Original Scientific paper
UDC 628.3.034.2(082):502.1
DOI: 10.7251/afts.2018.1019.085K
COBISS.RS-ID 7713048

ANALYSIS OF TECHNICAL AND TECHNOLOGICAL PARAMETERS OF WASTE WATER TREATMENT PLANT FOR UP TO 15 000 EQUIVALENTS

Knežević Nebojša[1], Pešević Dušica[2], Milunović Igor[3]

[1]*Civil Engineering Institute"IG", Banja Luka, Bosnia & Hercegovina, e.mail: knezneso@gmail.com*
[2, 3]*Faculty of Natural Sciences andMathematics, University of Banja Luka, Bosnia & Hercegovina,*

ABSTRACT

The purpose of the wastewater treatment plant project is to implement and achieve the goals set in the water management bases of the Republika Srpska and the Federation of BiH, which identified the necessary sectoral investments and the development of the institutional capacity needed to meet the requirements of the European directives. By implementing the projects of the wastewater treatment plant, settlements of up to 15,000 equivalent inhabitants (EBS) will meet European standards in urban wastewater treatment in order to protect the environment from harmful consequences of the discharge of municipal wastewater. The paper proposes a central sewage treatment plant that includes several treatments: mechanical, biological, chemical and sludge treatment. The paper presents the norms and standards used for the design of the purification process, as well as the basic input parameters during the calculation, which are used to dimension the necessary equipment.

Key words: *wastewater treatment, mechanical treatment, biological treatment and sludge treatment, standards*

INTRODUCTION

In BiH, as is the case in most developing countries, the development of sewage systems has been slow compared to water systems, which leads to great pressure on the quality of the environment. Most often, the sewage system is realized only in the central parts of the city, while suburban settlements and periphery are based on septic tanks - mostly improper, even on absorbent wells, which greatly endangers underground and surface waters. The special problem of sanitation in the settlements are unfinished sewage systems, which do not have wastewater treatment plants (WWTPs), but the waste water is discharged into a large number of spills, directly into the watercourses, often in the vicinity of the settlement, or in the settlement itself. Municipal wastewater treatment is an important component in today's water management system.Adequate treatment of municipal wastewater is needed to achieve high quality reclaimed water and to reduce health and ecological hazards [1].

The degree to which the wastewater needs to be purified depends on its composition, its mass, its class and the size of the recipient and the legislation. The basic requirement is that the discharged polluted water does not lead to a change in the water quality of the recipient. More than 90 percent of domestic wastewater is released without treatment directly into local surface waters, and less than 3 percent of household waste water goes through the full biological treatment [2]. A large number of existing WWTPs are not complete, as there is no secondary-biological purification component, so that mechanical treatment only removes suspended substances, but not organic pollution. An additional problem is the low efficiency of WWTP, so that criteria that are set in terms of the quality of purified water are often not met before they are discharged into recipients, especially according to the indicator BOD_5.

Based on the EU DABLAS Task Force project and the national WQM I + II (2005-2008) project, two lists of priorities for sanitation projects in BiH were developed. WQM List (2008) covers the whole country and takes into account the pollution load. The recently completed DABLAS list (2010) for the FBiH and the RS takes into account the vulnerability of the water body and includes the catchment area of the Black Sea (the Sava River Basin). According to these lists, the preparation of the following projects and programs began:

- GEF project: Water quality protection (wastewater treatment plant (WWTP) in Trnovo and Odžak, and first phase of the WWTP in Živinice and Mostar)
- GEF project: Neretva and Trebišnjica Management (WWTP Konjic and Ljubuški)
- EIB Project: Water and sanitation in FBiH
- World Bank/IPA 2010: Reconstruction and modernisation of the WWTP in Sarajevo,
- IPA 2007: Živinice water supply system and Međugorje WWTP
- Grant project Bihać WWTP (KfW) [2]

The key long-term strategic guidelines for water protection in BiH include the construction of waste water treatment plants (WWTP) of general type for all settlements larger than 2,000 ES.

