Fiber optic assisted LIF measurements in a water channel

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One of the most important quantity in all air quality related studies is the ground level concentration. Accurate measurements of the ground level concentration of a tracer or a pollutant in the field are not a challenge already for a long time. However, field measurements are expensive and the results are always specific to site geometry and environmental conditions. Therefore, there is a need to simulate air pollution dispersion in laboratory using wind tunnel or water channel. Due to the easiness of flow control, visualization and measurements water channels are sometimes preferred. Currently used systems to measure concentrations in water channels perform poorly for measurements of the ground level concentration. In this communication a newly developed system for measuring concentration in the water channels is presented. This system, based on the concept of Laser Induced Fluorescence (LIF), is equipped with optical fibers in order to measure the ground level concentrations at selected points. The performance of this system was evaluated with concentration measurements of the pollutants released from a ground level source at three different friction velocities. First, for simple geometries, measurements are validated with exact analytical solutions. Next, the system is deployed for ground level concentration measurements in more complex, urban like, setups for which there is no analytical solutions available. In addition to different geometries, various plume buoyancies and ambient conditions were investigated. These precise concentration measurements in complex geometries delineated new concentration pattern that are interpreted using flow and turbulence fields measured by Particle Image Velocimetry (PIV). High accuracy and the compact size of sensors give the system the ability to perform well in wide range of laboratory studies.

1. Experimental Setup

A custom-designed circulating water channel with a test section that is 1.5 m long, 1 m wide and 0.5 m deep (see schematic in Fig. 1a and a photograph in Fig. 1b) was utilized for the experiments. The channel is located in the Laboratory for Environmental Flow Modeling (LEFM) at the University of California, Riverside. Water is circulated through the channel test section using a 20 HP axial pump, which produces a maximum mean velocity of 0.5 m s⁻¹ in the test section. A variable frequency controller allows flow control with a resolution of 1/100 Hz (from 0 to 60 Hz) which corresponds to the mean velocity change resolution of only 0.08 mm s⁻¹. Flow conditioning is achieved with the profiled honeycombs and the custom-built perforated screens. The perforated screens are used to generate desired inflow velocity profiles as a part of the flow conditioning. The channel flow is steady and becomes fully developed before reaching the test section. The channel has flow control capability to maintain desired velocity profile starting from the classical logarithmic to the linear profile. As needed, the channel can also maintain well defined jets at desired height.

The LEFM is equipped with the Particle Image Velocimetry (PIV) system for velocity measurements. Detailed velocity field can be measured in the vertical or horizontal plane. PIV measurement technique is well established and widely used for fluid flow investigations (Adrian, 1988, 1991, 1997; Prasad et al., 1992).

![Water Channel Schematic](image)

**Fig.1 a** Water Channel Schematic. **b** Water Channel facility at University of California Riverside (LEFM)

**References**


