destroyed by industrial discharges all over the world, and several industrial

wastewaters also have ecotoxicological effects [20,21]. The heavy metal contents of wastewaters negatively affect soil [22]. In the Yozgat province, there are five facilities established for treatment of wastewater originating from a variety of industries.

**1. Industrial Wastewater Treatment Facility of Gedaş General Foodstuff Distribution, Marketing, Industry and Trade Joint Stock Company.** The facility was built in 2014 for treatment of wastewater resulting from processing of potatoes. Its capacity is 360 m<sup>3</sup>/day. It is made up of a coarse grid, rotating drum, primary clarifier, aerator, final sedimentation pond and sludge filter. It is subject to sector-specific restrictions prescribed in Table 5.9 of WPCR. The treated water is discharged to a dry stream bed. The resulting sludge is disposed of in the irregular storage area of the Boğazlıyan district of the Yozgat province.



**FIGURE 1**

**Urban and industrial wastewater treatment facilities and constructed wetlands examined within the scope of the study**

(a) Biological Wastewater Treatment Facility of Yozgat Municipality, (b) Biological Wastewater Treatment Facility of Bozok University, (c) Biological Wastewater Treatment Facility of Yerköy Municipality, (d) Biological Wastewater Treatment Facility of Şefaattli Municipality, (e) Biological Wastewater Treatment Facility of Saraykent Municipality, (f) Industrial Wastewater Treatment Facility of Gedaş General Foodstuff Distribution, Marketing, Industry & Trade Joint Stock Comp , (g) Industrial Wastewater Treatment Facility of Boğazlıyan Sugar and Confection Products Integrated Plant, (h) Industrial Wastewater Treatment Facility of Yerköy Branch of Kale Ceramics, (i) Industrial Wastewater Treatment Facility of Yozgat Kraft Sack Industry & Trade Joint Stock Company, (j) Industrial Wastewater Treatment Facility of Yozgat Sugar Plant of Turkey Sugar Plants Joint Stock Company, (k) Constructed Wetland of Belekcehan, (l) Constructed Wetland of Baydıgın, (m) Constructed Wetland of Ozan

TABLE 1  
Constructed wetlands which exist in the Yozgat province

Province	District	Municipality	Population (2017)	Facility Name	Date of Completion of Facility Construction	Treatment Mode	
Yozgat	Akdağmadeni	Belekçahan	1966	Belekçahan Municipality	2012	Biological (Natural Treatment)	
		Oluközü	1206	Oluközü Municipality	2011		
		Umutlu	1984	Umutlu	2011		
	Aydıncık	Aydıncık	2853	Aydıncık Municipality	2011		
		Baydığin	3238	Baydığin Municipality	2010		
		Ovakent	2314	Ovakent Municipality	2011		
		Sırçalı	1602	Sırçalı Wastewater Treatment Facility	2011		
		Uzunlu	2199	Uzunlu Municipality	2011		
	Boğazlıyan	Yamaçlı	2647	Yamaçlı	2011		
			291	Ömerli	2010		
			621	Sarıkaya	2007		
		Yenipazar	350	Yaraş	2010		
		1814	Yenipazar	2011			
		Çayıralan	Konuklar	1986	Konuklar		2011
			Çekerek	Özukavak	1390		Özukavak
		Kadışehri	Halıköy	1728	Halıköy		2016
			Saraykent	Dedefakılı	1505		Taşlıhöyük
		Sarıkaya Sorgun	Ozan	1397	Ozan		2014
	2146			Karayakup	2011		
	Araplı		1845	Araplı	2009		
			2138	Bahadın	2011		
	Çiğdemli		1975	Çiğdemli	2015		
			133	Çavuşlu Neighborhood	2009		
	Doğankent		2038	Doğankent	2009		
			20	Mahmatlı	2009		
			Eymir	1755	Eymir		2011
				1942	Gulşehri		2011
		Gulşehri	396	Hoşumlu Neighborhood 1	2014		
	396		Hoşumlu Neighborhood 2	2014			
	Yeniyer	2094	Ahmetfakılı Neighborhood	2009			

**2. Industrial Wastewater Treatment Facility of Boğazlıyan Sugar and Confection Products Integrated Plant.** The facility was established in 2006. It is made up of primary clarifier, anaerobic treatment and aerobic treatment units. The outgoing water should meet the standards stipulated in Table 5.11.a of WPCR. The incoming COD (Chemical Oxygen Demand) load of the facility was designed in a way to be 7000 mg/L and 7200 m<sup>3</sup>/day.

