



### (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl-methyl-methylphosphonate

(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl-methyl-methylphosphonate (PMMMPn for short) is used as a flame retardant (e.g. in textiles and fibres).<sup>1</sup> As a mixture with

bis[(5-ethyl-2-methyl-1,3,2-dioxaphosphorinan-5-yl)methyl]phosphonate P, P'-dioxide (Di-PMMMPn for short, CAS 42595-45-9), it is used in particular in the textile sector for home furnishings, textiles in the automotive industry and for special clothing (trade name “Amgard CU”; CAS 170836-68-7).<sup>2,3</sup>

Molar mass:  
286.201 g/mol

CAS:  
41203-81-0

C<sub>9</sub>H<sub>20</sub>O<sub>6</sub>P<sub>2</sub>

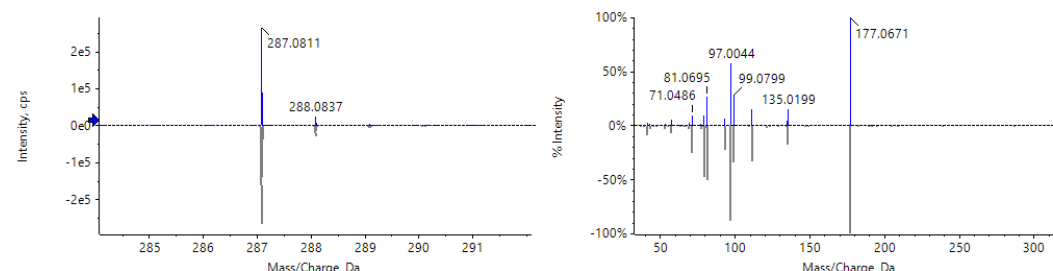
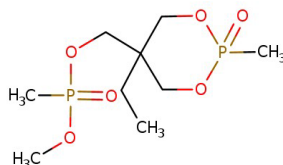


Figure 1: Comparison of isotope patterns (left) and fragment-ion-spectra (right; ESI positive); blue: sample from the River Wupper near Opladen; grey: reference substance

