

Policy brief on phenolic substances



Nonyl- and octylphenols – endocrine disruptors which should not occur in the environment

Baltic Marine Environment
Protection Commission

Policy briefs



What are Nonyl- and octylphenols?

Nonyl- and octylphenols are families of organic compounds belonging to a large group of alkylphenols. These families also include large number of isomers. The nomenclature of these substances is sometimes unclear.

Nonyl- and octylphenols are mainly manufactured compounds, though unique cases when nonylphenol is produced in nature are also known. These substances are used in industry as antioxidants, lubricating oil additives, laundry and dish detergents, emulsifiers, and solubilizers as well as intermediate products to produce phenolic resins, paints, pesticides and some other commercial products. These phenolic substances are not volatile, assuming that waterborne input is their main pathway to the environment. They are also moderately solu-

ble demonstrating tendency to absorb in soils and sediments.

The toxicity of nonyl- and octylphenols is caused by their ability to mimic hormones and cause reaction of respective receptors in biota. That's why the compounds were classified as endocrine disruptors. These substances are capable of interfering with the hormonal system of numerous organisms. The impact includes feminization of aquatic organisms, decrease in male fertility and survival of juveniles.

Octyl- and nonylphenols are included in the HELCOM List of Priority Hazardous Substances, established by Recommendation 31E/1. The 2021 Baltic Sea Action Plan calls HELCOM Contracting Parties to introduce by 2027 measures based on the best available scientific knowledge and technologies to restrict the use and prevent releases of phenolic compounds (action HL21).

Observed facts

More than 1500 measurements of phenolic substances in influents, sludges and effluents from about 200 wastewater treatment plants (WWTPs) were reported in response to HELCOM call for micropollutants (2018). Despite nonyl- and octylphenols and their isomers were of specific interest of this call, about 400 analyses of total monophenols were also reported. Certain inconsistency between reported names of substances and their CAS numbers slightly complicated the data analysis.

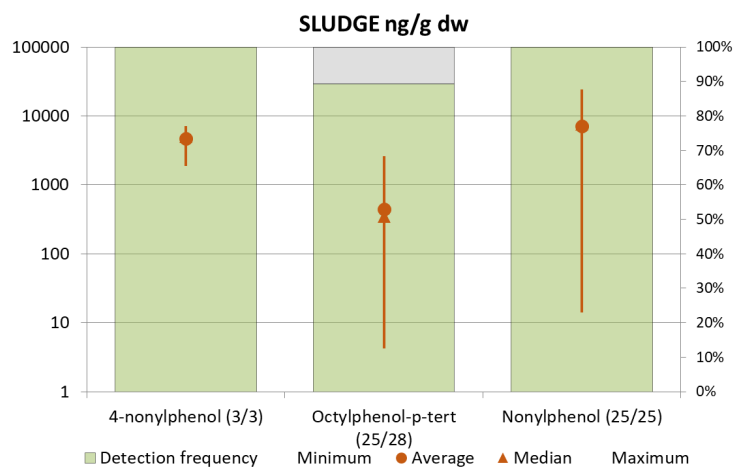
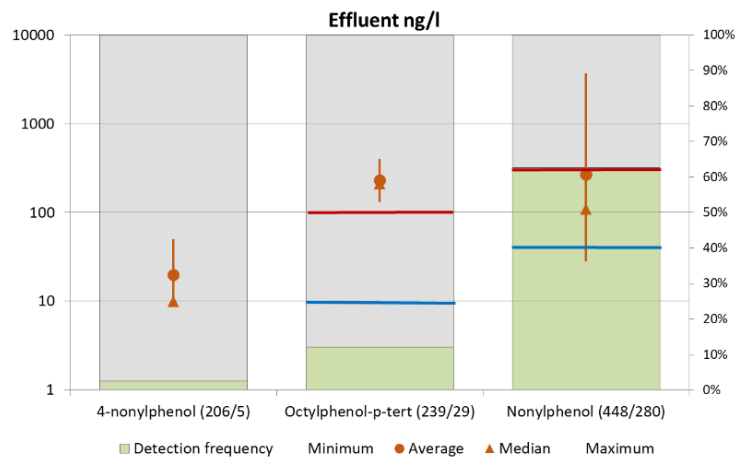
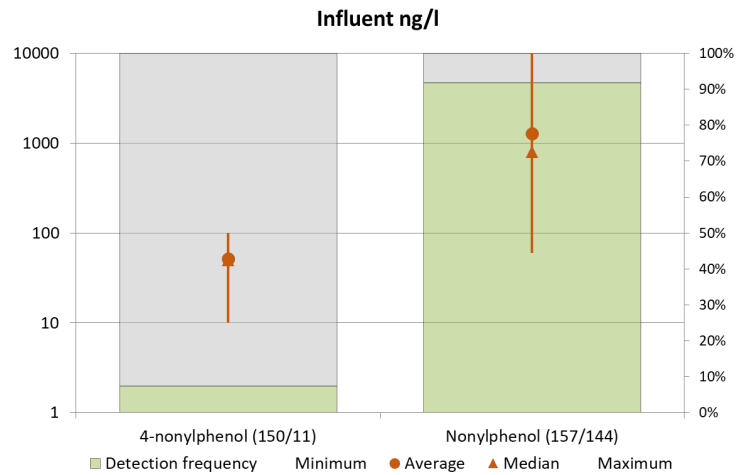
Despite detection limits for phenolic substances vary in an order of magnitude, reported data in general allows adequate evaluation of occurrence of these substances in effluents, especially, nonylphenol. However, most of the data for 4-nonylphenol and p-tert-octylphenol isomers were reported below the detection limits.

