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## CONTENT

|  |      |
|--|------|
| <i>Volume II</i>   |      |
| <i>Organic Physical Chemistry</i>  | 553  |
| <i>Material Science</i>  | 583  |
| <i>Physical Chemistry of Condensed Phases, Solid State and Fluids</i>  | 709  |
| <i>Macromolecular Physical Chemistry</i>   | 731  |
| <i>Environmental Protection, Forensic Sciences, Geophysical Chemistry,<br/>Radiochemistry, Nuclear Chemistry</i> | 761  |
| <i>Phase Boundaries, Colloids, Liquid Crystals, Surface-Active Substances</i>                                    | 857  |
| <i>Complex Compounds</i>   | 879  |
| <i>General Physical Chemistry</i>  | 907  |
| <i>Pharmaceutical Physical Chemistry</i>   | 921  |
| <i>Education, History</i>  | 991  |
| <i>Food Physical Chemistry</i>   | 1005 |
| <i>Physico-Chemical Analysis</i>   | 1039 |
| <i>INDEX</i>   | 1057 |

## ANALYSIS OF TAP WATER FOR GROSS ALPHA/BETA ACTIVITY

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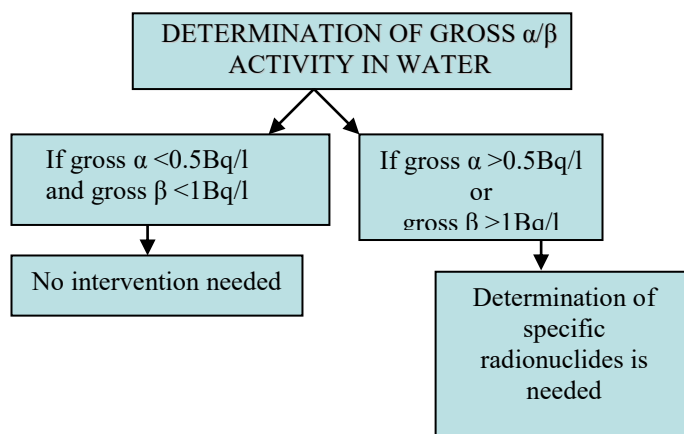
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### ABSTRACT

This paper describes determination of gross alpha and beta activity in tap waters used for drinking in Serbia. 19 samples from different cities were investigated. Method used for sample preparation was EPA 900.0 and activity was determined by proportional counter. Obtained gross alpha activity was in range MDA-0.318 Bq/l, while gross beta activity was in range MDA-0.370 Bq/l. With these values individual dose criterion of 0.1 mSv/year will not be exceeded. Based on the fact that all investigated samples met the criteria given in Serbian rule book, further analyzes were not conducted.

### INTRODUCTION

Drinking water may contain different radionuclides that could present a risk to human health. Naturally occurring radionuclides (<sup>40</sup>K, <sup>226</sup>Ra, <sup>238</sup>U...) and artificial radionuclides (<sup>137</sup>Cs, <sup>90</sup>Sr, <sup>241</sup>Am...) are present in environment. Different amount of radionuclides can be found in water, soil, sediment, indoor air, outdoor air, plant. Determination of gross alpha and beta activity presents screening technique for radioactivity measurement. Drinking water should be analyzed first for gross alpha/beta activity according to national and international standards and screening levels for drinking water below which no further action is required are 0,5 Bq/l for gross alpha and 1 Bq/l for gross beta activity [1] (Figure 1). These recommendations do not make a difference between natural and artificial radionuclides. Radionuclides with low beta energy (tritium and iodine) can not be detected with standard gross alpha beta measurement. If there is any reason to believe that these radionuclides may be present in water samples, some techniques must be performed such as liquid scintillation techniques or gamma spectrometry analysis to identify these radionuclides.



**Figure 1.** Application of guidance level for gross alpha/beta activity in drinking water

## EXPERIMENTAL

19 tap water samples from cities in Serbia: Belgrade (Vinča), Belgrade (Zvezdara), Čačak, Kragujevac, Ivanjica, Bujanovac, Ruma, Kučevo, Smederevo, Smederevska Palanka, Indija, Kikinda, Šabac, Obrenovac, Lazarevac, Kovin, Pančevo, Požarevac and Vršac were investigated for gross alpha and beta activity. Some chemical parameters were also determined. Sampling was performed in April 2018.

Total dissolved solids (TDS) was determined after evaporation of small volume of sample (40 ml), dried for at least 2 h in an oven at 105°C, cooled and weighted. The pH was measured by InoLab pH meter WTW using glass electrode SenTix 81. Calibration of the instrument was carried out by 4, 7 and 10 pH standard solutions. The conductivity of the samples was measured by Conductometer InoLab WTW Cond7110 at 22°C.