**3. Industrial Wastewater Treatment Facility of Yerköy Branch of Kale Ceramics.** The facility was built in 2007 for treatment of wastewater which results from industrial processes and domestic use. The mass flow rate of the incoming wastewater is approximately 200 m<sup>3</sup>/day. It consists of chemical

precipitation and biological treatment units. It is supposed to comply with the standards set forth in Table 7.4 of WPCR. The resulting sludge is dehydrated via a filter press and disposed of in the irregular storage area of the Yerköy municipality.

**4. Industrial Wastewater Treatment Facility of Yozgat Kraft Sack Industry and Trade Joint Stock Company.** The facility was established in 2009. The wastewater coming into the facility stems from processing of kraft sack production and domestic use. The facility consists of biological and chemical treatment units, and its capacity is 8 m<sup>3</sup>/day. The outgoing water should satisfy the standards put forward in Table 13.8 of WPCR.

**5. Industrial Wastewater Treatment Facility of Yozgat Sugar Plant of Turkey Sugar Plants Joint Stock Company.** The facility was built in 2006. Its designed mass flow rate is 3,840 m<sup>3</sup>/day. The wastewater which comes into the facility emanates from sugar beet washing and operational processes. The facility is made up of sludge ponds, a balancing pond, hydrolysis tank, anaerobic tank, degasification and lamella tank, nitrification and denitrification tank and final sedimentation pond.

#### Constructed Wetlands in Yozgat Province.

As of 2019, thirty constructed wetlands designed for treatment of domestic wastewater which originates from small settlements exist within the boundaries of the Yozgat province. Information on these constructed wetlands is presented in Table 1.

**Analysis of Samples.** Within the context of the study, samples were collected from the water outgoing from the domestic and industrial wastewater treatment facilities on a monthly basis, and the sam-

ples were analyzed in terms of the parameters prescribed in WPCR. The parameters and implemented methods are given below.

The analyses of the COD (Chemical Oxygen Demand), BOD<sub>5</sub> (Biochemical Oxygen Demand), SS (Suspended Solids), pH, Color and Settleable Solids parameters were conducted according to the Standard Methods. Heavy Metal (Pb, Cd, Zn) analyses were conducted according to EPA 200.8, and TDF (Toxicity Dilution Factor) analysis was conducted according to the TS 5676 method.

## RESULTS

In the study, urban and industrial wastewater treatment facilities and constructed wetlands were analyzed on the basis of project and operation characteristics, and analyses were performed with a view to identifying the treatment performance. Three urban wastewater treatment facilities which are located



**FIGURE 2**

#### Problems identified in the facilities

(a) Grid with accumulated solid materials, (b) Floating sludge in the primary clarifier, (c) White foam in aeration basin (d) Final sedimentation pond, (e) Accumulation of solid materials in grids, (f) Sand trapper, (g) White foam in aeration basin, (h) Accumulation of solid materials in the rotating tumbler grid, (i) Foam in the aeration pond, (j) Belt filter, (k) Belt filter

in the Yozgat province do not currently work. Of these facilities, the Biological Wastewater Treatment Facility of Yerköy Municipality cannot be put into use as it does not have permits required by the relevant regulations. The Biological Wastewater Treatment Facility of Şefaatli Municipality remains idle as it has not operated for years. The Biological Wastewater Treatment Facility of Saraykent Municipality is damaged as security measures necessary for protecting the facility were not taken, and it cannot be put into operation as certain equipment items are damaged, and the relevant judicial process still continues

As per the examinations on the facilities excluding the ones which did not work, it was found that there were a variety of operational problems. Depending on the facility, there were differences in these operational problems. The operational problems existed at different units such as grids, sand trapping ponds, primary clarifiers, aeration basins, anaerobic tanks, final sedimentation ponds or sludge dehydration units. These operational problems and solutions recommended for overcoming them are elucidated below, and images identifying the problems are presented in Figure 2.

- Unpleasant smell in grids: Solid materials accumulating in grids bring about an unpleasant smell. This unpleasant smell can be eliminated through more frequent cleaning of the solid materials accumulating in the grids.

- Leakage of solid materials from grids: Due to the high speed of wastewater flow, solid material leaks from grids. Therefore, lowering the speed of wastewater flowing through the grids is recommended.

- Splits in ropes in grids: Ropes tied to the rakes which are used for cleaning the grids are occasionally split. It is estimated that this happens as the rakes are jammed by hard solid materials. This problem can be overcome through regular checks on rakes.