NORMS AND STANDARDS APPLIED TO THE DEVELOPMENT OF THIS PROJECT DOCUMENTATION

Influent and effluent quality of municipal wastewater treatment plants plays significant roles in selecting the appropriate treatment technologies and influencing the ecology of receiving water bodies [3]. For purification of water, i.e. treatment on the Water line, the required effluent quality is defined according to the relevant EU directive The Urban Wastewater Treatment Directive 91/271/EEC of 21 May 1991 [4], in accordance with Annex l/lland EU Directive concerning the quality of bathing water 76/160/EEC Annex I, column C (good water quality in coastal areas) [5], as well as according to the relevant regulation of the Federation of BiH (Decree on conditions for discharging waste water into natural recipients and public sewerage systems, Official Gazette of FBiH, 6/12) [6]. The maximum values for Escherichia Coli and Intestinal Enterococcus parameters prescribed by the FBiH Regulation are higher than the corresponding values prescribed by the EU Directive, which practically means that if the quality of Efluent is in compliance with the EU Directive, it has previously met the requirements of the local regulation, that is, the FBiH Regulation (values shown in parentheses) (Table 1).

Table 1 Required effluent quality according to the EU Directive 91/271/EEC and FBiH Regulation (Official Gazette of FBiH, 6/12) (values shown in parentheses)

Parameter	Symbol	Unit	Value for the year 2030
Plant capacity in ES	-	ES	55,000
Max. concentrations in effluent:			
Biochemical oxygen demand	BOD5	mg/l	25
Chemical oxygen demand	COD	mg/l	125
Total suspended substances	TSS	mg/l	35
Total nitrogen	TN	mg/l	15
Total phosphor	TP	mg/l	2
Escherichia Coli	E. Coli	100 ml-1	500 (900)
Intestinal Enterococci	1. Enterococci	100 ml-1	200 (330)
Ratios of the load in the influent:			
BOD_5 and COD	BODg/COD	-	1:5
BOD_5 and TSS	BOD&/TSS	-	1:1.4

BOD_5 and TN	BOD_5/TN	-	1:0.6
BOD_5 and TP	BOD_5/TP	-	1:0.08
Temperatures of waste water and air:			
Waste water temperature	Tww, dim.	°c	12
Max. temperature of waste water	Tww, max.	°c	22

QUALITY STANDARDS FOR SLUDGE DISPOSAL

For the treatment of sludge, i.e. treatment on the Sludge Line, the required quality of it in order to be disposed of must comply with local FBiH regulations (Rulebook on determining the permissible quantities of hazardous and dangerous substances in the soil and the methods for their examination, Official Gazette of FBiH, No. 72/09) [7], which regulate the use of produced sludge in agriculture, as well as the EU directive (86/278/EEC) [8] (Table 2).

Table 2 Defined sludge quality

Parameter	Symbol	Unit	Values
Capacity in equivalent inhabitants	-	ES	55,000
Max. permissible concentrations:			
Cadmium	Cd	mg/kg	20-40
Copper	Cu	mg/kg	1,000-1,750
Nickel	Ni	mg/kg	300 - 400
Lead	Pb	mg/kg	750-1.200
Zink	Zn	mg/kg	2,500-4,000
Mercury	Hg	mg/kg	16-25
Chrome	Cr	mg/kg	-

The design of the UV disinfection unit is based on the EU Bathing Water Directive No. 76/160 / EEC [5] as well as the mentioned FBiH Regulation [6]. By examining the text of the Regulation, the only provision that deviates from the previous regulation (EU Directive for bathing water) refers to the limit value of the Intestinal Enterococcus parameter, which is limited to 185 cfu/100 ml, instead of 200 cfu/100 ml, as required by the said EU Directive [5].

This difference is overcome by the fact that the built-in disinfection equipment (Efluent) or UV unit will meet the lower of these two values (i.e. 200 cfu/100 ml). As a consequence, a UV unit has been adopted which can achieve the required disinfectant effect (i.e. 200 cfu/100 ml, which is in accordance with the requirements of the EU directive). The same situation is with the other parameter, Escherichia Coli (the EU directive requires reaching a limit of 500 cfu/100 ml, while the FBiH regulation requires 900 cfu/100 ml).

