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The importance of rehabilitation of existing Water Treatment Plants

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Abstract:

This paper emphasizes the importance of rehabilitation of existing water treatment plants.

From the surface water treatment processes (rivers or lakes) results waste water strongly load in the suspension or sludge with high humidity.

In order to reduce humidity, transportation and to use this sludge in various fields, more and more countries pay particular attention to the problem of sludge being treated. Also, an important part in treating this sludge is recycling the wash water from filters or from the sludge drying,

Most of the water treatment plants in Romania don't treat this type of sludge.

Keywords: water treatment plant, oil, sludge

1. INTRODUCTION

Considering the advanced age of most existing treatment plants in Romania, plants that are using technologies that lead to delivering low quality water, the rehabilitation and modernization of these plants should be considered as a must.

Directions to be reconsidered [6]:

- The selection criteria in establishing the types of reagents, coagulants and adjuvant used in the technological process;
- Replacing the installations used in preparing and dosing the reagents;
- Improving the settling process by adding water recycling tehnologies to existing settling installations of sludge;
- Reconsidering the control, drainage and distribution system of the rapid filters by improving the washing system and by replacing the filtering layer;
- Improving the technological flow by adding water recovery installations such as washing the filters, thickeners and drying the sludge retained in settlings tanks;
- Restoring the heating and the electrical installations and replacing the pumps and blowers.

Rehabilitation should be done considering the performance of existing installations based on the pilot studies which show that water treated by the proposed technology will fulfill quality requirements of Law 458/2002.

The sludge in water treatment plants comes mainly from the settlings tanks – about 65-70 % while 15 to 20% comes from filters washings remainder of deposits coming from exhaust deposits from sand clearing basins.

Suspensions of these sludge contain substances from raw water prior to treatment as plankton, minerals or flocculated organic hydroxides, metal (iron, manganese), and substances from the process treatment such as metal hydroxides from clotting as a result of chemical reactions of coagulation and flocculation reagents and existing substances in water, the treated calcium carbonate for de-carbonization stations (softening) [1], [5], [6], [7].

To establish the use of sludge coming from the treatment plant, operates should undertake a comprehensive analysis of the sludge produced in the station, stating all relevant data, such as sludge volume, quantity of dry substance expressed in weight units; composition of the sludge; main substances that make up any toxic substances, substances that occur accidentally in water; calorific sludge (for eventual incineration) physical properties and mechanical effect on the soil.

Each treatment plant makes a distinct case because of different composition of water, the treatment processes needed, the characteristics of coagulation / flocculation use etc. Consequently, the establishment of the sludge treatment scheme will be made for each case based on studies and tests laboratory, considering all water treatment process.

2. CASE STUDY

Situation before investment

Case study was done on a water treatment plant from Romania.

Currently wash water coming from washing the settlings tank and filters are discharged directly into the river [1], [5], [6], [7].

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Discharging the washing water in the nearby river is not complying with the new regulations on environmental protection that are found in HG188/2002 reviewed by HG352/2005. Therefore, it is necessary to make an investment that allow the treatment of wash water inside treatment plant and also the separation, thickening, dewatering and storage of sludge from the treatment of these waters.

Dewatered sludge (min. 35% dry substance - as OG 757/26.10.2004, art. 4.2.1.5) will be stored in containers that will be moved to an ecological landfill. This new investment will not allow the discharge of wash water in river unless they meet standards NTPA 001, thus respecting environmental regulations [1], [5], [6], [7].

Water Treatment Station (WTS) - treated surface water as sources Bega River and has a treatment capacity of 1500 l / sec. The average flow of raw water treated is 1000 l / sec.

The technological process of water treatment from Bega River aims coagulation of raw water suspension by treatment with reagents to ensure the requirements of the
standards for drinking water quality distributed in a centralized system (NTPA001).

Substances removed from the raw water are in the form of suspensions, which are clarified in the settling tanks in a proportion of about 93%. The remaining 7% is retain by the filter stations.

For water clarifying there are currently used 27 horizontal settlings tanks. The dimensions of settling tanks are: Length = 32 ml, width = 4 ml, depth = 3.5 ml, water volume = 330 cm.

Currently two settling tanks are washed up simultaneously. The frequency of washing of the settlings tanks depends on the raw water turbidity. The amount of wash water used in washing of a decanter is approx. 360 mc. In Table No. 1 we can see the washing frequency of the settling tank, the amount of sludge accumulated in settling tanks and the amount of washing water.

Table No.1. Washing frequency of the settling tank, the amount of sludge accumulated in settling tanks and the amount of washing water.