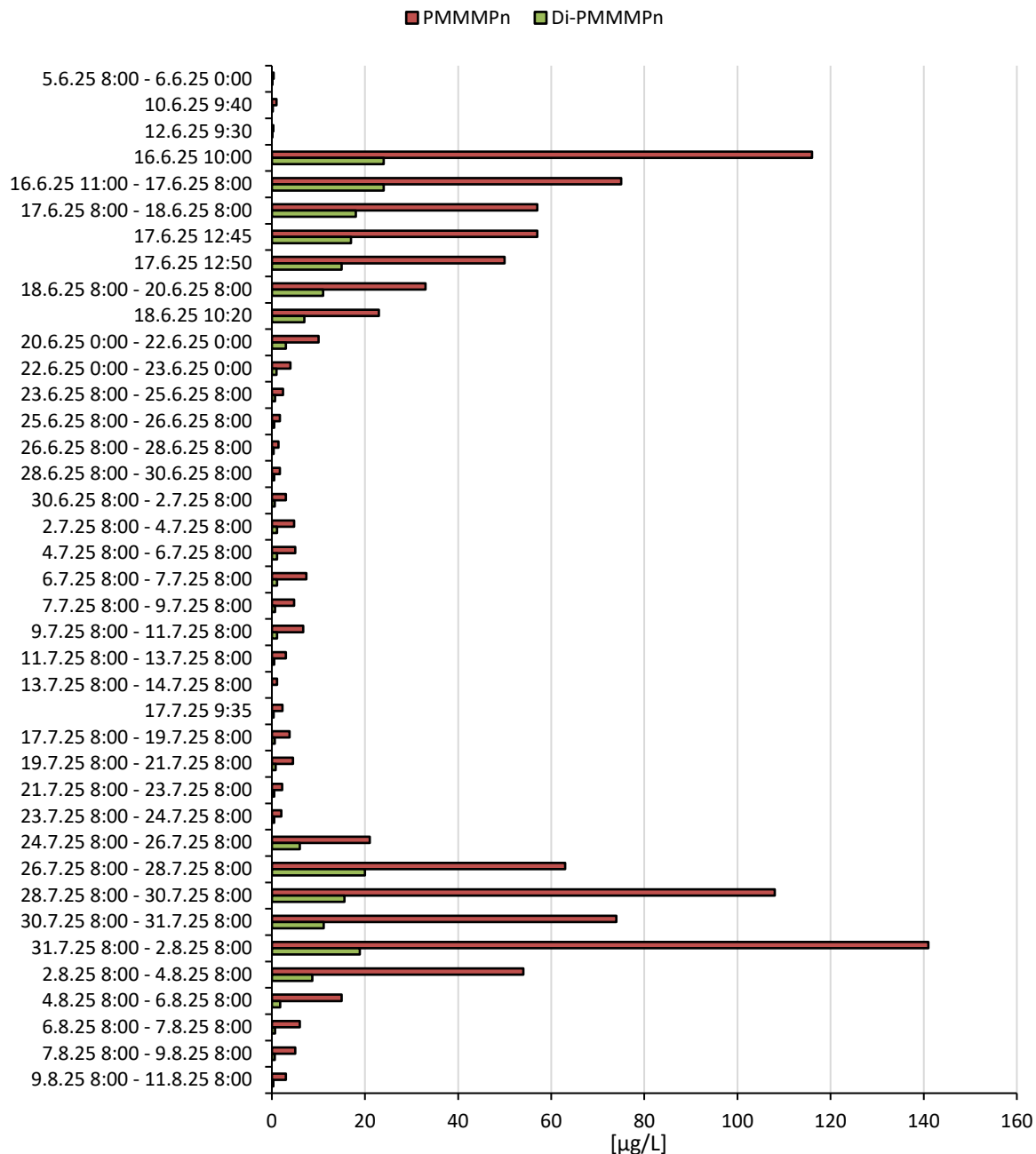
### Analytics and occurrence

As part of the intensified water monitoring program (*intensivierte Gewässerüberwachung; INGO*), two previously unknown substances (RT 9.31; RT 9.35; m/z 97, 111, 189) have been detected in the Wupper River near Opladen using SPE-GC-MS since June 16, 2025. Subsequently, one of the substances was clearly identified by HPLC-HRMS as (5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl-methyl-methylphosphonate (PMMMPn). The substance had previously been found in the river Berkel at the end of 2024 as part of a measurement program. The second substance is most likely (matching criteria 1 to 3) the related substance bis[(5-ethyl-2-methyl-1,3,2-dioxaphosphorinan-5-yl)methyl] methyl phosphonate P,P'-dioxide (CAS 42595-45-9) (Di-PMMMPn).

<sup>1</sup><https://pubchem.ncbi.nlm.nih.gov/compound/94516#section=Uses>, accessed on 10.09.2025

<sup>2</sup><https://echa.europa.eu/de/registration-dossier/-/registered-dossier/25453/1/1>; accessed on 10.09.2025

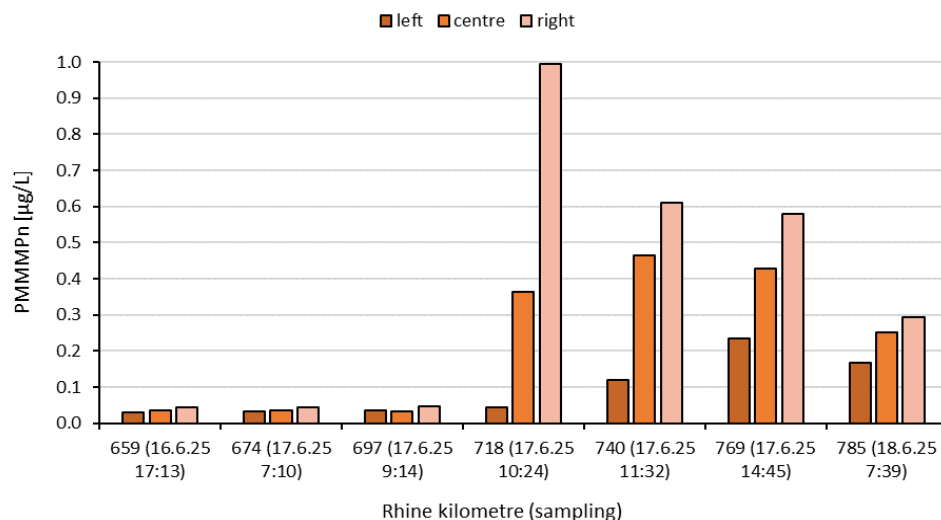
<sup>3</sup><https://hunan-chem.com/flame-retardant-organic-cyclic-phosphonate-cas-no-170836-68-7/>; accessed on 10.09.2025



**Figure 2: Concentrations of PMMMPn and Di-PMMMPn in the river Wupper near Opladen; PMMMPn calculated using a 3-point calibration (0.1; 1; 10 µg/L) until 16.06.25; 10:00 am, and subsequently using a 10-point calibration (0.5 to 5 µg/L); Di-PMMMPn was estimated using the internal Standard 1H-benzotriazole-4,5,6,7-D4**



Significant concentration peaks can be seen in the Wupper near Opladen around 16 June 2025 and 31 July 2025. The maximum finding of 141 µg/L PMMMPn was obtained in the 48-hour composite sample from 31 July 2025 to 2 August 2025. The general precautionary value of 0.1 µg/L was exceeded several times.



**Figure 3: Concentrations of PMMMPn from the Rhine cross-profile samples taken between 16 and 18 June 2025, estimated using the internal standard 1H-benzotriazole-4,5,6,7-D4**

The results of the Rhine cross-section samples clearly indicate pollution on the right bank of the Rhine between Rhine kilometres 697 and 718. This can be easily reconciled with the confluence of the Wupper and the Rhine at kilometre 703, which indicates at least one discharge into the Wupper. After consultation with the responsible district government, LANUK was given the

name of a discharger as a potential source, which was subsequently confirmed by an investigation of the discharge. In a sample taken from the discharge on 4 August 2025, 192 µg/L PMMMPn was measured.

### Relevance

No data on the ecotoxicological effects of PMMMPn are available. Modelled data do not indicate a high bioaccumulation potential and show that the substance is not readily biodegradable.

There are no legally binding limit values for PMMMPn in drinking water. The general precautionary value of 0.1 µg/L is therefore used for the assessment of drinking water production as a protected resource.

Hardly any substance properties or data on behaviour in drinking water treatment can be found for this substance. Based on the current data, no statement can be made on the relevance of the substance for drinking water.

### Further procedure:

The responsible water authorities, local water suppliers and downstream users (Netherlands) were informed. In addition, the responsible district government was asked to inform the polluter of our findings. The rivers Wupper and Rhine will continue to be sampled in order to identify any further polluters.