NORMS AND STANDARDS APPLIED TO THE TREATMENT PROCESS DESIGN

All dimensioning in the mechanical treatment was made according to the following widely accepted DWA/AT standards (Germany):

- ATV-DVWK-A 134 Planning and Construction of Wastewater Pumping Stations, June 2000 [8,9]
- ATV (DWA) Handbook for Mechanical Wastewater Treatment, Section 3.2 Screens, 4th Edition, 1997 [10]
- DWA Work Report of Technical Committee KA-5 Grit Chambers • Requirements, Systems and Dimensioning, published in KorrespondenzAbwasser May 2008 [11]

All dimensioning in the biologicaltreatment was made according to the following widely accepted DWA/AT standards (Germany):

- ATV-DVWK-A 131: Dimensioning of Single-Stage Activated Sludge Plants, ed. May 2000 [12]
- DWA-A 202 Chemical-Physical Methods for the Removal of Phosphorus from Wastewater, ed. May 2011 [13]
- DWA-M 205 Disinfection of Biologically Treated Wastewater, March 2013 [14].
- ATV-DVWK-M 265 Regulation of Oxygen Transfer with the Activated Sludge Process, March 2000 [15].
- DWA-M 268 Control and Regulation of N-Elimination Using the Activated Sludge Process, June 2006 [16].
- ATV-DVWK-M 368 Biological Stabilization of Sewage Sludge, April 2003 [17].

The planned capacity of the plant is 24,000 ES in phase I and 32,000 ES in phase II. The basic input parameters when calculating a plant capacity of 24,000 ES are shown in the table 3.

Table 3 The basic input parameters when calculating the estimated capacity of the plant is 24,000 ES

1.1	Sewage flow of raw sewage				
	Population equivalent	PE	=	24,000.00	
	Specific water consumption per PE			160.00	l/PE/d
	Dry weather flow	Q_t	=	4,608.00	m³/d
	Peaks h			12 h	
	max. hourly dry weather flow	$Q_{DW,max}$	=	478.80	m³/h
1.2.	Pollution loads of raw sewage				
	Population equivalent	PE	=	24,000.00	
	Biochemical oxygen demand	$B_{d,BOD5}$	=	1,440.00	kg/d
	Chemical oxygen demand	$B_{d,COD}$	=	2,880.00	kg/d
	Solids content	$B_{d,DSo}$	=	1,680.00	kg/d
	Total Kjeldahl nitrogen	$B_{d,TKN}$	=	264.00	kg/d
	Phosphorus	$B_{d,P}$	=	43.20	kg/d

The complete budget was made through the GPS-X software package, and on the basis of the obtained results, the dimensioning of the necessary equipment was carried out.

TREATMENT PROCESS PHASES

The whole process line consists of the following steps/phases, which are divided as follows:

a) Water line (influent flow meter, automatic vertical screen, precipitation water pool, receiving faecal cell, influent flow meter for plant, crusher, mast cell, sand/grease trap, sand washing, equalisation tank for SBR pools, $FeCl_3$ dosing, compressor cells, SBR pools, UV disinfection, effluent flow meter),

b) Sludge line (sludge tank from SBR pool, sludge pump to sludge centrifuge, preparation of polyelectrolyte, sludge thickening on sludge centrifuge, sludge storage) and

c) Service systems and buildings (drinking water and technological water supply system, filter for odourless smells, Ex-protection equipment space).

This paper, due to limited space, shall present only the function and capacity of process units; their equipment and work should be elaborated in detail in the project documentation.

TREATMENT ON THE WATER LINE

Flow meters. The plant will be equipped with three water flow meters. The position of the first meter is at the exit from the collector, before the entrance to the precipitation water pool. The second flowmeter should be placed on the water line after the precipitation water pool, and before the mechanical treatment plant and the third flow meter should be placed at the exit of purified water after the UV disinfection unit and before discharge into the recipient.

