^{131}I measurements in Weser water

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INTRODUCTION

The goals of the previous workshop have been met; following the field search for sediment and water sampling locations and gathering the necessary sampling equipment (water pump, sediment grabber) , suspended matter test samples from both the Waste Water Treatment Plant (WWTP) and its outlet in the river were gathered and analyzed as well as 3 sampling campaigns were arranged and preformed in the river.
Aim of the poster is to present these results, concerning both ^{131}I bound in suspended matter and in river water.

SUSPENDED MATTER

Several test samples were obtained (both WWTP effluent and river water) in order to determine the ^{131}I attached in suspended matter.

Methods

The main method used is based on Mundschenk (1993), "Verfahren zur gammaspektrometrischen Bestimmung von Radionukliden in Schwebstoffproben".
The samples were filtered though a 589/2 Whatman filter paper, designed for gravimetric analysis for standard medium fine precipitates. The suspended matter deposited on the filters was dried till constant mass at 105 ºC and then ashed at 200 ºC for 4 hours. The temperature selection was made in order to prevent volatilization of iodine from the sample [Herod M. et. al., 2014].

The ignition residue was ground to fine dust in a mortar to achieve homogeneity of the sample and measured in gamma spectrometer.

A different approach was selected for a sample taken from location D (fig. 1), for the verification of the results. The 50 liter sample was mildly stirred after the addition of 200ml Flockfix flüssig (by Planet Pool) and was let to precipitate overnight. The precipitate was measured in a gamma spectrometer and the ^{131}I activity concentration bound to suspended matter was determined.

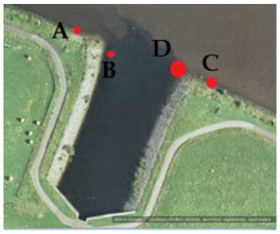

Fig. 1: Sampling locations on the WWTP outlet

Results

The ^{131}I in suspended matter was determined through 3 campaigns where WWTP water and surface river water in the WWTP outlet (fig. 1) was collected (due to the lower ^{131}I dilution). The results are given in the following tables:

Table 1: ^{131}I bound to suspended matter measurements- samples treated with Mundschenk method.

Sampling date	Type of sample	Total ^{131}I activity concentration in the sample [mBq/kg]	Total sample mass [kg]	Total ^{131}I activity measured in suspended matter [mBq]	Radioactive analysis (^{131}I in suspended matter[mBq]/total ^{131}I in sample[mBq]) [%]
6.5.14	WWTP effluent	149 ± 24	19.24	72 ± 11	2.51
6.5.14	WWTP effluent	197 ± 21	17.94	39 ± 6	1.10
6.5.14	WWTP effluent	198 ± 19	18.92	47 ± 9	1.25
20.5.14	WWTP effluent	315 ± 25	48.16	128 ± 16	0.84
20.5.14	WWTP effluent	272 ± 24	48.52	158 ± 19	1.20
20.5.14	WWTP effluent	306 ± 28	47.44	119 ± 18	0.82
18.6.14	River water- location A	63 ± 14	49.64	< 20	< 0.64
18.6.14	River water- location B	136 ± 19	48.46	< 15	< 0.23

Table 2: ^{131}I bound to suspended matter measurement- sample treated with Flockfix.

Sampling date	Type of sample	Total ^{131}I activity concentration in the sample [mBq/kg]	Total sample mass [kg]	^{131}I activity concentration measured in suspended matter [mBq/kg]	Radioactive analysis (^{131}I in suspended matter[mBq/kg]/^{131}I in sample[mBq/kg]) [%]
12.11.14	River water- location D	175 ± 20	51.20	6.0 ± 0.2	3.4

With ^{131}I activity concentrations of some Bq/kg in Weser River water, the ^{131}I bound to suspended matter (only 3% of the total ^{131}I activity), is highly unlikely to be measured.

RIVER WATER

Due to low ^{131}I activity concentration Weser River water, a chemical extraction method has to be applied in order to increase the sensitivity of the measurement.

Chemical extraction method

The ^{131}I extraction method was described in the 1st Workshop "Transaqua" on the 26th of March 2014 in Hannover. Detailed description of the procedure was also given in the ICRER 2014 in Barcelona [Souti M., et al., 2014].

A statistical analysis of the chemical yield, illustrated a normal distribution with its central tendency characterized by a mean of 83% with a standard error of the mean 2% (sample size of 33) and standard deviation of 11%. The normality of the distribution was verified by the Kolmogorov-Smirnov test.
There was not significant dependence of the chemical yield on measurable effluent parameters (salinity- values 0.3 or 0.4, conductivity- values between 1000 to 1250µS/cm and pH- value range 7.1 to 7.6).

