

GLOBAL LIQUID CONCENTRATION ANALYZER INSTANTANEOUS MEASUREMENTS OF THE GLOBAL CONCENTRATION FIELD

APPLICATION NOTE (A4)

Global Liquid Concentration Analyzer (GLCA) is a system which provides the measurements of the global concentration field in liquid mixing systems. It can be applied to mixing processes in microfluidic devices or shear layer mass transfer.

The GLCA offers turnkey operation for global concentration field measurements. Advanced software controls allow specific hardware operation and subsequent data analysis steps to be performed automatically. In addition to complete hardware control, the advanced software platform also features a host of processing algorithms for calculating the global concentration field, providing both the flexibility and power to obtain superior quality measurements even in challenging experimental arrangements.

A single laser source illuminates the plane of interest and the advanced Insight 4G™ software provides direct conversion of raw images to global concentration fields. All hardware components are controlled directly through the Insight 4G™ software, allowing for easy setup and operation using stored hardware parameters.

Added image arithmetic operations and direct links to both the Tecplot® and MATLAB® packages allow processing, analysis, and display routines. This yields a complete measurement system specifically tailored to the needs of a particular experiment or research agenda. Figures 1, 2 and 3 show the measurement results of concentration maps and profiles from a jet flow.

- Accurate measurements of the global concentration field
- Integrated link to MATLAB® and Tecplot® software packages for advanced analysis and display capabilities
- Fully integrated system with all hardware controlled through a single software platform
- In-situ image processing for rapid, accurate concentration measurements
- Advanced image arithmetic operations for simple customization of analysis algorithms



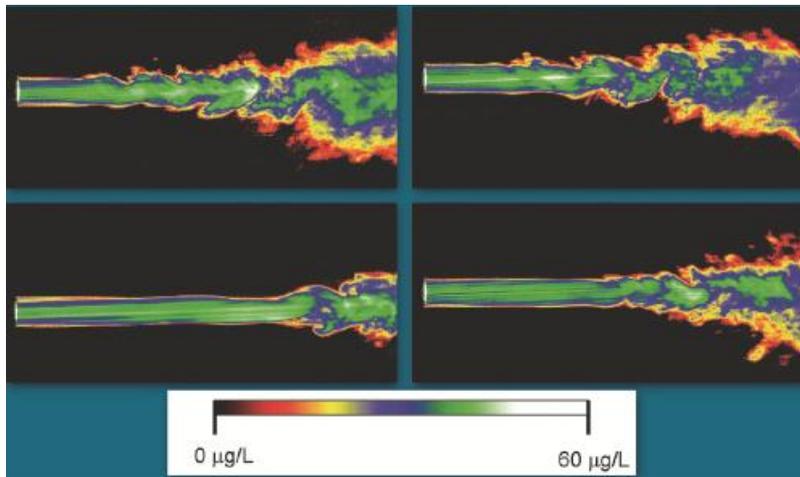


Figure 1: Results of concentration maps at different operating condition of a jet

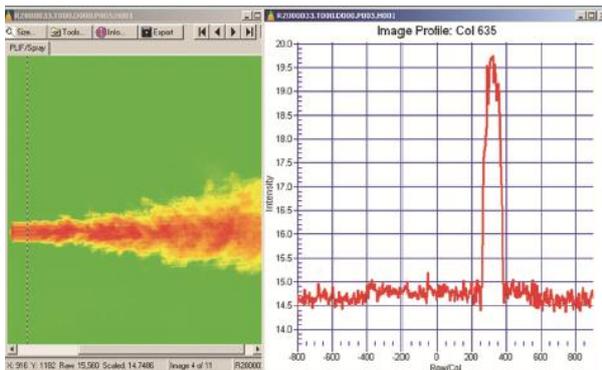


Figure 2a: Vertical profile of the concentration of jet at low flow rate

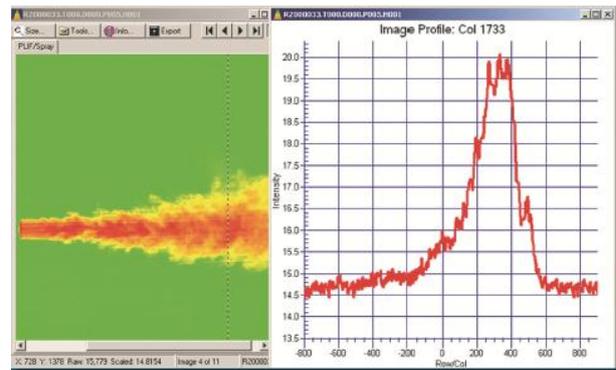


Figure 2b: Vertical profile of the jet at higher flow rate

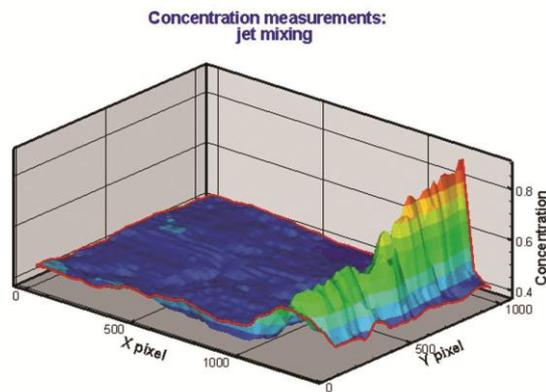


Figure 3: 3D representation of the concentration profile of the jet flow

The GLCA can also be upgraded to provide simultaneous measurements of the global concentration and velocity vector fields, allowing determination of higher order statistics such as mass flux.

System Components for the GLCA

For hardware, the GLCA includes primarily illumination, image capture, and analysis subsystems. Each subsystem is optimized per the requirements of the specific application, considering factors such as the size of the measurement region, the photo-physical properties of the measured contaminant, the geometric limitations of the experimental arrangement, and characteristics of the flow-field.

For a typical experimental arrangement where a tracer species is used to tag the contaminant flow, the illumination subsystem consists of a laser operating near 530 nm (typically either a Nd:YAG or a Nd:YLF laser), as well as appropriate optical accessories to illuminate the measurement region with a laser light sheet. Other lasers are sometimes used when a specific contaminant must be imaged.

Depending upon the particular application and size of the desired measurement region, lasers in a wide range of wavelengths and laser pulse energies can be used, allowing measurements in system sizes ranging from just microns up to 1 m x 1 m. The laser system is controlled completely from the Insight 4G software platform which features controls for pulse energy and repetition rate.

The image capture subsystem consists of a scientific grade digital camera along with associated frame grabbers and additional accessories. The choice of imaging device depends upon the application. A full range of CCD and CMOS cameras, from high sensitivity cameras for the most accurate concentration measurements to high frame rate cameras for time resolved information about flow field evolution, can be employed. Intensified cameras are also offered for imaging low signal levels in specialized applications. All camera functions are easily controlled through the Insight 4G software.

The GLCA is also available for mixing measurements in microfluidic systems and MEMS devices through the seamless integration of either a microlens assembly or an epi-fluorescent microscope.



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