Field fluorometers for the hydrogeology: Improved separation of uranine from other dye tracers using laser light

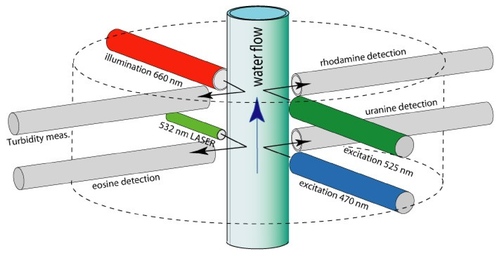
Pierre-André SCHNEGG

CHYN, rue Emile Argand 11, CH-2009 Neuchâtel - Switzerland e-mail: pierre.schnegg@unine.ch

ABSTRACT

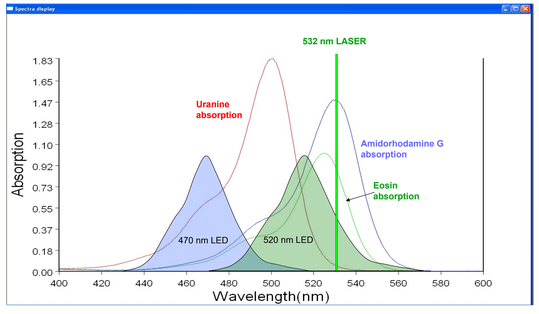
Flow-through field fluorometers for the hydrogeology are employed in tracer tests for detection of small concentrations of dye tracers. It is convenient to be able to detect several tracers with the same sonde. However, tracers with similar optical properties are difficult to separate with the LED sources used in conventional fluorometers. We replaced one of them by a green laser rod. Its narrow wavelength distribution allows separate a cocktail of three favorite tracers, otherwise hard to achieve without laboratory techniques: Uranine, eosin and rhodamine.

The flow-through fluorometer is a waterproof stainless steel cylinder hosting a vertical glass tube illuminated by four LEDs.

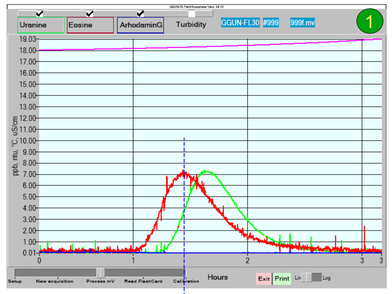


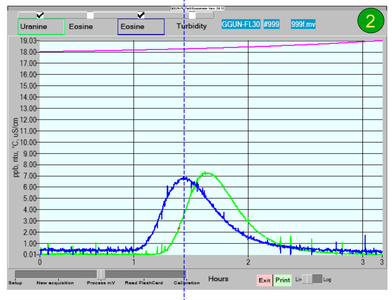
The new design was tested in a small stream (0.8 m^3 / s). In the first test, 1 g eosin was injected 650 m upstream at 10.00 am and 1 g uranine at 10.10 am. In the second test, 5 g eosin, uranine and amidorhodamine G were injected the next day at 10.25 am, 10.30 am and 10.35 am. Water turbidity was slightly above 10 NTU.

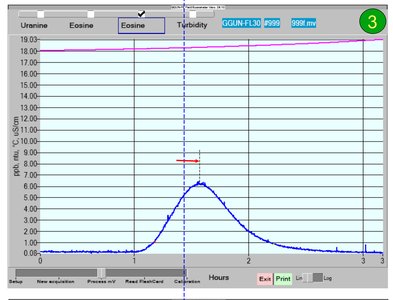
In this research, one of the LEDs was replaced by a 532 nm green laser rod. A set of color filters and condensers (for the LEDs and photo detectors) completes the set-up (not required for the laser!)

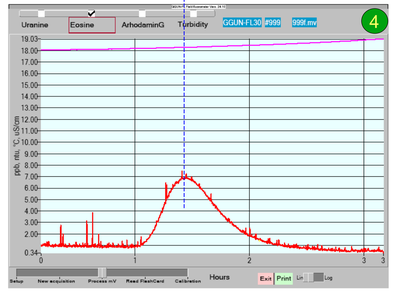


Absorption spectra of three dye tracers and light spectra of two LEDs and the green laser. Interestingly, uranine is hardly excited by the laser, easing the separation of the three dye tracers. This operation is done by solving the set of three linear equations of three unknown concentrations.









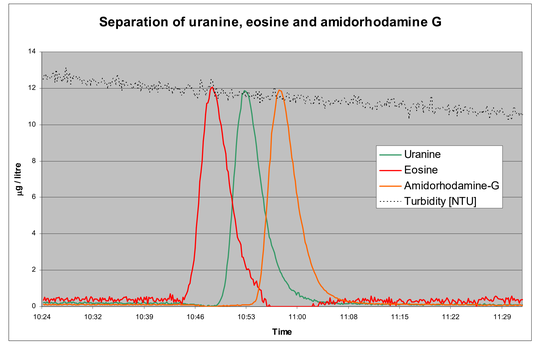
Test 1 – Two tracers : Eosin and uranine were injected in the stream at 10 minute interval. Only two optics were active at a time. Figs. 1 and 2 show the breakthrough curves after mathematical separation (eosin: red and blue, uranine: green). The 470 nm LED was kept active. In Fig. 1, the second optics was the 525 nm LED. In Fig. 2, it was the laser. There is no visible difference.

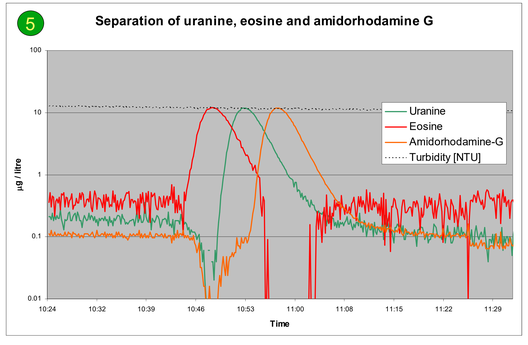
In the other figures, only one light source was active. The fluorometer is not instructed of the presence on uranine in the water. Fig. 3 was measured with the **525 nm LED**. The breakthrough curve is erroneous and delayed (red arrow) because this LED excites uranine as well as eosin.

Fig. 4 was obtained by illumination with the green **laser.** This time, the eosin curve is correct since the laser does not "see" the uranine.

Test 2 – Three tracers : Three tracers were injected at 5 minute intervals: **Eosin, uranine and amidorhodamine G** (5 g each). In spite of some turbidity (>10 NTU), the three breakthrough curves are well separated. A good separation of three optically similar dye tracer requires careful calibration of the sonde: Same batch of tracers for calibration and tracer test, calibration of the sonde in a 10 ppb solution prepared with the stream water, at the temperature of the stream.

As a rule of thumb, good separation is achieved if the tracers are in relative concentrations higher than 1:10. Fig. 5 shows instabilities occurring on the baseline of tracers of smaller concentration ratio.





2008 Joint Annual Meeting

Celebrating the International Year of Planet Earth

5 - 9 October, 2008 | Houston, Texas, USA

www.albillia.com

www-geol.unine.ch/geomagnetisme/tract.html