Automatic vertical screen. The role of automatic vertical screens is to remove all rough and inert material from crude waste water, whose dimensions are such that if it stays in water, it could cause the deposits in tanks, pipelines, as well as in the equipment along the process line. The mechanical pre-treatment was promoted by the introduction of screens primarily to reduce hair and fibrous substances [18]. Generally speaking, the most important purpose of vertical screens is the protection of pumps in the precipitation water pool from which the plant is fed with raw water. At medium and maximum flows, both screens should be in operation. When influent flows fall below the mean values (493.7 m^3/h), only one screen in operation will be sufficient to for plant's optimal function.

Receiving faecal cell. In order to receive the content of individual septic tanks (faecal sludge) in the plant, from the parts of the city and suburban settlements which will not be covered by the sewerage system, installation and operation of the receiving station of faecal substances is foreseen. The capacity of the faecal substances station must be 50 m^3/h, with an effective light opening of the grid of 6 mm, which is classified as a category of fine grids.

Precipitation water pool. The construction and process-technical concept of the precipitation water pool is based on both the given and our own thoughts, experiences and detailed considerations conducted during detailed project elaboration. The precipitation water pool is located on the supply line of the main sewage collector. The precipitation water pool has a triple function: the retention of incoming water for purification, space where a part of the solids is separated in automatic vertical screens and space for the pushing pumps to the plant. Accordingly, the pool is equipped with vertical screens, centrifugal pumps, and a system for automatic flushing of deposits on the walls and bottom of the pool. The precipitation water pool's volume is 500 m^3.

MECHANICAL TREATMENT PLANT

The mechanical treatment plant is required to be located in a building, protected from atmospheric impacts and low temperatures. This facility consists of the following units:

- Large substances crusher,
- Compact aerated grease/sand trap for extracting sand and grease from wastewater and
- Separates sand washer.

Crusher. Pumps from the pumping part of the precipitation water basin deliver water to the mechanical treatment that begins with a crushing plant. From this point, the water flows further gravitating through the crusher and compact aerated grease/sand trap to the equalisation pool.

Compact aerated grease/sand trap. A compact aerated grease and sand trap for separation of grease and sand from wastewaters consist of fine grids, a helical horizontal transporter for extracting precipitated sand and flotation part for the release of grease. By using sand conveyors, sand is taken to the sand washing machine from the residuals of organic matter, while the grease from the waste water is separated in the separate part of the sand trap by the principle of flotation, which is deposited in the related grease container. This compact unit is aerated with the aid of a compressor, and it is equipped with a horizontal tool for removing the grease the surface.

In order to prevent the occurrence of clogging and damage to equipment on the processing line, which can be caused by large suspended inert materials, as well as fibrous material, fine screens with automatic cleaning are planned for installation.

Sand washing. The sand washer is used to wash off the sand, so that the organic impurities are removed from the sand; the sand extracted is suitable for depositing. In this unit, the sand will finally be separated from the water (washed) and the helical conveyor transferred to the sand container, ready for transport to the final disposal site.

BIOLOGICAL TREATMENT

Equalisation pool. The basic function of the equalisation pool is the collection of mechanically pre-treated waste water from the mechanical purification plant and from the station for the reception of faecal substances and preparation for dispatch to biological purification. This is the place where biological purification begins in such a way that a part of the active sludge from the SBR pool is dosed into this container, into which is also input a smaller amount of air for circulation and oxygen enrichment, thus providing all initial conditions for processes that are continued in SBR pools. The adopted volume of the equalisation pool is 750 m^3.