Sampling results

Two sampling campaigns, with 5 sampling locations equidistant across the river, in the river section located in the WWTP outlet (fig. 2) took place during different tidal conditions (river flow towards Bremen city and Bremerhaven) and their results are given in Tables 3 and 4. The samples collected during the first two sampling campaigns were depth integrated samples.
Following took place a third sampling campaign where surface water in 3 locations downstream the WWTP was taken (fig.2)

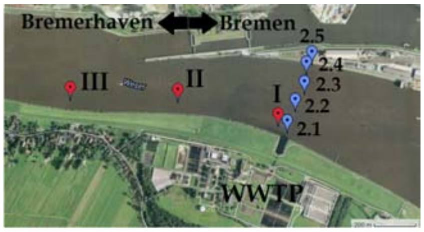

Fig. 2: Sampling locations on Weser River for 1st (sampling locations 2.1-2.5), 2nd (sampling locations 2.1-2.5), and 3rd (sampling locations I,II,II), sampling campaigns

Table 3: Results of 1st sampling campaign in Weser river - depth integrated samples.
River flow towards Bremen city (from LW (10:25) to HW (15:45))

Sampling point	Date/time of sampling	Depth of water column(m)	WWTP effluent activity concentration (mBq/kg)	Mass of sample (kg)	River water ^{131}I activity concentration (mBq/kg)
2.1	23.9.14/14:05	5	67 ± 12	49.68	<1.18
2.2	23.9.14/15:00	13	67 ± 12	48.42	<1.01
2.3	23.9.14/15:12	13	67 ± 12	49.80	<0.73
2.4	23.9.14/15:20	13	67 ± 12	48.12	<1.11
2.5	23.9.14/13:40	8.5	67 ± 12	48.86	<1.07

Table 4: Results of 2nd sampling campaign in Weser river - depth integrated samples.
River flow towards Bremerhaven (from HW (13:47) to LW (21:08))

Sampling point	Date/time of sampling	Depth of water column (m)	WWTP effluent activity concentration (mBq/kg)	Mass of sample (kg)	River water ^{131}I activity concentration (mBq/kg)
2.1	6.10.14/16:08	6	90 ± 17	50.56	1.2 ± 0.4
2.2	6.10.14/16:18	12	90 ± 17	41.64	<1.87
2.3	6.10.14/16:28	12	90 ± 17	50.34	<1.17
2.4	6.10.14/17:20	11.5	90 ± 17	51.80	<1.55
2.5	6.10.14/17:28	5	90 ± 17	50.96	<1.45

The low ^{131}I activity concentration in the depth integrated samples led us to a third campaign, in order to confirm our suspicion that the effluent is positively buoyant, thus leading us to sample from the surface water layer. The results are given in Table 5.

Table 5: Results of 3rd sampling campaign in Weser river – surface samples (0-0.3m).
River flow towards Bremerhaven (from HW (05:56) to LW (13:06))

Sampling point	Downstream distance from WWTP outlet (m)	Date/time of sampling	WWTP effluent activity concentration (mBq/kg)	Mass of sample (kg)	River water ^{131}I activity concentration (mBq/kg)	Dilution
I	0	12.11.14/11:15	327 ± 24	48.66	87 ±12	3.7
II	492	12.11.14/11:35	327 ± 24	47.84	2.4±0.8	136
III	980	12.11.14/11:45	327 ± 24	47.74	<1.38	>237

CORMIX simulations

In an attempt to refine our sampling locations and procedure, multiple simulations were run in the CORMIX model (fig. 3). CORMIX is a mixing zone model and decision support system licensed and distributed solely by MIXZON INC.
The fact that the simulations so far support our experimental results (dilution factors, flow description, intrusion of ambient water into the discharge opening), indicates that CORMIX could be a useful tool in determining our sampling locations by defining the downstream distance for complete lateral and vertical mixing.

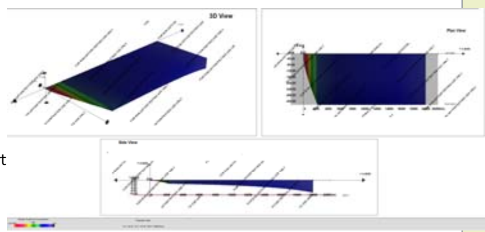
Fig. 3: CORMIX simulation, for mean effluent (flow rate 1.3 m^3/s) and river conditions (flow rate 330 m^3/s) for downstream distance from WWTP 20 km for a non conservative pollutant (decay coefficient 0.086 day^{-1}) of original activity of 250 mBq/l and surface discharge- non tidal current.

OUTLOOK

Additional mixing models will be used, along with CORMIX as guides in order to define new sampling locations. Our goal is to determine the ^{131}I activity concentration in the plume until it gets fully mixed with the river water. In the following months, sampling campaigns for river sediment will also be performed.

REFERENCES

Mundschenk H., 1993, Verfahren zur gammaspektrometrischen Bestimmung von Radionukliden in Schwebstoffproben, BMU, Leitstelle C. (http://www.bmub.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/strlsch_messungen_c06.pdf)
Herod M., et al., 2014, Extraction of ^{129}I and ^{127}I via combustion from organic rich samples using ^{125}I as a quantative tracer, J. Environ. Radioactivity , 138: 323-330.
Souti M., et al., 2014, I-131 extraction from fresh water and sewage plant effluent, poster presented at the International Conference on Radioecology and Environmental Radioactivity, Barcelona, Spain

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