Influence of UV Radiation on SRG Extra Fluorescence in Water Samples

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Abstract

The fluorescence ability of Sulphorhodamine G (SRG) Extra enables its using as artificial tracer in the water system studies. The problem is dealt with in relation to applying SRG Extra to trace and determine water movements within the karstic system and underground waters. The fluorescence intensity of fluorescent dyes in water samples depends on their physical and chemical properties, such as pH, temperature, presence of oxidants, etc. Besides that, UV radiation may induce photochemical decomposition of the dyes which can cause large measurement errors. This paper presents the obtained results in our lab studying the influence of UV radiation on SRG Extra fluorescence intensity in water samples in different conditions so-called: 'in the light' and 'in the shadow'. We have studied this influence putting water samples containing SRG Extra in colorless glass bottle and brown glass bottle in each situation mentioned above. The concentration and synchronous scan methods were used for the measurement of SRG Extra fluorescence by the means of a Perkin Elmer LS 55 Luminescence Spectrometer. The photodecomposition results help us to determine if the dye can be used or not in a water system study with tracing experiment. According to these results we can decide the conditions of the transport and storing of the water samples, too.

***Key words**: Spectral Determination, SRG Extra, Fluorescence Intensity (I_F), Synchronous scan, artificial tracer.*

Introduction

Management of aquatic systems requires one to know and study them in order to assess their water usability as well as to find optimum and sustainable ways of water management. Modern techniques of tracers in hydrology are elaborated to this purpose. The introduction of fluorescent tracers has led to enormous methodological and instrumental developments [1, 2]. The problems they deal with when applied in studying various water systems might be grouped into different groups, according to *where* is flowing groundwater to, *from where* it comes, *whether* exist underground hydraulic connections between different points of the system or not, *how* is flowing the groundwater in(to) and/or through the system under the study, etc [3].

System's water is labeled through fluorescent dyes as artificial tracers and then their presence is monitored from time to time in various parts of the system under the study. When measured in water samples SRG Extra fluorescence intensity depends on different physical and chemical properties of the sample matrix - pH, temperature, oxidants' presence, etc. [3, 4, 5]. Besides that, UV radiation may induce photochemical decomposition of the dyes. That's why we decided to monitor during four months the influence of UV radiation on SRG Extra fluorescence intensity in water samples, in different conditions. The concentration and synchronous scan methods were used for the measurement of SRG Extra fluorescence by the means of a Perkin Elmer LS 55 Luminescence Spectrometer.

Methodology applied

"Blank" solutions sampled from the different water system were analyzed in order to assess the natural presence of "SRG Extra" fluorescence in environment and to determine the so called "background".

A special software package (FL WinLab) manages different application programs the instrument LS 55 offers was used. Trace contents in water samples was detected and measured by using the Synchronous Scan and Concentration Applications. The instrument validation was performed through Raman spectra

(Raman Peak Wavelength, Raman Peak Intensity and Raman S/N ratio) from a sealed water cell [6] and a reference material, Anthracene [7]. The instrument stability is checked with regard to fluorescence intensity by the means of a reference material (Anthracene) [7, 8]. The instrument's parameters are organized so as through synchronous and concentration applications. The method elaborated to measure SRG Extra content in water samples is made up of the following parameters: Excitation wavelength- 531 nm; Emission wavelength- 552 nm; Excitation slit- 10.0 nm; Emission slit- 10.0 nm; Delta lambda – 21 nm; Auto Background Subtract, etc.

The characteristic peak wavelength was verified beforehand by some preliminary synchronous scans.

Influence of UV radiation SRG Extra Fluorescence in water samples was investigated. The instrument was previously calibrated with six SRG Extra standard solutions by the means of the calibration application [9] for SRG Extra determinations.

