GROUNDWATER POLLUTION DUE TO INFILTRATIONS FROM ASH DEPOSITS. CASE STUDY: S. C. RENEL S. A. CRAIOVA

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Abstract. Industry development and globalization have led the EU to reconsider the immediate need for production and transportation of thermoelectric power (PETRESCU-MAG & BURNY, 2008). The main objectives in this area are related to the minimization of environmental impact and to the development of a sustainable energy system (BALMACEDA et al., 2003). Irrespective of its production process, there are affected all the environmental components, namely water, aquatic habitat, air and soil (GAVRILESCU & GAVRILESCU, 2009). The study consisted of a hydro-geological mapping that has been done through a reference system of chemism of water types from the phreatic water level upstream and downstream of the location of ash dumps belonging to S.C. RENEL S.A. There have been determined the main chemical elements and established the variation thresholds in comparison to the standards in force. There have been established the characteristics of the environment where the phreatic water from the Jiu floodplain is stuck, its continuity and discontinuity as the deposit rock and the flow features in this environment. The most analysed indicators exceed the permitted limit.

Keywords: groundwater, ash and slag deposits, infiltrations, thermal power plants, water pollution.

Rezumat. Poluarea apelor subterane datorată infiltraţiilor de la depozitele de cenuşă. Studiu de caz: S. C. RENEL S. A. Craiova. Dezvoltarea industriei şi fenomenul globalizării au determinat UE să reconsidere nevoia imediată de producere şi transport al energiei termoelectrice (PETRESCU-MAG & BURNY, 2008). Principalele obiective în acest domeniu se referă la minimizarea impactului de mediu şi dezvoltarea unui sistem energetic durabil (BALMACEDA et al., 2003). Indiferent de modul de producere al acesteia sunt afectate toate componentele mediului, respectiv apa, habitatul acvatic, aerul şi solul (GAVRILESCU & GAVRILESCU, 2009). Studiul a constat într-o cartare hidrogeologică care s-a realizat printr-un sistem de referinţă a chimismului tipurilor de apă din orizontul de apă freatică în amonte şi în aval de amplasarea haldelor de cenuşă aparţinând S.C. RENEL S.A. S-au determinat principalele elemente chimice şi s-au stabilit limitele de variaţie în comparaţie cu standardele în vigoare. Au fost stabilite caracteristicile mediului în care este cantonat freaticul din Lunca Jiului, continuitatea şi discontinuitatea acestuia ca rocă magazin precum şi particularităţile curgerii prin acest mediu. S-au constatat depăşiri peste limita admisă a celor mai mulţi indicatori analizaţi.

Cuvinte cheie: ape subterane, depozite de cenuşă şi zgură, infiltraţii, centrale termoelectrice, poluarea apei.

INTRODUCTION

The phreatic water pollution from the S.C. RENEL S.A. area depends on the used fuel, production technologies and the thermal power plants location. The fuel used by the plants is the lignite extracted from the Oltenia mining basin, consisting of organic mass which contains carbon, hydrogen, nitrogen, oxygen, sulphur from the organic combinations, combustible mass and heavy metals: scandium, cobalt, strontium, yttrium, zirconium, and caesium. Some of these metals are found in the ash and slag deposited in the adjacent areas of the plant (RACOCEANU & POPESCU, 2006). As a result of the meteorological phenomena (rain, wind), they are transported in the phreatic waters through seepage and infiltration phenomenon. The ash dumps contain also radioactive elements (radium, thorium, uranium) that also pollute the aquatic environment. EU imposed in 2012 the re-engineering of thermal power plants, so by using the inertization technology, of "dense fluid discharge" type, the ash and slag are converted into an inert waste, such as construction materials as the organic ash rock (DIŢOIU & HOLBAN, 2005). Also, the existing ash dumps must be stabilized, one of the methods is to apply a thick layer of soil of 10-20 cm and cultivate it with trees species (acacia) and shrubs (sea buckthorn, hawthorn), ameliorative plants, to prevent their dissipation (DUMITRU, 2005).