- Persistent malfunctioning in engines of sand traps: The engines of sand traps frequently get out of order due to the entry of sand particles into the engine. Cleaning the engines on a regular basis is recommended for the solution of this problem.

- Problems in strippers of primary clarifiers: As a heavy load of solid materials overburdens the sludge strippers of primary clarifiers, certain problems may emerge. This is why, periodically, primary clarifiers should be drained off, strippers should be checked, disassembled and cleaned, and worn-out parts should be replaced with new ones.

- Foam brimming over primary clarifiers: The foam created as strippers of the primary clarifier fail to function properly may brim over the primary clarifier. The problem may be overcome by controlling and activating strippers.

- Formation of white foam in aeration basin: Formation of white foam is sometimes observed in

the aeration basin on undesirable levels. It is estimated that this situation arises from overburdening the facility with organic load. In this respect, the wastewater coming into the facility should be balanced, and flow and load should be directed to the facility in a controlled manner.

- Frequent break-down of blowers: Not renewing the blower which completes its economic life and failing to apply periodic maintenance to the blower frequently give rise to breakdowns. In this respect, it is recommended that periodic maintenance should be applied to the blower, and the blower which completes its economic life should be replaced.

- Blockage problem in heat exchangers: Blockage of the plates in heat exchangers which are used for providing the desired temperature in anaerobic systems prevents the water from heating. It is estimated that the blockage in heat exchangers is associated with solid materials accumulating on exchanger plates. The problem may be eliminated by having regular checks on the heat exchangers and washing the heat exchangers with pressured water.

- Increase in volatile fatty acid in anaerobic tanks: Excessive organic material load leads to an increase in volatile fatty acids in anaerobic tanks. The problem may be overcome if the load is dispatched in a balanced manner.

- Fall in the number of microorganisms existing in anaerobic tanks: Sugar plants are put into service only in certain periods of the year. Therefore, when the facility is not in service, organic materials do not sufficiently come into the facility, and the number of microorganisms goes down in anaerobic treatment facilities. For overcoming this problem, it is recommended that microorganisms should be obtained by inoculation from the closest facility in the period when the facility is to be put into service again.

- Rapid wear-down of stripper wheels in final sedimentation ponds: In final sedimentation ponds, stripper wheels may rapidly be worn down as the load arriving in the bridge is too much, or the surface on which the wheels move is not well-balanced. For the solution of this problem, reducing the load coming onto the bridge or straightening the surface on which the wheels move is recommended.

- Sludge condensation problem: As a consequence of the flawed adjustments in the amount of polymer added to the sludge following the dehydration process or due to the fast movement of the belt filter, it is likely to have sludge condensation problems. Checking the amount of polymer and slowing down the work speed of the belt filter are recommended for the solution of this problem.

- Additionally, raising the efficiency of the primary clarifier and sand filtration units is among the recommended solutions [23].

- Fast deformation of belt filter: It is estimated that the belt filter is deformed fast as the tum-

bler linked with the belt filter does not work in a balanced manner due to errors in the alignment of the belt filter which is used for dehydrating the sludge or owing to accumulation of sludge under the belt filter. It is supposed that, for solving this problem, the belt filter and the bottom side of the belt filter should be checked and cleaned, and the tumbler should be controlled and adjusted.

- Frequent power outages: Frequent power outages cause problems in machinery and equipment. For the solution of this problem, it is necessary to have power generators installed at the facilities.

- Problem of freezing: It was asserted that certain materials were frozen due to the climate conditions of the region. Insulating these materials is recommended for preventing them from freezing.

- Energy cost: Energy efficiency is negatively affected by issues such as not replacing the old equipment in the facilities, not separating the flows of sewage and rainwater in the infrastructure and changeability of the organic load coming into the facility.

In this respect, the flows of sewage and rainwater should be split from each other at the facilities if they were not already split, organic material load in the wastewater should be balanced, oscillations should be reduced, and necessary renovations should be made in terms of equipment and treatment technology [24].

A variety of problems were encountered in the constructed wetlands examined within the context of this study.

These problems are presented below:

- Plants rot and decay quickly due to climate conditions,
- Animals enter the facilities and eat the plants as there is no wire fence around the facilities,
- There is no road for having access to the facilities,

- Pipes are broken or clogged due to failure to select the entry and exit pipes well-suited to the facilities,

- Water accumulates in different parts of the facilities as the slope of the facility is not designed in a balanced manner,

- The water level inside the facility cannot be adjusted as the outlets are not well-suited,

- As the municipalities which build the facilities with their own financial resources are not strictly loyal to the original project, facilities which are different from the project come into being,

- Absence of staff in the facilities,
- Inadequacy of regular maintenance services provided for the facilities,

- Cesspits are not regularly cleaned,

- Failure to fight against weeds.

