CONTINUOUS FLOW INTEGRATIVE SAMPLER (CFIS). AN INNOVATIVE DEVICE FOR TIME WEIGHTED AVERAGE MONITORING

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Since the beginning of the evolution of passive sampling in water, which dates back to 1980, when Byrne and Aylott patented a simple device for the passive sampling of organic contaminants, a multitude of new devices and set-ups have been developed, and their main advantages and disadvantages have been discussed in publications. However, the range of possibilities for the development of new devices is relatively restricted by the theoretical principles governing passive sampling. It is clear that the ideal passive sampler would be one which would allow high sampling rates, and would be almost unaffected by environmental variables, such as turbulence, and with very low, or even zero lag time values. Passive Sampling devices typically consist of a receptor phase that acts as a sink for the compounds under study, which is usually totally or partially surrounded by a barrier through which the target substances can permeate or diffuse (BS, PAS 61:2006). This barrier plays a decisive role. A "thick" barrier will assure sampling rate values which are almost unaffected by turbulence. On the other hand, the actual sampling rates would generally be very low, and the lag times would generally be quite high, because the barrier is the limiting stage in the transfer of material from the water to the sorbent. In the case of passive sampling in air, where the diffusion coefficients are between two and three orders of magnitude higher than in water, this is not a problem. The situation being as it is, generally a compromise is accepted in which the barrier thickness is minimised, thus allowing high sampling rate values, and low lag time values, but which doesn't fully prevent the effects of turbulence. These types of devices, therefore, allow the measurement of low levels of concentration, while also responding rapidly to any concentration peaks in the sample medium. The variation in the uptake values which result from the variations in turbulence can generate important problems in determining accurately time weighted average concentrations obtained from sampling rates calculated from tests under laboratory conditions. In samplers which are based on sorbents, where the absorption and the release of compounds are isokinetic processes, the problem has been resolved elegantly by using performance reference compounds (PRCs). These are compounds added at a known concentration to the sorbent, and which are then released in a way which is proportional to the turbulence. In this way the sampling rate values can be estimated from the loss of the PRCs. It must be remembered however, that the concentrations calculated in this way are no longer proportional to the exposure time, but instead, to the turbulence. For this reason, the term "time weighted average concentration" should not be used, and should really be replaced by a more adequate term which is beginning to be used in scientific publications, which is the "flow weighted average concentration" (FWA). The problems of turbulence vs. sampling rate are still the main sticking point of passive samplers of polar compounds in general, with sorbents governed by adsorption principles. In this study, a new device is presented able to obtain TWA concentrations. The fully immersible device is small in size (20 x 7x 7 cm), and consists of a small peristaltic pump powered by a lithium battery, which produces a constant flow through a glass cell. The sorbent is located inside this cell. The device cannot truly be defined as a passive sampler because it needs an energy supply of 100mA to work the mini-pump, and so can be classified as "integrative". This new device, which has been patented, will allow autonomous sampling during long periods (up to 15 days) of both polar and apolar compounds alike, as well as heavy metals, depending on the sorbent, or combination of sorbents used. The constant flow rate through the cell will allow the collection of high sample rate values as an absolute figure, which will be independent of any turbulence in the sampled medium. Thus giving TWA concentrations which will be reproducible under different exposure conditions, with lag time values of almost zero. In this study, the results obtained from the CFIS device are presented for the compounds included in the 33 priority list of the Water Framework Directive with Log Kow between 4,5 and 8,5 using PDMS as the sorbent material. Two forms of PDMS are used; the bars which are available under the registered commercial name of Twister, 2 cm long and 0,5 cm film thickness. Tubes of PDMS 5 cm long and 0,5 cm film thickness were also used. The average sampling rate obtained from the Twisters was 50 mL/day, and 200 mL/day was obtained from the tubes of PDMS due to their greater exposed surface area. In this study, results are also presented for the use of the device for the measurement of the contaminant load of priority pollutants of effluents from residual water treatment plants. The results allowed the identification of sporadic spillages which had not been detected by the classical spot sampling methods.