YEAR	The average number of washes per day			Average amount of accumulated sludge from settling tanks tons / day			The volume of wash water used per day - mc/day		
	min	average	max	min	average	max	min	average	max
2008	1	2	3	1.33	2.37	3.93	360	720	1080
2009	1	2	3	0.7	2.77	10.47	360	720	1080
2010	1	2	4	0.57	5.33	12.67	360	720	1440
2011	1	3	6	0.87	7.27	31.6	360	1080	2160
2012	1	2	3	0.9	4.63	9.67	360	720	1080

Filtration is performed using three groups of filters as follows:

The first group of filters consists in 12 filters, each having two 25 m^2 settlers, with a total filtration area of 600 m^2. The filtration speed is 4-6 m / h, and the filtration capacity is 2400-3600 mc / h.

The second group of filters is composed of 8 filters, each having a filtration area of 37.5 m^2 with a total filtration area of 300 m^2. The filtration speed is 4-6 m / h, so the capacity of the filter is 1200-1800 m / h [1], [2], [3], [5], [6], [7]..

The third group of filters is composed of 8 filters, each having a filtration area of 37.5 m^2 with a total filtration area of 300 m^2. The filtration speed is 4-6 m / h and the filtration capacity is 1200-1800 mc / h.

Washing of filters is done sequentially with a frequency related to the turbidity of the filtered water (filtered water turbidity shall not exceed 1 NTU) as follows:

- For periods of low turbidity, the filters were washed successively at intervals of 72 hours;
- For periods of high turbidity the filters were washed successively at intervals of 36 hours;

Clarification phase lasts about 20 min. during which the volume of water consumed is about 370 m^3. The total amount of water used to wash the filter is about 400 m. In table no. 2 it is presented the frequency of filters washing, the volume of wash water and the amount of sludge resulting from the washing water.

Table no.2. Washing frequency of the filters, the amount of sludge accumulated in filters and the amount of washing water.

YEAR	The average number of washes per day			Average amount of accumulated sludge from filters tons / day			The volume of wash water used per day - mc/day		
	min	average	max	min	average	max	min	average	max
2008	7	9	10	0.067	0.133	0.333	2800	3600	4000
2009	8	10	13	0.033	0.200	0.267	3200	4000	5200
2010	9	10	13	0.167	0.433	0.733	3600	4000	5200
2011	11	12	13	0.067	0.433	0.967	4400	4800	5200
2012	8	10	13	0.067	0.367	1.167	3200	4000	5200

Table no. 3. Water turbidity from filters washing water

Sampling number	Sampling time	Sampling duration	Turbidity value- NTU			Average amount of sludge	Volume of wash water
	sec	sec	min	average	max	kg	mc
1	0	0	95	265	648	4.872	9.99
2	30	30	84	251	626	4.614	9.99
3	60	30	68	226	554	4.155	9.99
4	90	30	54	196	413	3.603	9.99
5	120	30	52	159	304	2.923	9.99
6	150	30	30	125	264	2.298	9.99
7	180	30	6	96	237	1.765	9.99
8	210	30	10	73	217	1.342	9.99
9	240	30	9	56	140	2.059	19.98
10	300	60	8	42	125	1.544	19.98
11	360	60	6	29	98	1.066	19.98
12	420	60	4	21	68	0.772	19.98
13	480	60	3	14	40	0.515	19.98
14	540	60	2	12	49	0.441	19.98
15	600	60	2	7	19	0.515	39.96
16	720	120	1.9	5.5	17.4	0.404	39.96
17	840	120	1.4	4	13.5	0.294	39.96
18	960	120	0.7	3.1	7.6	0.228	39.96
19	1080	120	0.7	2.8	5.8	0.206	39.96
20	1200	120	0.5	1.9	4.8	0.14	39.96
TOTAL					3851.1	33.756	439.56
Average concentration of sludge-kg dry substance/mc					0.07679		
Average concentration of sludge-% dry substance					0.007679		
					9114.36		

In table no. 3 is presented the evolution of water turbidity resulting from filters washing and the calculated dry sludge content.

CONCLUSIONS OF THE CURRENT SITUATION

1. The average amount of sludge (C_{mn}) extracted from the raw water in the drinking water treatment process is 4.783 tons / day (0.2 tones / hour) from which 4.47 tons are retained in settling tanks and 0.313 tons are retained in the filters. This means 93.46% is retain in settling tanks and 6.54% remains in the filters.
2. The maximum amount of sludge (C_{maxn}) extracted from the raw water in the drinking water treatment process is 32.767 tons / day (1.36 tons / hour) from which 31.6 tons / day (1.3 tons / hour) are retained in settling tanks and 1,167 tons are retained in the filter that is 96.44% in settling tank and the remaining 3.56% in filters.
3. The average frequency of settling tanks washing is of 2.2 settling tanks / day, resulting a discharge of wash water of 880 m3 / day or 36.67 m / h.
4. The maximum frequency of settling tanks washing is of 6 decanters / day resulting a discharge of wash water of 2400 m³ / day or 100 m³ / h.
5. The average frequency of washing filters is of 10.2 / day resulting a discharge of washing water of 4080 m^3 / day or 170 m³ / h.
6. The maximum frequency of filter washing is 13 filters / day resulting a discharge of wash water of 5200 m³ / day or 216.67 m / h, [4], [6], [7].