To overcome the operational problems mentioned above in the constructed wetlands, it is necessary to check the plants regularly and sow new plants if the existing ones are dead [25] and to enclose the facility with wire fences. Controlling the facility pipes, repairing the clogged and broken pipes, cleaning the pipes, employing the service staff necessary for the facilities and building roads for accessing the facilities are recommended.

Upon the review of the analysis results of the samples collected from two urban wastewater treatment facilities, three wetlands and five industrial wastewater treatment facilities (from Table 2 to Table 6), it is discerned that, although there were certain operational problems in the facilities, all facilities met the discharge criteria prescribed for them.

As per Table 2, the quality of the outgoing water from the wastewater treatment facilities satisfied the discharge criteria. However, it was observed that the quality of the discharged water changes in sugar plants depending on the differences in the production capacity of the facilities. The analysis results of the Gedaş plant presented in Table 2 also indicate that the facility met the discharge standards.

**TABLE 2**  
**Analysis results of industrial wastewater treatment facilities of Yozgat Sugar Plant, Boğazlıyan Sugar and Confection Products Integrated Plant and industrial wastewater treatment facility of Gedaş General Foodstuff Distribution, Marketing, Industry and Trade Joint Stock Company**

Year	Parameter	Unit	Analysis Results			Limit Value
			Yozgat Sugar Plant	Boğazlıyan Sugar Integrated Plant	Gedaş Analysis Results	
			2h	2h	-	2h
2018	TDF	-	<4	<4	-	4
	Suspended Solids	mg/L	39	60	-	100
	COD	mg/L	29	136	-	500
	pH	-	-	-	7.75	-
2019	TDF	-	<4	<4	-	4
	Suspended Solids	mg/L	0.25	26	10	100
	COD	mg/L	59	341.3	134.6	500

**TABLE 3**  
**Analysis results of the samples received from the industrial wastewater treatment facility of Yerköy branch of Kale Ceramics**

Year	Parameter	Unit	2 h composite sample mean results				Limit Value
			Spring	Fall	Winter	Summer	2h
2018	Cd		-	0.01	-	-	0.1
	pH		7.18	7.50	6.34	7.27	6-9
	Zn		0.12	1.08	0.89	0.24	3
	Pb		-	-	-	-	1
	Suspended Solids		16.26	17.46	86.50	15.84	100
	COD	mg/L	22.60	30.56	66.30	25.20	80
2019	Cd		-	-	-	0.01	0.1
	pH		7.45	6.91	7.65	7.30	6-9
	Zn		-	-	0.08	-	3
	Pb		-	-	-	-	1
	Suspended Solids		14.67	31	13.54	15.34	100
	COD		12.44	52.93	20.44	54.8	80

**TABLE 4**  
**Analysis results of samples received from the industrial wastewater treatment facility of Yozgat Kraft Sack Industry & Trade Joint Stock Company**

Year	Parameter	Unit	Instant Sample	
			Analysis Result	Limit Value
2018	Color	(Pt-Co)	19	280
	Settleable Solids	mg/L	0.24	0.50
	COD	mg/L	24	75
2019	Color	(Pt-Co)	20.7	280
	Settleable Solids	mg/L	0.2	0.5
	COD	mg/L	28	75

**TABLE 5**  
**Analysis results of constructed wetlands in comparison to limit values**

Parameter	Unit	Analysis Results			Composite Sample Limit Value	
		Belekcehan 2 h	Baydoğan 24 h	Ozan 24 h	2 h	24 h
BOD <sub>5</sub>	mg/L	14	35	35	50	45
pH	-	7.53	7	7	6-9	6-9
Suspended Solids	mg/L	8	40	40	200	45
COD	mg/L	36	90	90	180	120

The review of Table 3 demonstrates that the facility satisfied the discharge standards, and the quality of the outgoing water from the facility changed depending on the season and production capacity.

Table 4 shows that the quality of the water outgoing from the facility was stable and complied with the limit values. The results also showed that the investigated wetlands complied with the limit values, too, according to Table 5.

The differences in the quality of the water discharged from similar urban wastewater treatment facilities essentially arose from the differences in the amounts of the organic load which came into the facility [26]. According to Table 6, the biological wastewater treatment plants complied with the limit values, and additionally, seasonal changes affected the facilities as it may be seen from the seasonal results.



