

THE QUALITY OF THE SLUDGE PROCEEDED FROM GROUNDWATER TREATMENT

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Key words: groundwater treatment, sludge, agricultural use.

Abstract. The Public Service Vrancea Water Supply Rural Systems ensures rural water supply from groundwater. It owns several stations out of which two were taken into account for this study: Vulturu and Cârligele. The possibility to dispose of the resulted sludge, either by depositing or using it in agriculture, was studied. The studied materials can be safely disposed of as their chemical characteristics don't represent a threat to the environment. They can also be used in agriculture, observing the maximum allowable limits of heavy metals contents in the soils on which sludge can be applied as stipulated by the Order No.49/2004. The use of these materials would even have an amendment effect on acid soils due to their slightly alkaline reaction. An important mineral elements contribution is also to be expected for plant nutrition. No issues regarding nitrates and ammonium contents are to be expected. The studied materials should be carefully applied, especially the Vulturu station one, because of its high zinc and cadmium contents, even if the latter doesn't overrun the maximum allowable limit. The very low organic carbon content in the sludge resulted from the Vulturu station would bring about disequilibrium in soil if too much is used.

Introduction

Centralized water supply of the rural localities constitutes a highly topical interest. It is related both to the comfort and civilization degree enhancement and to the limited water supply in some parts of the country. Social and economic development of the territory can't be conceived any more, in our days, without secure and technically adequate water supply. The water supply source is chosen according to criteria that ensure the necessary flow both in design and in

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perspective and from the point of view of water quality and its predictable evolution.

Due to their low capacity, to location, building, and especially to working conditions, the water supply installations of rural centers require a different approach as compared to the big treatment stations where industrial conditions of operation and service can be ensured.

Most often groundwater sources are available for rural centers supply which have a better quality than the surface one and, furthermore, more stable physical and chemical characteristics.

Cases occur when individual water sources are chemically (with important quantities of ammonium, nitrates, pesticides, oil products) or microbiologically contaminated making them unsuitable as drinking water. Besides, shallow water sources available for operation require correction technologies of some characteristics such as ammonium, iron, manganese, hydrogen sulphide.

Drinking water quality is regulated by STAS 1342/91 for drinking water quality, the Law 458/2002 regarding drinking water quality, modified and completed by Law 311/2004.

Some of the more frequent procedures used to improve the chemical characteristics of groundwater in order to use it as drinking water are deferrization/demanganization, removal of sulphide/hydrogen sulphide, removal of ammonium, diminution of organic loading.

The Public Service Vrancea Water Supply Rural Systems ensures the operation, maintenance, modernization and development of water supply systems. It owns 24 treatment stations out of which 19 for disinfection – chlorination, 2 for deferrization and demanganization, 2 for ammonium reduction, and 1 for chlorination – deferrization.

1. Material and method

The water taken from three wells of the Cărligele system tops the legal standard limits for iron, manganese and ammonium drinking water contents, so it passes through the deferrization-demagnetization station. In order to retain the iron, manganese and ammonium excess, iron and manganese oxidation is needed. Salts of trivalent iron are obtained, as colloidal particles which are retained by filtering. Bivalent manganese is transformed in manganese dioxide (MnO_2) in the presence of an oxidizer substance – the potassium permanganate ($KMnO_4$). Gaseous chlorine (Cl_2) is also needed.

At the Vulturu station, water is taken from five wells and pumped up in a demanganization station where potassium permanganate and gaseous chlorine are used.

Certain quantities of sludge are produced at the two stations as a result of water treatment procedures, as seen in Table 1. These quantities have to be safely disposed of. They can be deposited in specially designed places or used in agriculture. In order to do so, their quality must be studied so that they don't represent a threat to the environment. When used in agriculture, they have to meet the requirements of the regulations regarding environment protection, especially soils, when using sludge in agriculture (Order No.49/2004 and Order No.344/708/2004).

Tab.1 - Sludge quantities resulted from the Cârligele and Vulturu stations after groundwater treatment

Treatment station	Year	Manganous sludge kg	Bivalent iron precipitate kg	Ammonium precipitate kg
Cârligele	2007	43	18	14
	2008	87	22	17
	2009	39	11	8
Vulturu	2007	117		
	2008	262		
	2009	223		

So, sludge samples were taken from both stations and laboratory analyses were performed to establish their chemical characteristics. Reaction, organic carbon content, total nitrogen and mineral nitrogen (ammonium – N-NH₄ and nitrates – N-NO₃), mobile phosphorus and potassium, and microelements (zinc, copper, iron, manganese, lead, cadmium, cobalt, nickel, chromium, mercury) were determined.

