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FLUSHING WATER AND SEDIMENTS UTILIZATION FROM SELECTED WATER TREATMENT STATION

UZDATNIANIE WÓD POPŁUCZNYCH I UTYLIZACJA OSADÓW NA STACJACH UZDATNIANIA WODY

Abstract: The development of urbanized areas increases the intensity of problems connected to wastes utilization. The products formed during water treatment are usually omitted as irrelevant. These products cover flushing water and sediment. The researches reported in the literature show that pollutant concentration in these products may reach very high values. The effects of their utilization absence may be very significant for the environment. The existing methods of water treatment by-products utilization are still not satisfactory and usually cause significant ecological problems. The problem is not solved by sediments storage, even after its primary dewatering. Sediments combustion, after significant reduction of its volume, may cause increase of the water treatment station functioning costs and also is not commonly accepted by the public. The Authors, basing on the water treatment station in Simferopol, Ukraine, present the method of flushing water treatment and sediments utilization. The proposed technology, based on application of several reagents, enables limitation of water loss. Application of sediments as cement component, in road construction etc. additionally reduces the costs of system functioning. The results of rinsed sewage of Simferopol water treatment station researches are presented as an example of the described problems. The methods of drains treatment and sediments usage in order to break stone chips production are offered and substantiated. The studies are supported by the preliminary economical analysis.

Keywords: water treatment station, flushing water, sediments

The problems of waste products utilization, generated by human life activity get more and more actual every year. Considerable territories, which are allocated for domestic waste disposal, are seriously technologically endangered. This situation may lead to the vast catastrophes. The common understanding of this problem is denoted favourably for the reprocessing or utilization technology development [1, 2].

Among the waste products utilization technologies the fritting technology becomes widespread. The admixtures, which are located in waste products or formed during their burning, considerably increase at the end of burning process in many cases. Receiving the burning products of lower quantity, but ecologically dangerous, requires the development of their utilization technology [3, 4].

In a number of these problems the technological drains utilization on drinking water treatment stations acquires particular significance practically all over the territory of former Soviet Union countries every year. During the period of developing drinking water treatment stations acting standards (BDaR (*Building demands and rules in Ukraine*) 11-31-74, BDaR 2.04.02-84) these problems are not taken into consideration. This explains why there is usually not any solution of technological drains processing or such solutions are extremely simplified on most of drinking water treatment stations. Herewith, as a rule, the ecologically safe technologies of sediments utilization are not expected. There are high concentrated admixtures, which are typical for particular water supply source like a SiO_2,

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Fe_2O_3, CaO, MgO, BOD (*biological oxygen demand*), COD (*chemical oxygen demand*), nitrogen, water colouring etc., and water treatment technologies. The presence of different admixtures in sediments is caused by using different reagents in technology of water purification, its disinfections and conditioning (Al_2O_3, Fe_2O_3, chloroorganic compounds, aluminates, and products, which are created during the water pollution with an oxygen contact etc.) [5]. A considerable concentration of referred products on silt (technological) sediments is marked unfavourably on technological burden in region of their arrangement. Pollutions from these sediments transported by surface water infiltrate also to underground aquifer [6].

Simferopol hydroelectric power centre and water station

Our investigations concerning admixtures contents in the sediments on drinking water treatment stations of Simferopol hydroelectric power centre, affirm that the concentration of different admixtures visibly differs from typical limiting values for river Salgyr, where they can be discharged. The mentioned indices differ from limiting values demands, which are signalised in the technological rules on drinking water treatment station (Tab. 1). Besides that our research showed that the quality of rinsed water differs considerably according to many parameters from the filtering station demands (attached to returning rinsed water in a mixer on filtering station) and from river-water demands (attached to rinsed water draining to the river).