Sequential biological reactor (SBR). Biological purification will use the method of active sludge with simultaneous aerobic stabilisation of the sludge as a SBR driving concept - the process. SBR - technology is a discontinuous time-based technology. Spatially separated components, the functions of the conventional device (biological phase / final settlement) are performed in one container. In one series of the SBR reactor, the biological purification phase is implemented, followed by the final precipitation and clarification phase. As a standard module, the SBR process would have dynamic control, which implies that certain work phases will last in the SBR reactors, depending on the input volume and the current process parameters such as oxygen and/or ammonia or nitrates. The proposed mechanical and electrical metering process and control technology enable such a mode of operation. The procedural advantages of the SBR system in comparison with the conventional active sludge unit are in the optimal method of operation. The work of the SBR consists in the execution of the following phases of the process one behind the other, during one cycle: aeration phase, nitrification phase, denitrification phase, deposition phase, decanting phase. During the nitrification phase (phase of aeration, oxygen concentration in SBR> 1.0 mg/l), the remaining organic melt substances are oxidised. In addition, NH_4-N is converted to NO_3-N. During the nitrification phase, oxygen control is carried out. The control system keeps the level of oxygen on the desired level (e.g. O_2) = 1.5 mg/l during the nitrification phase in the SBR. In the denitrification phase (concentration of oxygen in the boil. step = 0 mg/l), special microorganisms (denitrification agents: *Pseudomonas et al.*) use chemically bound oxygen from nitrates to maintain metabolism as an alternative source of oxygen. The created elemental nitrogen comes out as a molecular nitrogen.

One of the disadvantages of early SBR technology was the lack of reliable and simple automaticcontrol systems. The situation has changed through the use of modern PLC systems and the development of more reliable digital meters that can determine the amount of free oxygen in the water, the concentration of nitrates, nitrite, phosphorus, level control and suspended substances.

The decanting phase comprises the process steps: the clear water release phase and the excess sludge drainage phase.

$FeCl_3$station (inorganic coagulant). In order to efficiently remove phosphorous from wastewater, it is necessary to provide at the plant site sufficient amount of iron chloride solution ($FeCl_3$). The principle behind the chemical removal of phosphorus is very simple: taking into account that virtually all phosphorus in influent is present in the form of completely soluble orthophosphate (PO_4^{3-}), for its removal the reaction of formation of its insoluble salt with ferric ion (Fe^{3+}) is used. In other words, in the water treated in the SBR pools, the undiluted 40% $FeCl_3$ solution is dosed in the pool itself.

Unit for disinfection of effluent with UV radiation. The reason for the disinfection of purified water (effluent) prior to its discharge into the recipient is the requirement that the quality of purified water must comply with EU directives on bathing water quality [5].

Since today it is already the standard that UV radiation is mainly used for disinfection of effluent, it is necessary to mention the following:

a) The process of purification defined as such (mechanical and biological treatment) is a natural barrier to coliform microorganisms, which pose the greatest danger to human health, as well as the downstream ecosystem of the river into which the effluent is discharged.

b) The aerobic microorganisms, on whose activity in the floccules of active sludge the purification process is based, are permanently present in the effluent (practically water is enriched in the purification process because they are in the effluent at the detection limit, whereas in the effluent before disinfection, concentrations of minimum 105/100 ml can be expected).

c) For the previous two reasons, the largest number of plants of this type of concept work without any disinfection, but there is a possibility that microorganisms that are not specific to wastewater occur in the influentduring the work, but very dangerous to health (causing infectious diseases, for example, from the discharge from hospitals and other similar institutions), and for them the process itself is not a natural barrier. For the last reason, it is good to have disinfection of the effluent immediately prior to its discharge into the recipient.

As possible solutions, in practice, dosages of various chlorine preparations (most common NaOCl solution, rarely gas chlorine or a third agent) and exposure of the effluent to UV radiation occur in practice.If these methods of disinfection are compared (according to the amount of investments, the amount of operating costs, the consumption of electricity, equipment costs and maintenance, the effects of disinfection compared to the required and other parameters), one can clearly see the advantage of the third of the compared methods, i.e. disinfection with UV radiation (no chemicals, relatively low operating costs, maintenance is minimal, requires very small space, disinfection efficiency is extremely high, risks are low), and furthermore this method will be developed.

The effect of disinfection is provided by exposure of the effluent to ultraviolet (UV) light or radiation. UV disinfection provides proven quality disinfection [19] with max. the effects of the removal of living cells of microorganisms, and the method is environment friendly and is associated with low costs, as well as easy maintenance. A special advantage of UV disinfection is that it does not use any chemicals that could be harmful to operators or the environment (including the recipient ecosystem) [20]. When exposed to UV rays, cells of microorganisms are inactivated within a few seconds, as radiation causes irreparable damage to the DNA of the microorganisms.