SITUATION AFTER INVESTMENT

The daily discharge of dry sludge (DS) resulted from settling tanks washing is minimum 0.57 tones the average discharge is 4.47 t / day and the maximum discharge is 31.6 t / day (mean 1.3 t / h).
It seems that the best would be to use two centrifugal sludge dewatering with a capacity of 0.75 t / h. One of these will be the backup for the other and will also provide sludge treatment in special situations when there is high turbidity of raw water.
The mentioned peak sludge flows are once every five years and their duration is of 2-3 days. These peaks for sludge flow can be reduced by accumulating sludge in settling tanks and sludge thickeners.
The storage capacity of sludge thickeners (sludge with a concentration of 6% dry substance) is 50 tones dry substance (DS). This amount of sludge will ensure the continuous operation of dewatering plant for a period of three days.

In the **Figure No. 1** it is presented the technological flux inside the water treatment after investment.

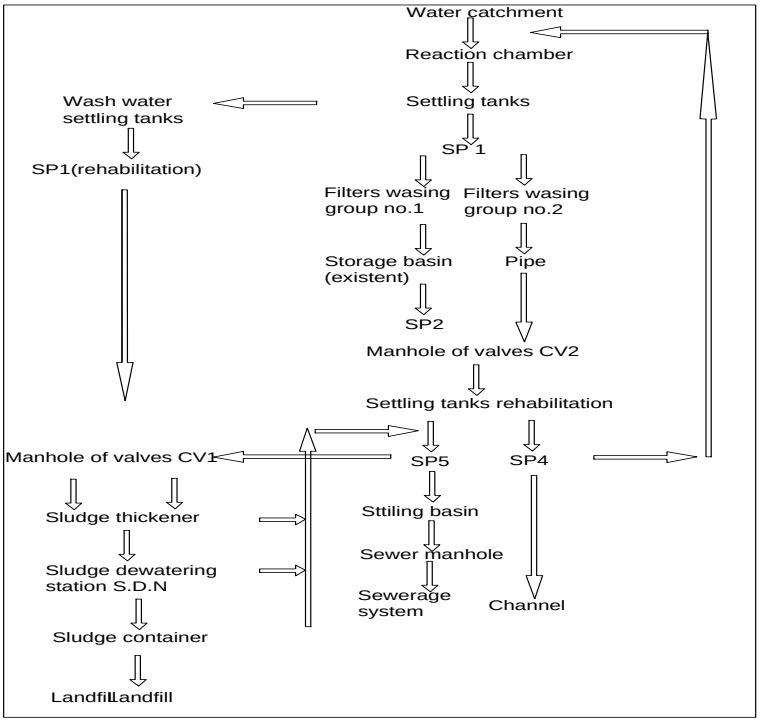

Fig.1. Technological flux after investment

Centrifugation is a method of separation using the action of centrifugal force to cause the accelerated settling of particles of a solid-liquid mixture.

By this investment is proposed to treat the washing water by achieving the following objectives:

- Execution of a sludge pumping stations;
- Execution of a sludge dewatering stations;

In sludge dewatering station (SDN) the water with sludge is temporarily stored in two tanks with a volume of 15 m^3. The thickened sludge to 10% DS is continuously pumped at a rate of 13 m^3 / h to a sludge dewatering station. Sludge dewatering plant has treatment capacitated 1.3 tones DS / h mean 3.71 m^3 / h sludge with 35% DS.

Dewatered sludge plant can accept input of centrifugal sludge with 10% DS at a maximum rate of 13 m^3 / h or 6% DS sludge at a rate of 21.67 m^3 / h.

Because of the 5% of remaining suspensions in raw water are retained by the filters, there is need for treating the washing water used for cleaning the filters (by retaining sludge) and recycle it by reintroducing the raw water in the technological flow of drinking water (pumped to capture).

The ensuring of the sludge dehydration involves treating such waters with polyelectrolyte prepared in a station [7].

3. CONCLUSION

The sizing of the dehydration installation must be done according to specific costs (lei/ m^3 35% DS). In this case the installation capacity must be below 1.1 tones DS / h to work at least 4 hours / day, in normal operating situations.

By adding the polyelectrolyte, it increases the solids content of the sludge, so it must be taken into consideration when designing and choosing drying equipment.

The centrifuged installation sizing is complete after polyelectrolyte is established.

Mixing reagent with sludge should be considered when conceiving the scheme for preparing and dosing of the polyelectrolyte.

The recommended contact time is between 5 and 10 minutes. A longer contact or sludge storage may damage the sludge filterability.

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