Results Obtained

The influence of the UV radiation on SRG Extra Fluorescence Intensity

UV radiation may induce photochemical decomposition of SRG Extra which can cause large measurement errors [10]. To investigate this phenomenon it was prepared SRG Extra standard solution conc. = 0.881ppb (solvent: distil water) and add it in 2 colorless glass bottles and in 2 brown colored bottles. Than we put them in two different situations so-called: 'in the light' and 'in the shadow'. We put one colorless glass bottle and one brown colorless glass bottle in the first situation "in the light" and one other uncolored bottle and one brown colored flask in the second situation 'in the shadow'. The SRG Extra fluorescence intensities of these four flasks were measured at the same time according to one schedule. At the beginning the measurements were frequently and after some times were less than before.

The supervision of this process continued four months. The obtained results of SRG Extra photodecomposition in different conditions are shown in the following diagrams. The figure 1 show the decay of the fluorescence of SRG Extra standard solution 0.881ppb in the colorless glass bottles exposed to daylight in the so called condition 'in light'.

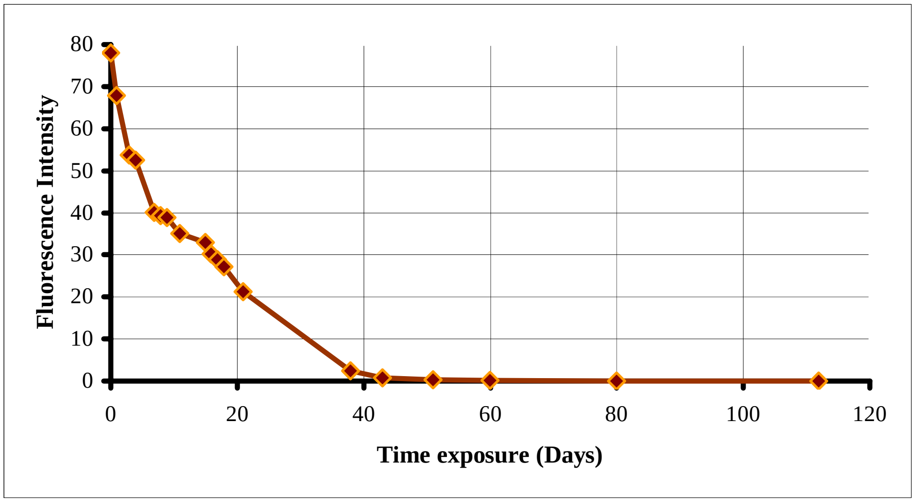

Figure 1. Photodecomposition of SRG Extra – colorless bottle, 'in light'

It is obvious from the results that UV radiation decay sensibly SRG Extra fluorescence. Daylight destroys 97 % of the total fluorescence intensity after 38 days, whereas after 42 days exposure, SRG Extra fluorescence was destroyed 100%.

Figure 2 shows the results of SRG Extra fluorescence intensity (I_F) decay after the exposure to daylight in brown glass bottle, 'in light'

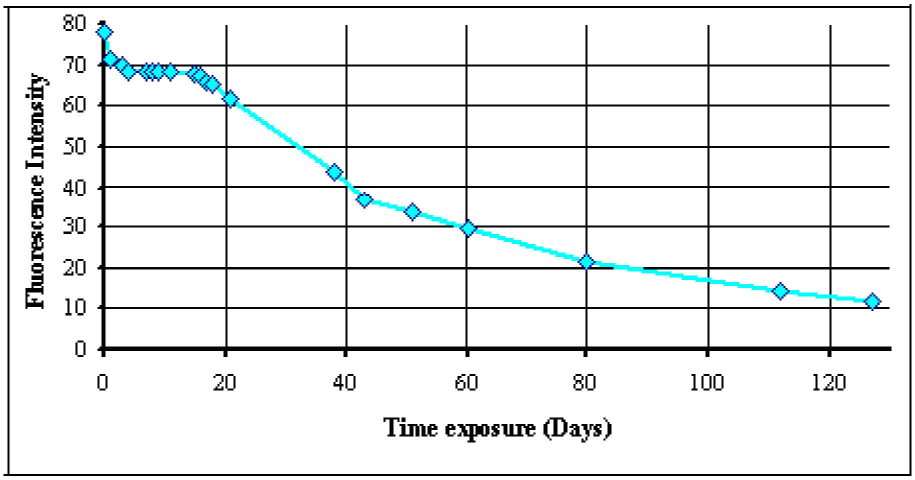

Figure 2. Photodecomposition of SRG Extra in brown glass bottle, ‘in light’ (C_0=0.881ppb).