Preparation of tap water samples for gross alpha and beta determination was performed according to EPA method [2]. Initial volume of each sample was 3 l and preparation includes evaporation to complete dryness and ashing. A certain amount of ash sample was transferred to aluminum planchet and measured by proportional counter ThermoEberline FHT 770 T. Calibration of counter was performed using standard sources of  $^{90}\text{Sr}$  (EM145, Prague) and  $^{241}\text{Am}$  (EM445, Prague). The counting gas was a mixture of 90% argon and 10% methane and the counting efficiencies for the system are 28% for alpha and 34% for beta.

## RESULTS AND DISCUSSION

All samples belongs to poor basal water or poorly acidic. Four investigated waters belong to the medium mineral class (residue > 500 mg/l) and the others

belong to the low mineral class (residue 50–500 mg/l). Generally, good correlation exists between TDS and conductivity. Gross alpha activity in investigated samples range from minimum detectable activity to 0.318 Bq/l, until gross beta activity range from minimum detectable activity to 0.370 Bq/l. Based on these results it can be concluded that further investigation is not necessary. Because of gross alpha and beta activities are below the 0.5 and 1 Bq/l, it is assumed that the indicative dose of the parameter values is 0.1 mSv. The gross alpha radioactivity is mainly due to uranium and radium isotope, and the gross beta is due to natural long-lived isotopes  $^{40}\text{K}$ ,  $^{210}\text{Pb}$  and  $^{228}\text{Ra}$  or artificial isotopes, such as  $^{90}\text{Sr}$  and  $^{137}\text{Cs}$ .

**Table 1.** Results of chemical parameters and gross alpha/beta activity of investigated tap water samples

| Sample origin       | pH   | TDS (mg/l) | Conductivity ( $\mu\text{S}/\text{cm}$ ) | Gross alpha (Bq/l) | Gross beta (Bq/l) |
|---------------------|------|------------|--|--------------------|-------------------|
| Čačak               | 7,44 | 470        | 444                                      | < 0.055            | < 0.121           |
| Kragujevac          | 6,67 | 738        | 1066                                     | < 0.105            | < 0.165           |
| Belgrade (Vinča)    | 6,97 | 285        | 385                                      | 0.068±0.023        | 0.071±0.032       |
| Kikinda             | 8,29 | 535        | 745                                      | 0.318±0.063        | 0.370±0.078       |
| Ivanjica            | 7,97 | 160        | 365                                      | 0.120±0.031        | 0.143±0.033       |
| Bujanovac           | 7,22 | 383        | 564                                      | 0.230±0.060        | 0.249±0.065       |
| Belgrade (Zvezdara) | 7,83 | 190        | 451                                      | 0.088±0.033        | 0.143±0.037       |
| Ruma                | 8,21 | 618        | 348                                      | < 0.105            | 0.189±0.076       |
| Kučevo              | 7,08 | 363        | 594                                      | < 0.062            | < 0.095           |
| Smederevska Palanka | 7,32 | 603        | 953                                      | 0.219±0.072        | 0.292±0.081       |
| Šabac               | 6,77 | 320        | 451                                      | 0.148±0.038        | 0.200±0.051       |
| Obrenovac           | 8,41 | 130        | 428                                      | < 0.050            | < 0.070           |
| Lazarevac           | 7,94 | 50         | 558                                      | 0.271±0.057        | 0.370±0.074       |
| Smederevo           | 7,04 | 295        | 607                                      | 0.152±0.046        | 0.233±0.057       |
| Pančevo             | 7,71 | 398        | 487                                      | 0.224±0.052        | 0.244±0.059       |
| Indija              | 7,09 | 425        | 388                                      | 0.222±0.057        | 0.259±0.058       |
| Kovin               | 7,85 | 275        | 739                                      | < 0.081            | < 0.125           |
| Požarevac           | 6,93 | 485        | 714                                      | 0.107±0.043        | 0.118±0.053       |
| Vršac               | 6,97 | 340        | 537                                      | < 0.051            | < 0.079           |

Measurement uncertainty presented in Table 1 is expressed as an expanded measurement uncertainty for the factor  $k = 2$  which corresponds to a normal distribution with a confidence level of 95%.

## CONCLUSION

Determination of gross alpha/beta activity in drinking water samples from Serbia was performed. Results for all investigated tap water samples are below the limits defined by rule book and can be used for drinking if a radiological examination is observed. Activities obtained in this study are the same order of magnitude as the data present in the world literature [3-6].

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