Generally, the collated data shows that nonylphenol is the most frequently observed compound in both influents and effluents. Its concentrations vary in a range of three orders of magnitude. In influents both average and median concentrations are around a 1000 ng/l while in effluents average value is seven times lower and median is even ten times lower. Octylphenol and its isomer was not reported for influents, and a few samples where 4-nonylphenol was observed in influents demonstrate concentrations much lower than nonylphenol. The same concerns observations of octylphenols and 4-nonylphenol in effluents.

Elevated concentrations of all phenolic substances except for octylphenol were observed in wastewater sludges. However, nonylphenol demonstrates the highest average and median values, which are around 7500 ng/g dry weight. These values for p-tert-octylphenol are one order



of magnitude lower. There was no data reported on other phenolic compounds sufficient for statistical analysis. There is rather limited information on predicted non-effect concentrations (PNEC) of phenolic substances in sludges and soils. According to data given in the European Union Risk Assessment Report (2002), concentrations of nonylphenols measured in sludge are significantly lower than respective PNECs. Both average and median concentrations of nonylphenol in effluents are lower than AA-EQS for inland waters but higher than the threshold for new chronic EQS for nonylphenol (the Ecotox Centre Eawag-EPF). However, concentrations in individual samples exceed AA-EQS for inland waters tenfold. Average and median for p-tert-octylphenol concentrations exceed both AA-EQSs for this substance. However, these values might be overestimated since the substance was detected only in 12% of measurements.



Concentrations of nonyl- and octylphenols in WWTP influents, effluents and sludges. Only concentrations above limits of quantification (LOQ) are reflected. Red lines indicate annual average Environmental Quality Standards (AA-EQSs) for nonyl- and octylphenols in inland surface waters (DIRECTIVE 2013/39/EU). Blue lines indicate AA-EQS for octylphenol in other surface waters (DIRECTIVE 2013/39/EU) and new chronic EQS for nonylphenol (the Ecotox Centre Eawag-EPF). EQS values are used here for indicative comparison but not for the assessment of contamination level.

Key messages



Data on concentrations of phenolic substances in influents, sludges and effluents from WWTPs compiled through the HELCOM call for micropollutants does not allow for comprehensive estimation of the magnitude of input of these substances to the aquatic environment from sewage systems in the Baltic Sea region.



The data demonstrates however that both phenolic substances are being currently released to municipal wastewater systems. Especially it concerns nonylphenol and p-tert-octylphenol isomer. Nonetheless, concentrations in effluents are moderate and only in some cases might lead to deterioration of environmental health of water bodies.



Conventional municipal wastewater treatment plants reduce concentrations of phenolic substances in wastewater almost tenfold. However, additional treatment still needs to be applied to minimize releases of these compounds to the aquatic environment.



During wastewater treatment process, phenolic substances tend to be accumulated in sludge. Concentrations of some substances in sludge are significantly elevated but remain below identified PNECs. However, available information is not sufficient for the assessment of risks for soil and ground contamination through application of recycled products based on sewage sludge.



Safety requirements for recycling products based on sludges from WWTPs potentially containing phenolic substances need to be developed.



Systematic monitoring of octyl- and nonylphenols as well as their isomers, based on harmonised monitoring methodology, has to be organized across the Baltic Sea region (for the EU member states as implementation of WFD). Analytical methods, providing sufficient quality of measurements, should be elsewhere applied for the monitoring.



Targeted measures to prevent releases of octyl- and nonylphenols as well as their isomers, need to be developed based on the best available scientific knowledge, to prevent contamination of the aquatic environment.

References

European Union Risk Assessment Report 4-NONYLPHENOL (BRANCHED) AND NONYLPHENOL. 2002.

DIRECTIVE 2013/39/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 August 2013.

Swiss Ecotox Centre: Proposals for Acute and Chronic Quality Standards. 2016.