One can see from the results that the fluorescence intensity of SRG Extra was destroyed 88 % of the initial fluorescence after 127 days exposure to daylight in brown glass flask, ‘in light’ so 97 days later than in the case of colorless bottle in the same conditions. This proves that brown flask delay the decomposition of SRG Extra. At the end of the process we measured 15% of the initial fluorescence of SRG Extra.

The obtained results of SRG Extra fluorescence intensity (I_F) decay after exposure to daylight in colorless glass bottle, ‘in shadow’ is shown in figure 3.

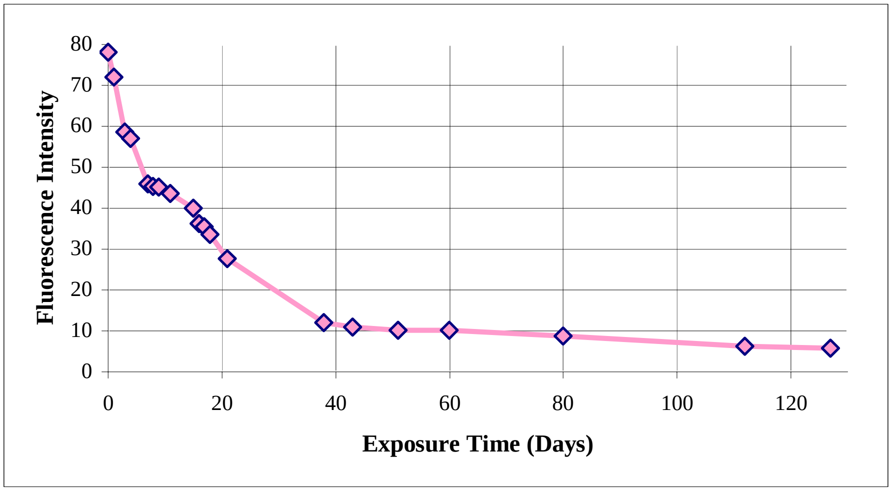

Figure 3. Photodecomposition of SRG Extra in the colorless glass bottle, ‘in shadow’ (C_0=0.881ppb).

It is clear from the results that UV radiation decay more gradually SRG Extra in the case of colorless bottle ‘in shadow’ than ‘in light’. At the end of the monitoring in these conditions UV radiation destroys 92.66 % of the initial fluorescence intensity.

The obtained results after exposure to daylight of SRG Extra standard solution in a brown flask in condition ‘in shadow’ are shown in the figure 4.