Table 1

The indices of water quality in Simferopol basin, river Salgyr, limited values of purified rinsed water before discharge into river Salgyr and before recycling

Denomination	**Rinsed water[a]**	**Simferopol basin[b]**	**Limiting values of discharging into Salgyr**	**Limiting values of returning into works mixer**
Unsedimentable suspension [mg/dm^3]	99.1	4.45	12	8
Dry residue [mg/dm^3]	529.2	340.1	530	440
Nitrogen of ammonia [mg/dm^3]	0.093	0.18	0.1	0.23
Nitrates(III) [mg/dm^3]	0.028	0.0124	0.027	0.016
Nitrates(V) [mg/dm^3]	7.69	2.79	7.9	8
BOD_5 [mg O_2/dm^3]	2.047	1.67	2.0	2.3
Permanganate oxidation[c] [mg O_2/dm^3]	7.62	4.67	4.9	6
Iron [mg/dm^3]	0.164	0.15	0.17	0.2
Aluminium [mg/dm^3]	4.76		0.07	0.3
Chloroform[d]	15.61	1.1		15
Carbon tetrachloride	0.57	0.02		0.03
Bromodichloromethane	45.28	5.11		6.6
Dibromochloromethane	5.53	0.94		1.22
Chlorides [mg/dm^3]	32.85	35.39		45
Sulphates [mg/dm^3]	53.8	67.64		87

[a] - average data for 2002-2003 years; [b] - average data for 1992-2003 years; [c] - average data for 2003 year; [d] - during the experiment data.

Simferopol hydroelectric power station contains the technical solutions focused on the improvement of rinsed waters quality based on two-hours desilting incapable to ensure not only necessary lowering the content of admixtures like dibromochloromethane and bromodichloromethane, carbon tetrachloride, but also unsedimentable suspension.

Moreover, the technological drains and sediments localization on the mentioned hydroelectric power centre requires a considerable territory; which is absolutely unprofitably from the economic point of view in Crimea conditions.

Different reagents application (eg "Polvak" or "Magnaflok" produced by Ciba - part of BASF company) for intensification of the desilting process as sulphuric acid aluminium, iron chloride, permits to increase the efficiency of this process. The necessary efficiency of mentioned process is achieved by the applied reagents dose regulation. The choice of reagent is realized on the technological and economic calculations base. Herewith it should be taken into consideration that increased dose of reagents results in their increased presence in sediments.

The essential reduction of admixtures in rinsed water by its preliminary desilting and filtration allows adding prepared in this way water into a mixer of drinking water treatment facility [7]. The research of rinsed water treated by the "Polidadmak" (Loser Chemie GmbH, Germany) reagent treatment process affirms that such admixtures as dibromochloromethane and bromodichloromethane, aluminium etc. cause volume decreases noticeably. The level of mentioned reduction reaches 40÷90%.

The proper choice of reagents and technologies of preliminary rinsed water treatment results in the further effective water treatment process and creates a possibility of reagents return into mixer on drinking water treatment station. This solution along with an ecological effectiveness has an economic expediency. Daily wastes in a money equivalent are about 600÷800 $/24 hours with a quantity of twenty-four-hour fault of rinsed water 3000÷4000 m^3 on Simferopol hydroelectric power centre "Petrovs'ki skeli", with a total cost of about 0.2 $/$m^3$.

Proposed method of rinsed water reuse and sediment treatment or utilisation

The necessity of technical solutions providing effective rinsed water treatment application is obvious. The return of purified rinsed water into a mixer on drinking water treatment stations leads to utilization of formed sediments in order to receipt the product which is not dangerous for environment.

On drinking water treatment station "Petrovs'ki skeli" 500 tones of sediments are accumulated roughly (Fig. 1). Sediments lose more than 70% of their mass while the frying, which affirms that its burning is possible.

A presence of various harmful admixtures in sediment confirms such decision. It shows the technological reasons of its incineration fixation in the process of sediments utilization. Application of the other technologies of sediment utilization is considered (eg in road linen, using as concrete ingredients, application for cement production), but the technical and economical parameters of these methods are required [1-5, 8, 9]. In a number of cases such methods of utilization of sediments result in lower quality of eventual products and these methods are not appropriate ecologically.

The chart of technological drains treatment and utilization of sediment is proposed (Fig. 2) as a solution for the described problem. The basic feature of such a process is treatment of the technological drains on the filters with a floating load (filter with a fused charging), able to work with rinsed water containing the high concentration of mechanical admixtures. The arrangement of pumps and capacities keeping rinsed water for their washing are not required. Possibilities of simultaneous application of two processes

(filtration and sedimentation) in one technological unit (device), allow to abandon the expensive constructions and results in reduction of sizes of the rinsed drains cleaning station.

