Water-Monitoring in an WWII explosives factory with Gaiasafe Passive Collectors

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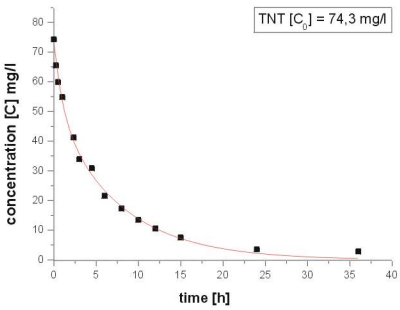
General
The gaiasafe passive collectors resemble a paper like arangement of different sorption active fibers. As paper sheets they are advantageously applied for water analysis, in the form of wool they are used for gas analysis applications. Once in use, it is only necessary to protect passive collectors from physical destruction by fluid action. Passive collectors are emplaced into the fluid or gaseous phase to be investigated, for example for ground water, surface water or waste air. After a collection time intervall of about four weeks they are removed from the investigated phase. Then they can be dried and sent to the laboratory.

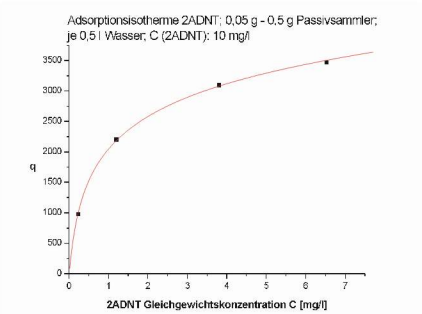
Pic. 1: Passive Collector total view (left) & enlarged view (right)

Kinetic studies for explosives
The explosives and byproducts 2,4,6-Trinitrotoluene (TNT), Hexogene (RDX), Octogene (HMX), 2-Amino-4,6-dinitrotoluene, 2,4-Dinitrobenzoic acid and 2,4-Dinitrotoluene sulfonic acid(5) were tested in laboratory experiments. After a reaction time of 72 h a sorption rate of 89-99% was detected. The sorption characteristic follows an exponential function.
Other compounds like arsenic, uranium and thorium ions follow the same sorption characteristic.

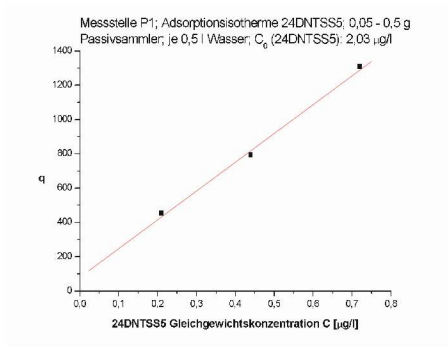


Pic. 2: Sorption of TNT (C = 74,3 mg/l) on gaiasafe passive collectors

Adsorption isotherms
The adsorption isotherms were obtained for some explosives and byproducts. Effects of saturation were observed by using 50 mg Passive Collector and 5 mg compound (for example 2-Amino-4,6-dinitrotoluene in **Pic. 3**).
The sorption capacity of the Passive Collectors is in the percent range of the total weight of the Passive Collector.
Pic. 4 shows the adsorption isotherm for the compound 2,4-Dinitrotoluene sulfonic acid(5) in a real water sample (C = 2 µg/l). No saturation effect is visible.

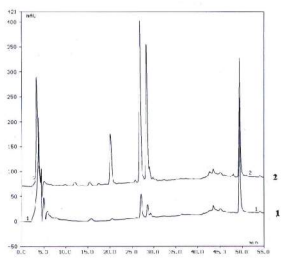


Pic. 3: Adsorption isotherm of 2-Amino-4,6-dinitrotoluene (C = 10 mg/l)



Pic. 4: Adsorption isotherm of 2,4-Dinitrotoluene sulfonic acid(5) (C = 2,03 µg/l)

Enrichment of explosives during the collecting period
After a collection time of 30 days explosives and byproducts are enriched on the Passive Collector. During long collecting times the LOD for explosives is higher compared to normal water analysis. In **Pic. 5** the comparison of HPLC chromatograms of a water sample, enriched with SPE methods, and a passive collector sample of surface water out of an explosives plant is shown.



Pic. 5: Comparison of HPLC chromatograms of a water sample after SPE extraction (1) and a Passive Collector sample (2) of surface water in an explosives factory

Desorption of loaded Passive Collectors
In laboratory experiments 0,5 g Passive Collectors, loaded with one single compound, C = 10 mg/g, were extracted 7d with 500 ml water. The equilibrium concentrations on the Passive Collcetors are 95-99,5% for explosives and 88-93% for polar TNT metabolites (medium of three parallel experiments).

compound	water (%)	Passive Collector (%)
2,4,6-Trinitrotoluene (TNT)	1,55	98,45
Hexogen (RDX)	5,0	95,0
2-Amino-4,6-dinitrotoluene	0,45	99,55
2,4-Dinitrobenzoic acid	12,0	88,0
2,4-Dinitrotoluene sulfonic acid(5)	7,2	92,8

Influence of other compounds on the sorption rate
Laboratory experiments show no influence of inorganic salts and Na-Huminate on the sorption rate of explosives and byproducts. Only the polar TNT metabolites 2,4-Dinitrobenzoic acid and 2,4-Dinitrotoluene sulfonic acid(5) show a decreasing sorption rate in presence of high Na-Huminate concentrations. Inorganic salts in high concentrations have no influence on the sorption rate (medium of three parallel experiments).

compound	dest. Water (%)	+ 140 mg/l inorganic salts	+ 500 mg/l Na-Huminate
2,4,6-Trinitrotoluene (TNT)	98,1	98,5	98,3
Hexogen (RDX)	90,8	92,3	84,5
2-Amino-4,6-dinitrotoluene	97,8	97,9	96,9
2,4-Dinitrobenzoic acid	76,5	78,4	32,3
2,4-Dinitrotoluene sulfonic acid(5)	81,8	86,0	44,2

State of research development and Testing
The validation of the Gaiasafe Passive Collectors is still under way for specific compounds. The Passive Collectors are in use in some projects for monitoring ground water contamination plumes in Germany. In Brazil, Belarus, Tajikistan and Ivory coast other projects for monitoring of river water, drinking water, waste water and air pollution are still in progress.
Gaiasafe Passive Collectors are patented and avaiable only from gaiasafe gmbh at a pricing of 20 € per single item.

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