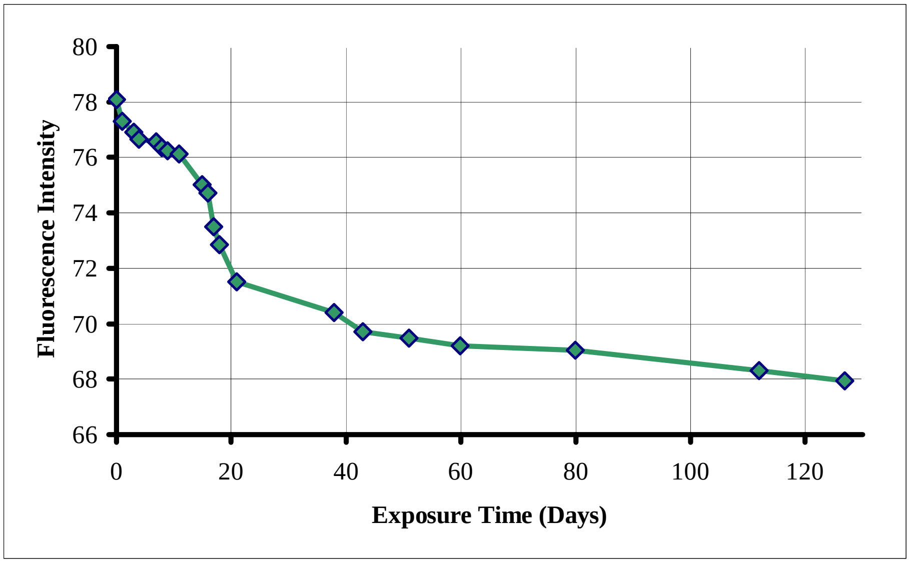

Figure 4. Photodecomposition of SRG Extra in the brown flask, ‘in shadow’ (C_0=0.881ppb).

The results of figure 4 show clearly that the decay of SRG Extra fluorescence intensity in brown glass flask, ‘in shadow’ is more gradual than the decay in the other conditions. In this case, daylight destroys 68 % of SRG Extra total fluorescence intensity after 127 days.

Figure 5 shows the dynamics of SRG Extra decomposition after exposure to daylight in four different conditions mentioned above.

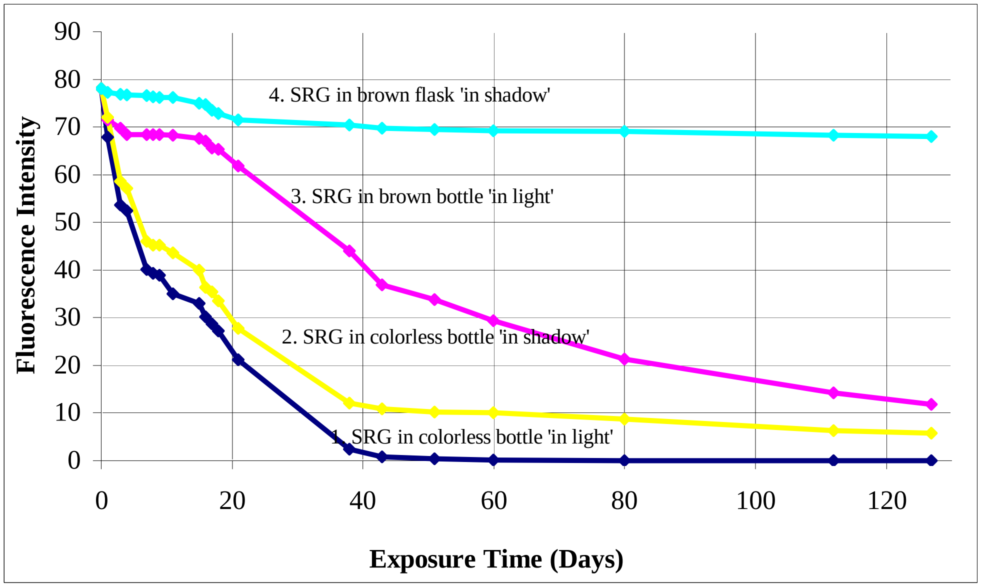

Figure 5. Decay of the fluorescence of SRG Extra in aqueous solutions exposed to daylight in different conditions.

It is obvious from the graphs that brown glass and especially brown flask delay the decomposition of SRG Extra fluorescence.

The results show clearly the influence of the UV radiation on SRG Extra fluorescence. One must have this influence in consideration when one use SRG Extra as an artificial tracer for water system studies and during the samples transport and standard solutions saving, too. UV radiation decay more slow SRG Extra fluorescence than in the case of Eosine and Uranine Fluorescence for the same conditions [5]. That means SRG Extra can be used in underground and surface water tracing experiments.

Conclusions

UV radiation induces the destruction of the SRG Extra, which leads to analytical errors.
It is indispensable to transport the SRG Extra water samples protecting them from day light.
One should store SRG Extra standard solutions in brown glass and in the dark.
Water samples containing SRG Extra should be stored in the dark, too.
SRG Extra is gradually affected by UV radiation than some other dyes. SRG Extra can therefore be used in underground and surface water tracing experiments.

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