This results in thetermination of micro-organism cell proliferation (i.e. cell division is prevented by the damaged DNA molecule). UV lamps are installed in an open concrete channel, and their position is horizontal and parallel to the effluent stream through the channel. The operation of the UV unit is provided by the local control centre, which monitors and manages all functions of the UV unit, including the management of the current required dose of UV radiation. After UV units, purified and disinfected water is sampled (automatic sampler) and this sample is analysed in the propulsion laboratory.

Disinfection of the effluent on the plant is dimensioned to the max. input concentration of faecal coliforms of 10^5/100 ml (in front of the biological treatment), the output concentration of 2 x 10^3/100 ml (after biological treatment) and the output concentration of total faecal coliforms of 10^4/100 ml (after biological treatment). Taking into account that the requested disinfection effect is guaranteed for max. time flows in dry weather, at medium or lower flow rates, which occur most of the time in the year, the effects of disinfection will be significantly better than the required. To install the UV unit, one channel is sufficient and contains all the necessary UV lamps.

TREATMENT ON THE SLUDGE LINE

Excess sludge reservoir. As a result of the entire previously described treatment on the Water line, sludge is produced. All quantities of the sludge produced during the day should be removed from the system, by the excess sludge pumps. From the bottom of each SBR reactor, the sludge is pumped directly into the sludge tank by submersible pumps. Excess sludge is periodically evacuated from the bottom of the sludge tank to drain the centrifuge. This is done by sludge pumps.

Sludge draining. The thickenedwet sludge from sludge tanks is drained by a dehydration sludge unit with a centrifuge. The thickenedsludge should be transported for draining. The helical conveyors (the horizontal one that collects the sludge cake from the centrifuge raises it to the required height) transfer the drained sludge into the drained sludge container. The filtrate (evacuation or desiccant water) from the centrifuge is collected into the collector unit within the centrifuge, from where it is discharged into an equalization tank through the internal sewer network.

Odor removal filter. Unpleasant odours that appear in the mechanical treatment and during sludge draining are collected and biologically treated through the filter for unpleasant odour removal. The substance that is primarily removed on the filter is hydrogen sulphide (H_2S), and then other gases that smell unpleasant: ammonia (NH_3) and volatile organic compounds - VOCs.Volatile organic substances are removed from the air solely because of an unpleasant odour, while ammonia and hydrogen sulphide are removed and because they are very dangerous to human health (extremely high concentrations of H_2S gas can cause death). The process of removing contaminants and unpleasant smells takes place inside the KF filter, which consists of several layers of different active masses. The molecules that cause unpleasant odours and other contaminants in the air, in contact with the active mass in the filter, are neutralized and oxidized. The KF filter is an innovative chemical-physical filter that provides more than 98% of air pollution removal. The remainder are only inorganic salts and a spent filter mass, which is non-hazardous waste. The result is clean air without unpleasant stench. The results of software calculation of the capacity and plant dimensions, which were acquired based on the defined input parameters are given in the table 4.

Table 4 Results of software calculation of the plant with given parameters

Design of reactor volume, verification for biological purposes and sludge-water separation				
Dimensioning of collection container				
Selected storage time		=	1	h
Required net volume at maximum hourly flow		=	479	m³
Dimensioning of reactors				
Minimum volume of reactors (total) for ensuring the sludge age is calculated as	V_{BB}	=	5780	m³
Selected number of reactors	n	=	3	
Maximum required exchange volume is calculated using maximum hourly water inflow, the shortest cycle time and the number of reactors. The following is assumed: continuous inflow of maximum water quantity into the plant.	ΔV_{max}	=	798	m³
Required total volume per reactor is the sum of minimum volume/number of reactors and exchange volume	requ. V	=	2725	m³
Given/selected maximum water level in reactors is	H_{max}	=	5.50	m
For circular tanks, the minimum diameter of reactors is	requ. D	=	25.12	m
Selected basin diameter is	D	=		m
For rectangular basin dimensions, minimum side length is	a/b	=	22.26	m
Selected side length is	a	=	25.00	m
	b	=	20.00	m
Given basin volume per reactor is thus calculated as	giv. V	=	2750	m³
Minimum water level in reactors is thus	H	=	3.90	m