- [7] Bdour, A.N., Hamdi, M.R. and Taraeneh, Z. (2009). Perspectives on Sustainable Wastewater Treatment Technologies and Reuse Options in The Urban Areas of the Mediterranean Region. *Desalination* 237, 162–174.
- [8] Samsunlu, A. (2011). Wastewater treatment (In Turkish). Birsen Press İstanbul. 20-21.
- [9] Jin, L., Zhang, G. and Tian, H. (2014). Current State of Sewage Treatment in China. *Water Research*. 66, 85-98.
- [10] Cherchi, C., Badruzzaman, M., Oppenheimer, J., Bros, C.M. and Jacangelo, J.G. (2015). Energy and Water Quality Management Systems for Water Utility's Operations: A Review. *Journal of Environmental Management*. 153, 108–120.
- [11] Yıldız, S., Namal O.O. and Cekim, M. (2013). The Historical Development of Wastewater Treatment Technologies. *Selcuk Univ. Journal of Engineering Science and Technology*. 1, 55-67.
- [12] Daigger, G.T. (2009). Evolving Urban Water and Residuals Management Paradigms: Water Reclamation and reuse, decentralization, and resource recovery. *Water Environment Research*. 237, 162–174.
- [13] Panepinto, D., Fiore, S., Zappone, M., Genon, G. and Meucci L. (2016). Evaluation of the energy efficiency of a large-scale wastewater treatment plant in Italy. *Applied Energy*. 161, 404–411.
- [14] European Commission. (2016) Minimum Quality Requirements for Reused Water in the EU (New EU Legislation) [Internet];. Available from: <http://ec.europa.eu>. [cited 01 July 2020]
- [15] Kang, Y. and Zhang, R. (2020). Research on sewage source heat pump air conditioning system in sewage treatment plant. *Fresen. Environ. Bull.* 29(6), 4607-4611
- [16] Sheik, A.R., Muller, E.E.L. and Wilmes, P.A. (2014). Hundred Years of Activated Sludge: Time to Rethink. *Frontiers in Microbiology*. 14(5), 1-7.
- [17] Morgenroth, E., Sherden, T., Van Loosdrecht, M.C.M., Heijnen, J.J. and Wilderer, P.A. (1997). Aerobic Granular Sludge in A Sequencing Batch Reactor. *Water Research*. 31, 3191–3194.
- [18] Yozgat PDE. (2018) Environmental Situation Report on Yozgat Province. [Internet] Available from: [https://webdosya.csb.gov.tr/db/ced/icerikler/yozyat\\_2018\\_cdr\\_rev-ze-20190802143446.pdf](https://webdosya.csb.gov.tr/db/ced/icerikler/yozyat_2018_cdr_rev-ze-20190802143446.pdf). [cited 01 July 2020]
- [19] Yozgat Governorate. (2018) Yozgat population data. [Internet] <http://www.yozyat.gov.tr/nufus-verileri>. [cited 01 July 2020]
- [20] Tursun, Y. and Keskinler B. (2015). Determining The Effects of Industrial Discharges on Urban Wastewater Characteristics and The Plant Operation, Inspection of Industrial Discharges. *Fresen. Environ. Bull.* 24(10b), 3524-3531.
- [21] Ostra, M., Boklova, M., Stoupalova, M. and Ostry, M. (2017). Ecotoxicity Evaluation in Municipal and Food Industry Wastewaters. *Fresen. Environ. Bull.* 18(9a), 1675-1681.
- [22] Irmak, S., Kasap, Y. and Surucu, A. (2007). Effects of Town Waste on The Heavy Metal Contents and Plant Nutrient Element Contents of Soils in Harran Plain, Turkey. *Fresen. Environ. Bull.* 16(3), 285-289
- [23] Yang, G., Zhang, G. and Wang, H. (2015). Current State of Sludge Production, Management, Treatment and Disposal in China. *Water Research*. 78, 60-73.
- [24] Niu, K., Wu, J., Qi, L. and Niu, Q (2019). Energy Intensity of Wastewater Treatment Plants and Influencing Factors in China. *Science of the Total Environment*. 670, 961-970.
- [25] Lu, J.Y., Wang, X.M., Liu, H.Q., Yu, H.Q. and Li, W.W. (2019). Optimizing Operation of Municipal Wastewater Treatment Plants in China: The Remaining Barriers and Future Implications. *Environment International*. 129, 273-278.
- [26] Zhang, Q.H., Yang, W.N. and Ngo, H.H. (2016). Current Status of Urban Wastewater Treatment Plants in China. *Environment International*. 92–93, 11-22.

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