MATERIAL AND METHODS

The study was conducted in 2008-2010 in the adjacent area of the S. C. RENEL S. A. thermal power plant, which is located at 11 km north-northwest from the centre of Craiova municipality, on the left bank of the Jiu river, in an industrial zone, covering an area of 440 ha, from which the slag and ash deposits cover 306 ha. They are located in the north and west part of the plant, having about 136 and respectively 170 ha, with a height of approx. 40 m. In order to determine the level of pollution of the phreatic waters in the area of slag and ash deposits, water samples have been collected from the following locations: upstream and downstream of the Amaradia catchment, upstream of the Jiu left bank and upstream of the Jiu right bank, and the water from the phreatic layer drained from the slopes.

The methods used to determine the physico-chemical properties of water are complying with the Water Law 458/2002 and GD 930/2005. The following parameters were determined: conductivity, fixed residue, calcium, sodium, bicarbonates, nitrates, chlorides, sulphates, pH, alkalinity, hardness, magnesium, potassium, iron, ammonia and phosphates, the obtained values being compared to maximum admissible concentration.

RESULTS AND DISCUSSIONS

All the types of dumps and facilities, located on a permeable land, lose water through infiltrations.

The immediate consequences of these water losses are mainly the change of levels and of groundwater quality.

The physico-chemical analysis of phreatic water is correlated to a prognosis study of flows, groundwater levels and quality which involved the following:

- the knowledge of the initial groundwater regime (levels, flows, water quality characteristics, etc.);
- the determination of factors that may change the current regime of the groundwater layer, infiltration rates, the dissolved substances driven to the groundwater, the rainfall regime in the area, the influence of natural water reservoirs (the Jiu) on groundwater flow regime - levels, flows, quality, etc.

The physico-chemical analysis emphasized that the mobility component of ash leachate in groundwater (HANSEN et al., 2002). The forecast calculations of groundwater regime in the dumps area for industrial waste disposal take less into account the variation of the groundwater level and focus more on the variation of water quality. The impact of fly ash on groundwater quality was investigated by SIMSIMANA et al., 1987, which revealed the presence of SO_2, Na.

In figure 1 there is observed that all the analysed indicators exceed the maximum permitted concentration, excepting for the chlorides and sulphates. The high values of conductivity show a high degree of water mineralization (high content of dissolved organic and inorganic salts). The fixed residue value varies depending on the characteristics of the rocks with which the water interacts, adding also the involved substances after rainfalls which lead to the washing of ash and slag layer (GAVRILESCU & GAVRILESCU, 2009). When using this type of water, we can have negative economic consequences or harmful physiological effects, such as dehydration of tissue cells and even the destruction of organisms.

The figure 2 shows the variation of calcium content which does not exceed the maximum admissible concentration, only in the water sampled from the phreatic water drained from the slopes. This value is higher also due to the application of amendments. The nitrates range between normal limits, except also the phreatic waters from the slopes, whose values are induced by water infiltration from the chemical fertilizers combine and ~~to~~ the usage of the nitrogen-based fertilizers (ammonium nitrate, urea) by the inhabitants. The high magnesium content is mainly due to the mineral substratum. In figure 3 there is observed that the sodium exceeds the threshold values. The sodium is present in almost all the waters due to the high solubility of its salts and due to its abundance in the mineral deposits. Besides the infiltrations from the slag and ash deposits, it can come also from the discharges of domestic and commercial waters. These salts are not toxic, but together with potassium may lead to the metabolism disorder of aquatic organisms. The other elements, namely the pH, alkalinity and potassium, range within normal limits, depending largely on the chemical structure of the substratum. The pH plays an important role because it determines the degree of natural endurance towards the impact with acids or sodium salts, potassium, calcium and magnesium.

