National Measurement System

Priority water pollutants – meeting the measurement challenge

LGC scientists have developed a method for the quantification of low levels of priority pollutants in complex environmental matrices, to support the implementation of the EU Water Framework Directive.

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The requirement

Water pollution is a major priority for the EU and the rest of the world. Poor quality water systems can have a devastating impact on human health and huge economic implications for agriculture, manufacturing and energy production.

Despite the existence of UK and EU legislation to protect and preserve water supplies, demand by the public and environmental organisations for cleaner rivers, lakes, groundwater and coastal beaches has continued to increase. This led to the introduction in the EU of the Water Framework Directive (WFD, Directive 2000/60/EC) and its daughter directives. Its aim is to protect, enhance and restore the condition of all water in the natural environment across the EU, with the first set of ambitious targets for achieving 'good status' for all inland and coastal waters set for 2015. However, the majority of water bodies in the UK and EU are failing to meet WFD targets. Only 27% of rivers, streams, lakes, estuaries, coastal waters and groundwater in England are currently classified as being of 'good status' under the standards set down by the WFD[1].

When assessing the chemical status of water, Directive 2008/105/EC lists 45 priority substances and their maximum permitted levels under the WFD. The ability to quantify these priority substances in whole water samples depends on the availability of suitable reference methods and materials.

One group of priority pollutants is polybrominated diphenyl ethers (PBDEs), a group of over 200 compounds used to increase the fire resistance of consumer products. However, they are also persistent and bio-accumulative industrial chemicals that are classified as possible human carcinogens. While the use of many priority pollutants has been banned, their continued presence in the environment, even within the polar ice caps, results from the degradation of electronic and textile waste.

Measurement of pollutants in water samples is not trivial as the limits of quantification required are low (sub nanogram per litre) and analysis must be performed on unfiltered water, where the presence of contaminants such as suspended solids can affect the extraction of the pollutants as they associate with the suspended matter. Countries are failing to meet WFD targets as they lack suitable measurement procedures that allow for accurate analysis of these challenging samples.

The solution

Researchers at LGC are addressing this issue by developing traceable methods for the accurate measurement of the total concentration and partitioning of the six WFD priority PBDEs.

A gas chromatography-inductively coupled plasma-mass spectrometry (GC-ICP-MS) method to quantify these PBDEs has been developed and validated at LGC, with a full uncertainty budget provided. Methods to extract the target PBDEs from whole water samples based on liquid/liquid extraction were optimised using a model water system designed to mimic the dissolved and particulate phases of water. The model system contained PBDEs at the challengingly low levels specified by the WFD for total PBDEs (<0.2 ng/L, Directive 2009/90/EC) and high levels of organic particulate matter (humic acid). The method was applied successfully to environmental samples (lake and river waters) at the required levels with uncertainties better than those required by the WFD.

Impact

Pollutants such as PBDEs have been identified as possible carcinogens, as well as potentially causing other health issues such as thyroid problems and neurodevelopmental effects. The provision of validated reference (primary) methods for pollutants such as PBDEs will help bring quality of life benefits to the UK population via reduced exposure to potentially harmful compounds, and economic benefit to the UK economy via reduced healthcare costs.

The reference method developed at LGC represents the current state-of-the-art, demonstrating what is achievable and, as such, is likely to be influential in future legislative decision-making processes setting practical control limits for critical pollutants in environmental waters.

Furthermore, the analytical capabilities developed will be necessary to provide reference values to field laboratories for environmental monitoring as Panayot Petrov, Science Leader from the Inorganic Analysis team at LGC, explained:

> *"The accurate determination of critical pollutants in water samples is still challenging for many chemical laboratories due to the extremely low limits of quantification required. There is an urgent need for a reference method in order to help field laboratories validate their water quality monitoring methods to remove method variability and ensure they are operating with the required accuracy."*

[1]Elordui-Zapatarietxe S. et al. Novel concepts for preparation of reference materials as whole water samples for priority substances at nanogram-per-liter level using model suspended particulate matter and humic acids. Anal. Bioanal. Chem., 2014. DOI 10.1007/s00216-014-8349-8.

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