2. Results and discussions

The samples reaction (pH) values belong to the slightly alkaline range (tab. 2; ICPA, 1987). It's a generally favourable range for crops. If applied on soil, the analysed materials would raise its pH value.

The organic carbon content is extremely low in the Vulturu sample and low in the Cârligele one. The total nitrogen content is high, respectively medium, so these materials, applied on soils, would ensure an important nitrogen supply for plant nutrition.

The mineral nitrogen forms: nitrates (N-NO₃) and ammonium (N-NH₄) have very low content values, nitrates nitrogen is even beneath the minimum limit for cultivated soils (20 mg/kg, Vintilă et al., 1984) in both the analysed materials.

Applying these materials on soils will certainly not bring about soil contamination issues, but it also won't contribute to increasing nitrogen content accessible for plant growth.

The mobile phosphorus contents, soluble in ammonium acetate lactate, are very high in the Vulturu sample and high in the Cârligele one. An important contribution would be expected, especially in the first case, to the accessible phosphorus supply for plant nutrition when these materials are applied on soil. Even more as in Romania the soil mobile phosphorus content is generally low and very low and phosphorus fertilizers are rarely used due to their high prices.

The mobile potassium contents are very high in the Vulturu sample and medium in the Cârligele one. It's a similar situation with that of the phosphorus contents only Romania soils are well enough supplied with accessible potassium for plant nutrition.

The heavy metals contents (tab. 3) are generally bellow and much bellow the maximum allowable limits according to Order No.49/2004. There is an exception: the zinc content in the Vulturu station sample exceeds by far this limit. Besides, the Vulturu sample also has higher contents of copper, nickel, cobalt, cadmium, and lead than the Cârligele sample.

Tab. 2 - The reaction and macro-elements contents of the analysed sludge samples

Sludge origin	pH _{H₂O}	Organic C	Nt	N-NO ₃ *	N-NH ₄ *	P _{AL}	K _{AL}
		%	mg/kg				
Vulturu	7.60	0.14	0.375	8.9	5.7	266	1432
Cârligele	8.20	1.15	0.217	6.5	3.5	50	178

* recalculated values for the soil dried at 105°C

Tab. 3 - The reaction and micro-elements contents of the analysed sludge samples

Sludge origin	Zn	Cu	Fe	Mn	Ni	Co	Cr	Pb	Cd	Hg
mg/kg										
Vulturu	2,499	25.8	19,427	14,443	20.5	36.2	bdl	27.4	5.07	0.245
Cârligele	57.6	8.0	50,540	15,113	bdl	4.69	bdl	11.1	0.31	0.130
Maximum allowable limits according to Ord.49/2004	2,000	500	-	-	100	50	500	300	10	5

*** bdl – bellow detection limit

The heavy metals contents (tab. 3) are generally bellow and much bellow the maximum allowable limits according to Order No.49/2004. There is an exception: the zinc content in the Vulturu station sample outruns by far this limit. Besides, the Vulturu sample also has higher contents of copper, nickel, cobalt, cadmium, and lead than the Cârligele sample.

Taking into account the chemical characteristics of the samples, the analysed materials can be safely deposited of as they present no threat to the environment. Moreover, the materials can be used in agriculture provided the maximum allowable limits for heavy metals concentrations in the soils on which sludge is applied are observed as stipulated in the Order No. 49/2004. Due to their pH values, applying these materials would even have an amendment effect on acid soils. An important mineral elements contribution is also to be expected for plant nutrition.

Nevertheless, applying these materials on soils should be done carefully, especially the sludge from the Vulturu treatment station, because of the high zinc content and the cadmium content. The latter doesn't exceed the maximum allowable limit but it's rather high. On the other hand, the low organic carbon of this material can bring about disequilibrium from this point of view if too much is used.

Conclusions

The Public Service Vrancea Water Supply Rural Systems ensures rural water supply from groundwater. It owns several stations out of which two were taken into account for this study: Vulturu and Cârligele. The possibility to dispose of the resulted sludge, either by depositing it or using it in agriculture, was studied.

The studied materials can be safely disposed of as their chemical characteristics don't represent a threat to the environment.

They can also be used in agriculture, observing the maximum allowable limits of heavy metals contents in the soils on which sludge can be applied as stipulated by the Order No.49/2004.

The use of these materials would even have an amendment effect on acid soils due to their slightly alkaline reaction.

An important mineral elements contribution is also to be expected for plant nutrition.No issues regarding nitrates and ammonium contents are to be expected.

The studied materials should be carefully applied, especially the Vulturu station one, because of its high zinc and cadmium contents, even if the latter doesn't overrun the maximum allowable limit.

The very low organic carbon content in the sludge resulted from the Vulturu station would bring about a disequilibrium in soil if too much is used.

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