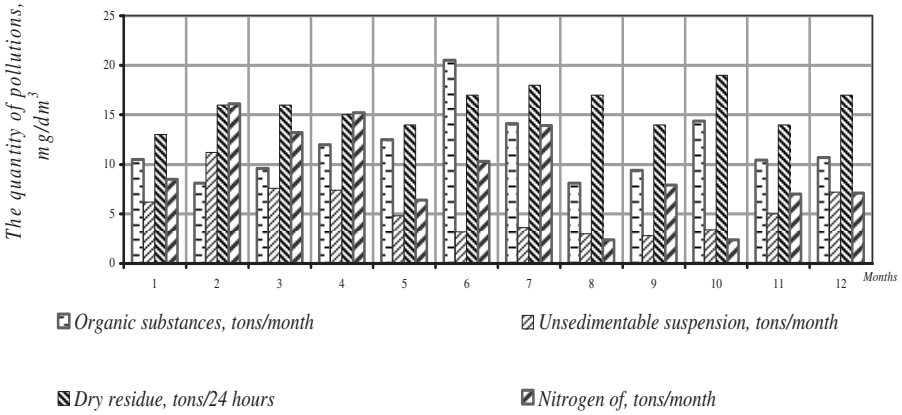

Fig. 1. Quantity of pollutions, which get into water treatment works "Petrovs'ki skeli" with water from Simferopol' basin (there are other mentioned admixtures in sediment)

The rinsed water is treated by reagent processes before it enters the fused charging filter. The dose of reagent depends on quality of rinsed water. The technological and structural parameters of filter depend on quality of the aggregates formed in the rinsed water after its treatment by the reagent. The partly cleared water fulfils the requirements of technological regulation on the drinking water treatment station and can be delivered to the mixer.

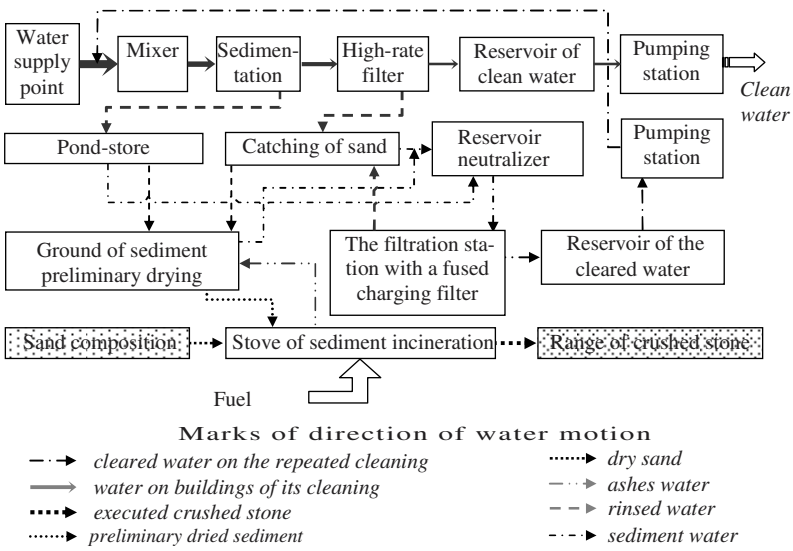

Fig. 2. Chart of technological flows cleaning and sediment utilization on the water drinking treatment station

The sediment localized in a pond-store and in grid chamber goes to the zone of its preliminary drying. Water polluted by ashes generated during sediments incineration is directed to the grounds of sediment preliminary drying. The surface of drying zone ground is covered by hydroisolation to prevent the infiltration through the moistened surface.

The process of sediments preliminary drying in the Crimea conditions, characterized by high average annual temperatures, can also be successfully conducted in the natural terms. Application of natural sediment preliminary drying technology effects positively on technical and economic indexes of the proposed process of technological water cleaning.

The next step of conducted process is sediments drying in the high temperature. According to the haydite gravel requirements described by State Standardizing 9759-71 the gravel standards obtained during our experiments after burning the sediment at the temperature of 1120 and 600°C match the "B" class.

The conducted researches show that: as a result of 500 tons of sediment containing about 80% combustible substances incineration, annually over 100 tons of mineral admixtures obtained from water flux will be utilized. That means that 100 tons of harmful for environment technological admixtures can be neutralized annually on water treatment works "Petrovs'ki skeli".

Conclusion

The considerable sediment mass containing environmentally harmful admixtures accumulates on the drinking water stations. Sediments contain up to 80% of combustible admixtures.

