Determination of Chlorates in drinking water samples

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Abstract

Chlorate ions occur in drinking water as a result of chlorine products used in disinfection and have an adverse effect on the human health. Their management is a challenge for European water systems, after the latest revision of the European legislation (EU) 2020/2184, in which a maximum concentration level for chlorate ions was established for the first time (0.250 mg/L and 0.700 mg/L when the used disinfection method produces chlorates).

The purpose of this study was to investigate the occurrence of chlorate ions in drinking water as a result of using NaClO as a disinfectant.

Towards this, 269 water samples from the Athens water supply network were analyzed for chlorate ions by ion chromatography followed by conductometric detector. The median chlorate ions concentration was calculated at 0.027 mg/L and the maximum concentration was at 0.173 mg/L. No sample exceeded the parametric values of 0.250 and 0.700 mg/L. Additionally, 40 samples from a remote area operating metachlorination were analyzed. The maximum chlorate ions concentration value was 0.229 mg/L while the median concentration was 0.130 mg/L, significantly higher than the corresponding one for the rest of the network due to the additive effect from the secondary chlorination stage. Moreover, 410 water samples from 10 small water treatment plants outside Attica, were examined. There were no exceedances of the 0.700 mg/L parametric value. As for the value of 0.250 mg/L, the compliance concerned 69 % of the measurements (median concentration=0.183 mg/L, max concentration=0.652 mg/L).

The strong correlation between NaClO storage time and chlorate ions' formation was experimentally documented and the catalytic role of temperature in chlorate ions' formation was confirmed. The results of the experimental research were also verified by disinfectant delivery time data.

From the above, it is concluded that water companies should take action by reviewing all NaClO management practices in order to comply with the new chlorate ions legislation.

References

Alfredo, K., Stanford, B., Roberson, J. A. and Eaton, A. (2015) 'Chlorate ions challenges for water systems', Journal - American Water Works Association, 107(4), pp. E187–E196. https://doi.org/10.5942/jawwa.2015.107.0036.

Breytus, A., Kruzic, A.P. and Prabakar, S. (2017) 'Chlorine decay and chlorate ions formation in two water treatment facilities', Journal - American Water Works Association, 109(4), pp. E110–E120. https://doi.org/10.5942/jawwa.2017.109.0034.

Constantinou, P., Louca-Christodoulou, D. and Agapiou, A. (2019) 'LC-ESI-MS/MS determination of oxyhalides (chlorate ions, perchlorate ions and bromate) in food and water samples, and chlorate ions on household water treatment devices along with perchlorate ions in plants', Chemosphere, 235, pp. 757–766. https://doi.org/10.1016/j.chemosphere.2019.06.180.

Goslan, E., and Hassard, F. (2019) 'Chlorate ions in Drinking Water. Defra: Drinking Water Inspectorate ' (Vol. 2209). https://www.dwi.gov.uk/research/completed-research/risk-assessment-chemical/chlorate ions-in-drinking-water.

Meritxell Valenti-Quiroga, Maria José Farré, Paolo Roccaro (2024) 'Upgrading water treatment trains to comply with the disinfection by-products standards introduced by the Directive (EU) 2020/2184', Current Opinion in Environmental Science & Health, Volume 39, June 2024, 100547, https://doi.org/10.1016/j.coesh.2024.100547.