The RIP positions in dependence on the moisture

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Introduction

IMS is a very sensitive but low resolution spectrometric technique. When using radioactive sources in both modes, positive and negative of the drift voltage, occur so called reactant ion peaks (RIP). Commonly air is used as drift gas. It is continuously cleaned by a loop filter. Filter materials are silica gel, activated carbon or molecular sieves. The best results concerning the purity of the gas are reached by using molecular sieves. They have a middle capacity to water (10 per cent in dynamic, up to 20 per cent in static case) and a suitable one for trace contamination. The influence of the moisture to the RIPs shall be investigated in this poster.

Reactant Ion Peaks

In presence of nitrogen there is a positive RIP and in presence of oxygen there is a negative RIP. The question which ions form the peaks is discussed in several other papers and shall not be discussed here [1, 2, 3]. The ion reactant peak is not only one peak. Small peaks around this can give information about the state of the drift gas. The adsorption of the filter will be reduced depending from the already retained water. The filter breaks through at the above mentioned theoretical values of capacity. The theoretical value of the capacity to water are in practice not reached. The performance of the IMS goes extremely down before that point.

Signal processing

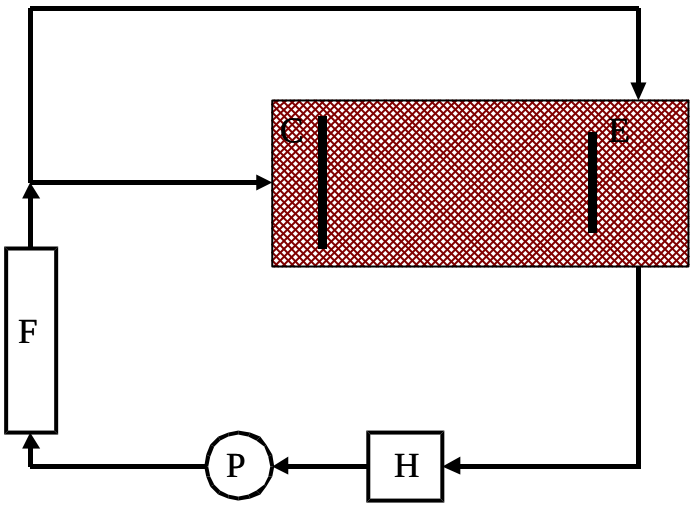
Due to the low resolution of the IMS the most peaks of the spectrum are unresolved. Using deconvolution the resolution can be enhanced by a factor of 1,5 till 2,0.

The deconvolution algorithm has two parts:

1) wavelet denoising as regularization [4]
2) Lucy - Richardson – iteration for enhancing resolution [5]

The wavelet denoising is necessary, thus deconvolution is an ill-posed problem. To overcome this problem the influence of noise must be reduced by regularization, for example by wavelet denoising.

Experiment setup



In figure 1 the schema is described: IMS drift tube (collector and emitter (**C**, **E**)) with dew point meter (**H**), loop pump (**P**), loop filter (**F**).

The IMS used in the experiment has the following parameters:

producer:	IUT GmbH
drift length:	55 mm
drift voltage:	2000 V
pulse width:	50 µs
pulse height:	350 V
frequency:	33 Hz
drift gas:	450 ml/min
carrier gas:	50 ml/min
temperature:	32°C
pressure:	atmospheric pressure
data points:	2048 at 100 kHz
delay:	1 ms
averaging:	128 times
ionisation:	Tritium, < 50 MBq
loop filter:	80 g of molecular sieve mixture of 5 A and 13 X

The humidity is measured with the Panamatrics Hygrometer System II and calibrated sensors from – 110°C to 10°C dew point. For vaporisation double distilled water is used. Both, carrier and drift gas have the same humidity. The concentration of the moisture is related to the volume (ppm(V)).

Results

Significant peaks in positive mode

standardised drift time at 1013 mbar and 20°c	relative drift times according to the main peak
6,69 ms	0,938
6,95 ms	0,975
7,13 ms	1
7,31 ms	1,025

Significant peaks in negative mode

standardised drift time at 1013 mbar and 20°c	relative drift times according to the main peak
6,31 ms	0,953
6,62 ms	1
6,90 ms	1,042
7,08 ms	1,070

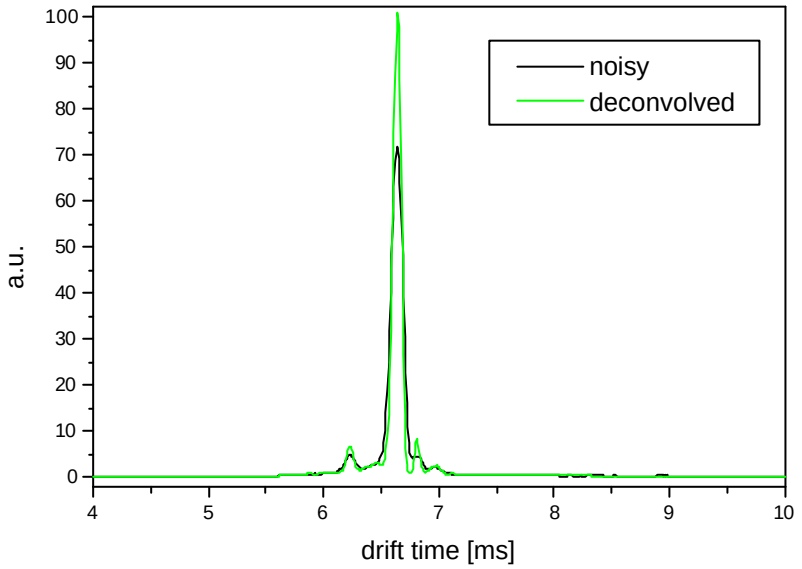


Figure 2: Example of deconvolution – positive mode 5 ppm H_2O

Peaks of negative mode are more sensitive to moisture than positive ones. For a broad range the peaks of both modes are stable. Higher contents of moisture will shift both RIPs longer drift times. The relative drift time according to the main peaks is more stable than the standardised peaks (equivalent to K_o). Self calibration due to the “age” of the filter is possible by software algorithms.

Literature:

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