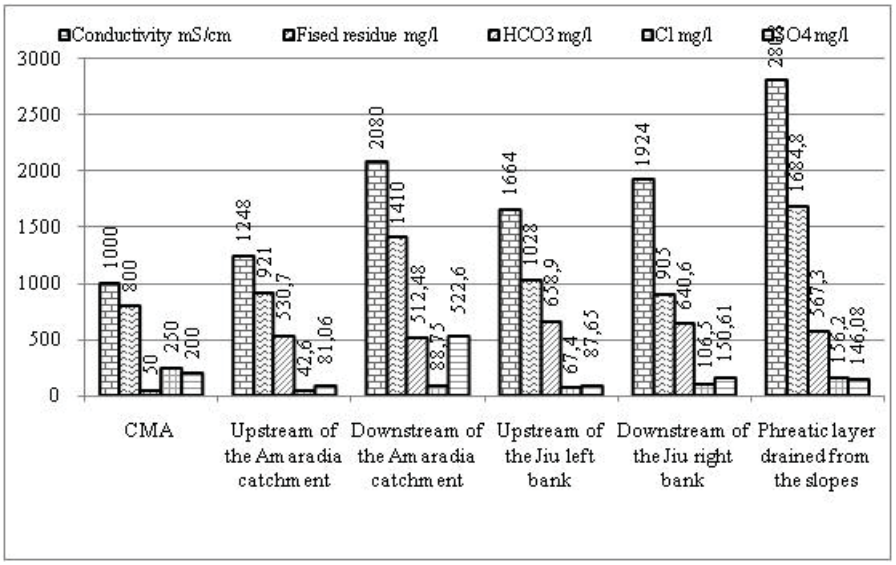

Figure 1. The values of conductivity, fixed residue, carbonates, chlorides, sulphates in the sampling points.
Figura 1. Valorile conductivității, reziduu fix, carbonați, cloruri, sulfați în punctele de prelevare.

The content of iron, ammonia and phosphates exceeds the maximum permitted values. The iron is found in the water both as ferrous, ferric or colloidal elements, being linked to the presence of humic acids. Water pH influences the form of iron. It may come from the rain water drainage which washes the ash and slag, causing a decreasing of the dissolved oxygen in the water. The ammonium ion derives from the infiltration waters from the Isalnita platform, but also from the usage of chemical fertilizers, not deriving from the ash and slag dumps. The phosphates can derive from agricultural soils drainage, meteoritic waters, industrial water discharges, being found both as organic and inorganic compounds. If the ratio of nitrogen and phosphorus changes in favour of nitrogen, the organic pollution phenomena or abnormal geochemical phenomena appear (Fig. 4).

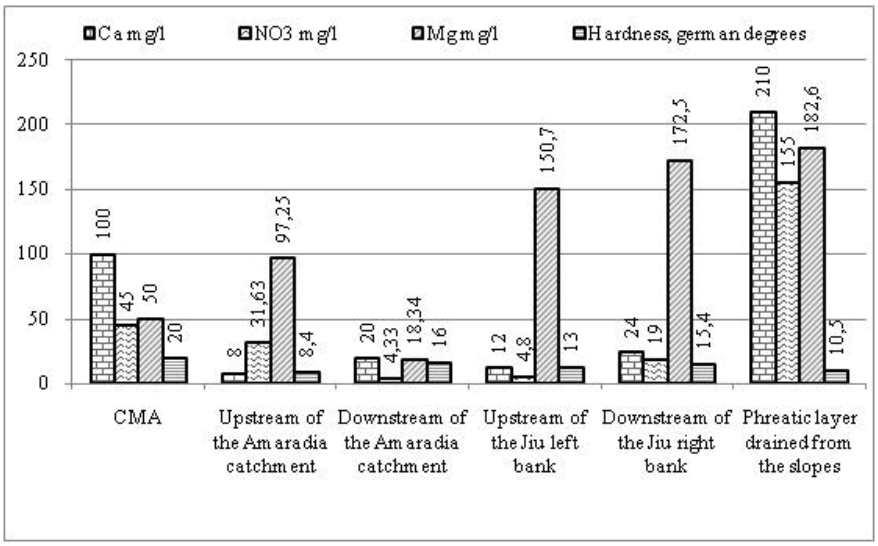

Figure 2. The values of calcium, nitrates, magnesium and hardness in the sampling points.
Figura 2. Valorile calciului, azoţaţilor, magneziului şi durităţii în punctele de prelevare.