It is selected as the minimum water level	H	=	3.90	m
Maximum possible exchange level is calculated as	ΔH_{max}	=	1.60	m
Maximum possible exchange volume per reactor is thus	ΔV_{max}	=	800	m³
Minimum water volume is	V_{min}	=	1950	m³
Maximum hydraulic capacity of the plant is calculated using maximum exchange volume with possible number of cycles per day	$Q_{d,max}$	=	11520	m³/d
Verification for biological purposes				
Sludge loading is calculated	B_{DS}	=	0.06	kg/kg d
generally by comparing BOD load of the sludge mass in the				
reactors.				
Nevertheless, a correction of biologically inactive times of				
the sedimentation and decantation is made				
Total sludge age is	$t_{DS,tot}$	=	25	d
Relevant sludge age is calculated by analogy to sludge loading,	t_{DS}	=	15	d
where a correction of total sludge age by biologically				
inactive times is made.				
This sludge age then corresponds to the sludge age of a conventional plant.				
The aerobic sludge age is based exclusively on the aeration phases.	$t_{DS,aerob}$	=	10	d
DS content at the maximum water level is comparable to	DS_R	=	5.0	kg/m³
the DS content which is set at conventional plants in the aeration basin.				
This quantity is calculated by correcting DS content in minimum volume				
by the ratio between minimum and maximum water level.				
Verification of sludge/water separation				
Selected sludge volume index	ISV	=	100	ml/g
Start of sedimentation after switching off the agitators		=	5	min
Sludge volume at the beginning of the sedimentation (max. WSP)	VSV_1	=	496	ml/l
is calculated as				
Sedimentation path of the sludge up to the beginning of the decantation is	h_{sed1}	=	0.8	m
Decanter				
Sludge volume at the beginning of the decantation is	VSV_1	=	580.85	ml/l
Mean sedimentation rate of the sludge level up to the beginning of	V_s	=	1	m/h
the decantation is				
Decantation may begin at the earliest	t_{sed1}	=	0.7	h
when the sludge level has made this path				
Verification: sedimentation time in accordance with the cycles sequence is	$t_{sed1,0}$	=	1	h
Thus the required verification for the sedimentation time up to the beginning of the				
decantation is provided				
Sludge volume at the end of the sedimentation	VSV_2	=	803	ml/l
(0,50 m safety margin at min. WSP) is calculated as				
Mean sedimentation rate of the sludge level up to the end of	V_s	=	0.8	m/h
the decantation is:				
Required sedimentation path up to the end of the decantation process is	h_{sed2}	=	2.10	m
Sedimentation and decantation may end at the earliest after:	t_{sed2}	=	2.56	h
The total of the times for sedimentation and decantation was determined subject to	$t_{sed2,0}$	=	2.00	h
selected cycles sequence at				
The verification for the sludge/water separation is thus provided.				

CONCLUSION

The purification of wastewater in BiH, according to the EU Water Directive, becomes the obligation for more than 2,000 inhabitants in the coming period, which imposes the need to find more rational technologies for wastewater treatment plants (WWTP). When defining the necessary degree of purification and selection of technology and the concept of wastewater treatment, we took into account legislation, i.e. local regulations, as well as the norms of the European Union. The operation of the WWTP will have more positive effects on this area, as it will improve the basic elements of the environment as well as the living conditions of the population. The process of wastewater treatment consists of four stages (main groups) of treatment: mechanical, biological, chemical process and sludge treatment.