The application of filters with a floating load into the technological scheme of sediment treatment is expedient. These filters are able to work with rinsed water containing the high concentration of mechanical admixtures.

Safe sediment utilization on the drinking water treatment stations can be attained by the application of the high temperature sediments treatment with a crush stone acquirement as a finished product.

References

[1] Zhurba M.G., Chekryshov A.V. and Govorova Z.M.: Flow water and precipitations treatment on waterworks: Survey information. Engineering providing of building objects, VNIIINTPI 2001.

[2] Miłaszewski R.: *Ekonomiczne aspekty zarządzania jakością wód w Polsce*. I Kongres Inżynierii Środowiska. Materiały. Monografie Komitetu Inżynierii Środowiska PAN, 2002, **12**, 175-189.

[3] Pawłowski L.: *Neutralization of wastes in a cement kiln.* Thermal Solid Waste Utilisation in Regular and Industrial Facilities, Environmental Science Research. Kluwer Academic/Plenum Publishers, 2000, **58**, 1-10.

[4] Lihachov N.I., Larin I.I. et al: Wastewater systems for inhabited places and industrial enterprises, ed. V.N. Samokhin, 2nd edition. Stroyizdat, Moscow 1981.

[5] Baloyan B.M., Chudnova T.A. and Smyrnova L.M.: *Nonwaste technology of continuous drinkable water treatment.* Materials of ECWATECH-2002 Conference, 2002, 269-271.

[6] Yakovlyev V.V.: The drinkable water-supply of cities on the basis of the separate underground water use (on the example of Kharkiv). Abstract of candidate's dissertation. Kharkiv 1999.

[7] Shevchenko L.Y.: *Heat treatment using for industrial flow water treatment*. Collected scientific articles Rivne State Technical University, Department of Education in Ukraine, 1999, **2**(2), 121-125.

[8] Borys M. and Filipowicz P.: *Ocena wykorzystania mieszanin popioło-żużlowych w budownictwie hydrotechnicznym*. II Kongres Inżynierii Środowiska, Materiały tom 1, Monografie Komitetu Inżynierii Środowiska PAN, 2005, **32**, 1063-1070.

[9] Lorber K.E.: *Recovery of materials and energy form waste in Austrian cement works*. Thermal Solid Waste Utilisation in Regular and Industrial Facilities. Environmental Science Research, Kluwer Aacademic/Plenum Publishers, 2000, **58,** 19-27.

UZDATNIANIE WÓD POPŁUCZNYCH I UTYLIZACJA OSADÓW NA STACJACH UZDATNIANIA WODY

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Abstrakt: Postępująca urbanizacja prowadzi do nasilenia problemów z utylizacją powstających odpadów. Pośród nich często pomija się jako mało ważne (zdaniem niektórych) produkty powstające w procesie uzdatniania wody. Należą do nich wody i osady popłuczne. Badania dostępne w literaturze wskazują, że koncentracja zanieczyszczeń w tych produktach może być bardzo wysoka. Konsekwencje braku ich utylizacji mogą być bardzo znaczące dla środowiska. Istniejące metody utylizacji produktów ubocznych stacji uzdatniania wody wciąż nie są satysfakcjonujące i często prowadzą do znacznych ekologicznych problemów. Składowanie osadów, nawet po wstępnym ich odwodnieniu, nie rozwiązuje problemu. Spalanie osadów przy znacznym ograniczeniu ich objętości podnosi także znacząco koszty pracy stacji uzdatniania. Nie jest ono także powszechnie akceptowalne przez opinię publiczną. Na przykładzie stacji uzdatniania wody w Symferopolu autorzy prezentują metodę uzdatniania wód popłucznych i utylizacji osadów. Zaproponowana technologia, przy zastosowaniu szeregu reagentów, umożliwia ograniczenie strat wody. Zastosowanie osadów jako komponentów do cementu, budowy dróg itp. dodatkowo zmniejsza koszty funkcjonowania stacji uzdatniania. Autorzy prezentują wyniki badań zanieczyszczeń zawartych w wodach popłucznych wybranej stacji uzdatniania, omawiają zastosowany proces technologiczny oraz prezentują wyniki badań jego efektywności. Rozważania uzupełnione zostały o wstępną analizę ekonomiczną.

Słowa kluczowe: stacje uzdatniania wody, wody popłuczne, osady