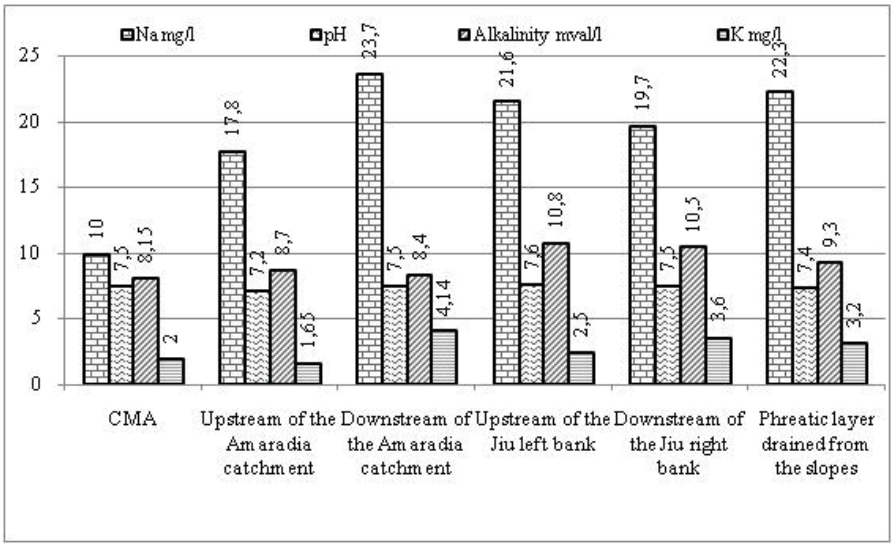

Figura 3. The values of sodium, pH, alkalinity, potassium in the sampling points.
Figura 3. Valorile sodiului, pH-ului, alcalinităţii, potasiului în punctele de prelevare.

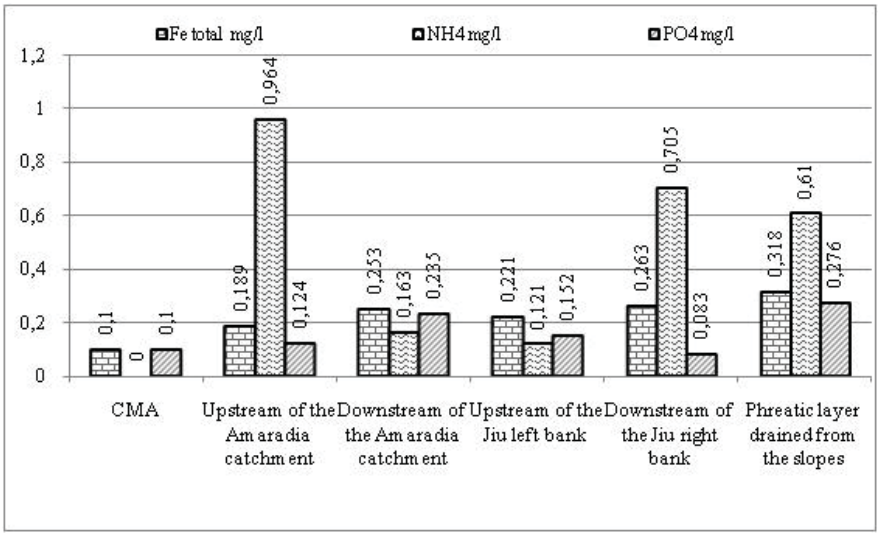

Figure 4. The values of iron, ammonium and phosphates in the sampling points.
Figura 4. Valorile fierului, amoniului si fosfaţilor în punctele de prelevare.

CONCLUSIONS

According to the carried out tests, most of the studied indicators have exceeded the maximum permitted concentrations.

In order to prevent the limitation and to eliminate the impact generated by the electricity and heat production activities based on fossil fuels (coal, oil, natural gas) there are necessary the following measures:

- supply and use of fuels, combustibles and lubricants with low content of pollutants (S, N, P, heavy metals, etc.);
- optimizing the existing production processes;
- modernization and re-engineering of facilities and equipments for neutralization, containment, dilution and dispersion of pollutants in the environment;
- adopting the best available techniques without involving excessive costs in developing projects and development programs (CIUBOTARU & SOCOLESCU, 2009);
- monitoring the quality parameters of all the environmental factors both on industrial site and in its immediate vicinity;
- development of security plans, notifying reports and internal emergency plans on the industrial site in compliance with legal regulations in force and offering the financial resources necessary for the implementation of these projects, plans and programs;
- compliance with the measures and conditions imposed by the competent bodies on the occasion of inspections made on the industrial site, and compliance with the provisions from the plans of prevention and limitation of accidental pollution, or of the action in case of disaster, or great natural phenomena (earthquakes, floods, heavy rainfalls, strong winds, drought, etc.) (BANU & RADIVICI, 2008).

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