Primary treatment includes crusher, compact aerated grease/sand trap and separated sand washer. The secondary (biological) purification uses the active sludge with simultaneous aerobic stabilization of the sludge as a drive concept SBR - Procedure (Sequencing batch reactor) as one of the most efficient biological treatment technologies with a high degree of efficiency. Chemical removal of phosphorus is planned by using a solution of iron chloride ($FeCl_3$). After this procedure, disinfection of wastewater with ultraviolet radiation is foreseen, instead of the earlier most commonly used chlorination process, in accordance with the development of science and technology and the trend of environmental protection. Treatment of waste sludge is provided in the process line, and the final product is dehydrated sludge which can be used exclusively in accordance with the regulations. All dimensioning in mechanical and biological treatment was done according to widely accepted German standards (DWA/ATV).

(Received March 2018, accepted july 2018)

LITERATURE

[1] Ma, D., Gao, B., Hou, D., Wang, Y., Yue, Q., Li, Q. (2013). Evaluation of a submerged membrane bioreactor (SMBR) coupled with chlorine disinfection for municipal wastewater treatment and reuse. *Desalination,* Vol. 313, pp. 134-139.

[2] European Commission of the United Nations for Europe (2011). Review of the environment. Bosnia and Herzegovina, second review. The United Nations, New York and Geneva.

[3] Sun, Y, Chen, Z., Wu, G., Wu, Q., Zhang, F., Niu, Z., Hu, H. (2016). Characteristics of water quality of municipal wastewater treatment plants in China: implications for resources utilization and management. *Journal of Cleaner Production*, Vol.131, pp. 1-9.

[4] COUNCIL DIRECTIVE of 21 May 1991concerning urban waste water treatment (91/271/EEC)

[5] Council Directive of 8 December 1975 concerning the quality of bathing water (76/160/EEC)

[6] Decree on the conditions for discharging wastewaters into natural recipients and public sewerage systems, no. 6 (2012). Official Gazette of FBiH

[7] Rulebook on determination of permitted amounts of hazardous and dangerous substances in soil and methods of their testing, no. 72 (2009). Official Gazette of FBiH

[8] Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (EU: Sewage Sludge Directive 86/278/EEC)

[9] ATV (2000) GermanATV-DVWK-A 134 Planning and Construction of Wastewater Pumping Stations, June, German Association for Water, Wastewater and Waste, Germany

[10] ATV (DWA) (1997). Handbook for Mechanical Wastewater Treatment, Section 3.2 Screens, 4th Edition, published by Ernst &Sohn Berlin, 1997.

[11] DWA (2008). Work Report of Technical Committee KA-5 Grit Chambers • Requirements, Systems and Dimensioning, published in KorrespondenzAbwasser. May 2008. Germany.

[12] ATV (2000). A131 Bemessung von einstufigenBelebungsanlagen (A131: Dimensioning of single stage activated sludge plants). AbwassertechnischeVereinigunge.V. Hennef.

[13] DWA-A 202 (2011). Chemical-Physical Methods for the Removal of Phosphorus from Wastewater, ed. May 2011. Germany.

[14] DWA-M 205 (2013). Disinfection of Biologically Treated Wastewater – German Rules and Standards. Hennef. Germany.

[15] ATV-DVWK-M 265 (2000). Regulation of Oxygen Transfer with the Activated Sludge Process, March 2000. Germany.

[16] DWA-M 268 (2006). Control and Regulation of N-Elimination Using the Activated Sludge Process, June 2006. Germany.

[17] ATV (2003). German ATV-DVWK Rules and Standards, Advisory Leaflet, ATV-DVWK-M 368E, Biological Stabilization of Sewage Sludge, April 2003. Germany.

[18] Frechen, F.B., Schier, W., Lindan, C. (2008).Pre-treatment of municipal MBR applications. *Desalination,*Volume 231, Issues 1–3, Pages 108-114.

[19] Hijnen WA, Beerendonk EF, Medema GJ. (2006). Inactivation credit of UV radiation for viruses, bacteria and protozoan (oo)cysts in water: a review. *Water research,* 40(1):3-22.

[20] Paraskevas, P.A., Pantelakis, I.S., Lekkas, T.D. (1998). Disinfection of wastewater by UV radiation. Protection and restoration of the of environment IV, Vol. 2, Halkidiki, Greec.