

EnviroNote 1132 - October 2023

Organotins Analysis



Organotins, why the concern?

Organotins are molecules that include at least one tin atom covalently bound to hydrocarbon substituents. These compounds are used in a wide range of industrial and agricultural applications. As they possess antifungal and antibacterial properties, they are valuable components in antifouling paints and wood preservatives. Moreover, they also serve as stabilisers and catalysts in the production of plastics especially PVC. There is a great array of different organotin compounds manufactured globally and found in the environment as shown in Table 1.

Compound	Formula	CAS	Molar Mass [g/mol]
Tributyltinoxide (TBTO)	$C_{24}H_{54}OSn_2$	56-35-9	596.11
Monobutyltin (MBT)	C_4H_9Sn	787763-54-9	175.82
Dibutyltin (DBT)	$C_8H_{18}Sn$	1002-53-5	232.94
Tributyltin (TBT)	$C_{12}H_{27}Sn$	688-73-3	290.05
Monophenyltin (MPT)	C_6H_5Sn	2406-68-0	195.81
Diphenyltin (DPT)	$C_{12}H_{10}Sn$	1011-95-6	272.92
Triphenyltin (TPT)	$C_{18}H_{15}Sn$	892-20-6	351.036
Sn	Sn	7440-31-5	118.7

Table 1: Different Organotin Compounds found in the Environment.

However, the presence of Tributyltinoxide (TBTO) especially in the marine environment has garnered the most attention out of all the Organotins. It was commonly used as the active ingredient in antifouling paints to prevent the growth of marine organisms on ship hulls. However, TBTO is labile and easily breaks down to Tributyltin (TBT) Cation which has been shown to be highly toxic

to aquatic life posing severe risks to marine and human health due to its endocrine-disrupting properties. In Australia, this has been shown in the early 1990s that TBT was negatively impacting oyster populations in estuaries (Batley 1991). As a result, many countries have banned or restricted the use of TBTO initiated by the International Maritime Organization (IMO). Follow-up research found that the TBT concentrations subsequently declined in the marine environment. However, some hotspots remain in active port areas and where dredging is performed. Regulations on TBTO have clearly been effective at reducing the contamination globally. Continued monitoring is still needed to ensure TBT levels remain low and do not negatively impact wildlife.



Organotins may temporarily leach from PVC pipes as they are used as a plastic stabiliser

Organotins in Drinking Water

Organotins are also used as a plastic stabiliser and may temporarily leach from Polyvinyl Chloride (PVC) pipes. Additionally, Organotins were used as an antifouling agent in boilers and thus could contaminate the drinking water.

The Need for Speciation

As previously mentioned, there are multiple organotin compounds that can be found in the environment, each exhibiting varying levels of toxicity. Consequently, speciating these different compounds is essential to assess their individual impact within the analysed sample accurately. However, it is crucial to note that legal limits exist only for TBTO/ TBT as Sn.

Organotins Analysis Historically

Numerous methods exist for the analysis of organotin compounds, using Gas Chromatography (GC) or Liquid Chromatography (HPLC) in combination with various detection techniques. These approaches can provide excellent sensitivity and specificity. However, these methods require an analyte derivatisation prior to analysis as well as health and safety concerns with the use of these toxic reagents. This extra step can extend the analysis duration and introduce additional sources of uncertainty.

How do we Analyse Organotins at Eurofins Environment Testing?

By combining the principles of organic and metal chemistry, a rapid method for the speciation of Organotins was developed, deploying Liquid Chromatography with Inductively Coupled Plasma Mass Spectrometry (LC-ICP-MS). This technique offers exceptional sensitivity, specificity, and selectivity, eliminating the need for the additional derivatisation step.

Organotin analysis using LC-ICP-MS involves a fast and straightforward water extraction by solid-phase extraction (SPE). Then, the LC separates the organotin compounds from the sample matrix and the ICP-MS is used for the detection and quantification. Tripropyltin (TPrT) is used as a Surrogate during the analysis, as it is not found in the environment.

Our approach allows for the quantitative determination of Monobutyltin (MBT), Dibutyltin (DBT), and Tributyltin (TBT) in aqueous (drinking water, surface water, saline water, wastewater, leachates) and solid (soil, sediment, biosolids) samples.

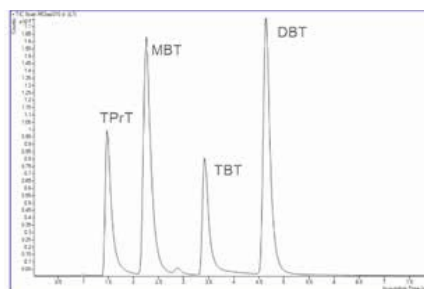


Figure 2: Chromatogram of a 500 µg/L mixed standard

Our method is ISO17025 accredited, and the Limits of Reporting (LORs) vary per matrix and analyte but are according to the relevant guidelines within

Australia and Aotearoa New Zealand. The advantage of this instrument setup is that it can also be adapted for the speciation of **arsenic** and **chromium**.

Reporting Results

For comparison of the obtained results with the regulatory limits (see Table 2) of the relevant Guidelines in Australia and Aotearoa New Zealand, the TBT results are stoichiometrically converted into the correct format TBTO and Tributyltin (as Sn) using the factors outlined in Figure 3.

Guidelines	Regulatory Limits
Australian Drinking Water Guideline	0.001mg/L for Tributyltin Oxide (TBTO)
VIC EPA Waste Disposal Categories Total Concentration (1828.2)	Leachate: 0.05 mg/L for Tributyltin oxide Soil: 2.5 mg/kg for Tributyltin oxide
National Assessment Guidelines for Dredging	Tributyltin (as Sn) 9 µg Sn/kg normalised to 1% Total Organic Carbon (TOC)

Table 2: Guidelines relevant to Australia and Aotearoa New Zealand.

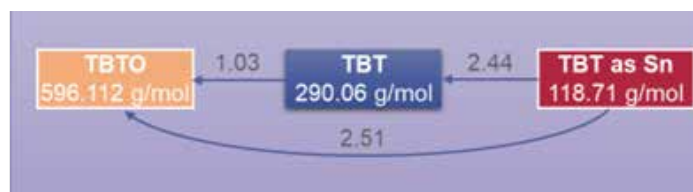


Figure 3: Conversion factors of measured results to TBTO and TBT as Sn.

Additionally, in the case of the NAGD, this value normalised against 1% total organic carbon. This is another calculation when dealing with Organotins. **What number are you using?**

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