195 Stafford Road West
Ottawa, Ontario, CANADA, K2H 9C1
Tel: +1.613.829.2772 – Fax: +1.613.829.4921
Email: info@brightwelltech.com

# MFI™ for UV Disinfection Studies

UV disinfection can inactivate biological pathogens, including *cryptosporidium* oocysts, at a favorable cost and with a relative freedom from disinfection byproducts. As a result, the technology is gaining increasing acceptance in the drinking and waste water sectors. Studies have shown that log reductions in active pathogen concentration obtained by UV disinfection are linked to the particulate characteristics in samples being irradiated. Specifically, it has been observed that when biological pathogens are enmeshed within larger particulates, the additional material has a shielding effect. This leads to a non-linear and, ultimately, saturated dose-inactivation response. Shielding effects depend on the size, shape and optical density of a particle. At a particle population level, the distribution of these parameters depends, in turn, on the source water characteristics and pre-treatment prior to irradiation. Typical validation studies characterize the particle distribution and correlate this with the active pathogen concentration following each pre-treatment and irradiation step. Studies must be repeated as source waters, target pathogens, pre-treatment processes and irradiation parameters vary.

## The MFI™ Advantage

When compared with established particle analysis technologies (principally Obscuration Particle Counters or OPC's), Micro-Flow Imaging (MFI™) has a number of unique advantages leading to its' selection for a growing number of UV disinfection studies. These include:

- **Comprehensive Characterization of Parameters Relevant to UV Shielding**: Studies have linked particle size (expressed as Equivalent Circular Diameter or ECD) with the potential for UV shielding. However, in addition to ECD, particle shape and optical density are also highly influential. MFI™ can provide these additional parameters.

- **Accuracy and Material Independence**: Unlike light scattering or obscuration devices, MFI™ measurements are insensitive to particle material. Since typical samples contain a range of materials, this assists in obtaining consistent and understandable results.

- **Direct Observation**: During analysis, frames are displayed in grayscale (or black-and-white) at a rate of one per second. This provides immediate visual feedback on the nature of a particle population. Software assisted filtering can save particle images meeting user-defined characteristics.

- **High Sensitivity**: The sensitivity of MFI™ for detecting and sizing small particles exceeds that of OPCs. This feature, along with the capability for time dependent measurement studies, is important for aggregation/meshing/flocculation studies.

- **Speed and Convenience**: MFI™ analyzers are easy to operate and provide complete analysis of a 1ml sample in less than 5 minutes.

195 Stafford Road West
Ottawa, Ontario, CANADA, K2H 9C1
Tel: +1.613.829.2772 – Fax: +1.613.829.4921
Email: info@brightwelltech.com

## MFI™ Capabilities – Sizing and Counting Sensitivity

Figure 1 illustrates results from a study measuring sensitivity of different instruments to dynamic changes in particle populations when a filter is subjected to a fluctuating hydraulic load. The higher detection sensitivity of the MFI™ instrument is evident.

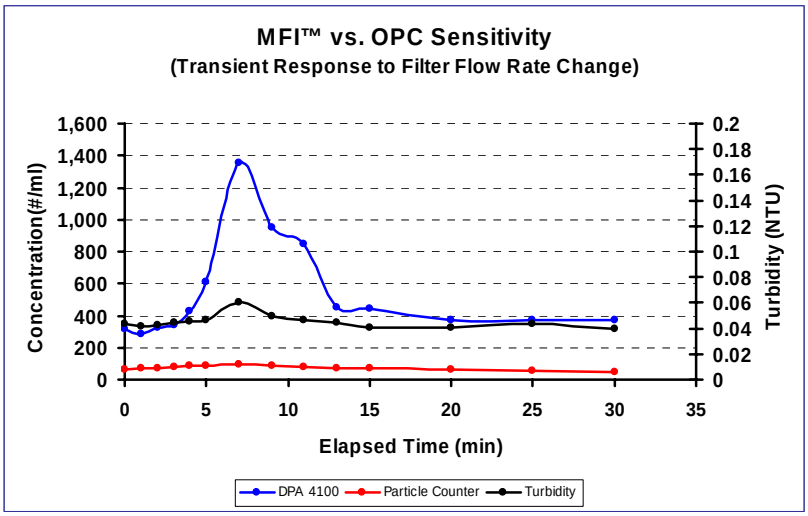
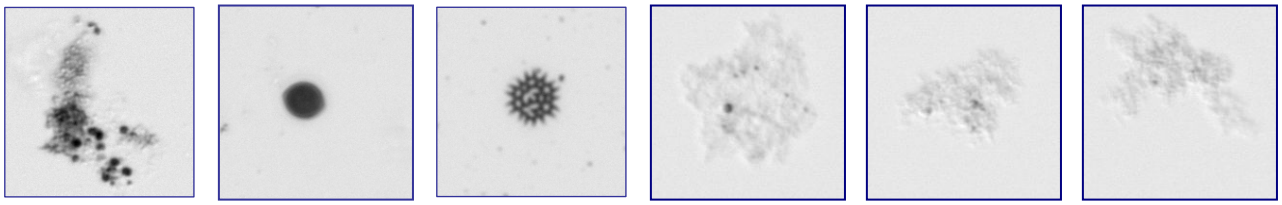



**Figure 1 – MFI™ vs. OPC Sensitivity**

## MFI™ Capabilities – Shape and Transparency Analysis

Figures 2 to 7 are images acquired by the DPA4100 and show particles from raw and processed water samples. The morphological differences which can exist between similarly-sized particles are evident. These images highlight the importance of understanding particle shape and transparency, in addition to size, when assessing shielding properties. Any combination of measured parameters may be plotted in the form of histograms or scatter plots and used to characterize sample populations.



**Figures 2 to 7 - Surface Water and Floc Particles (300 x 300 µm)**

195 Stafford Road West
Ottawa, Ontario, CANADA, K2H 9C1
Tel: +1.613.829.2772 – Fax: +1.613.829.4921
Email: info@brightwelltech.com

## Published Works

The following represent a subset of publications involving MFI™ technology. Please contact Brightwell Technologies if you would like copies or more information on any of these reports.

**An Investigation of UV Disinfection Performance Under the Influence of Turbidity and Particulates for Drinking Water Applications**, *Guo Lui, Masters Thesis, University of Waterloo, 2005*

**A Closer Look at Filter Effluent Particles Using Image-Based Particle Analysis**. *E. Phillipi, G. Harrington, B. Lau, S. Russell, D. Thomas. Water Quality Technology Conference, Nov 2005*

**Use of Microscopic Fluid Imaging for Identification and Quantification of Organisms in Water**. *J. Clancy, R. McCuin. Water Quality Technology Conference, Nov 2005*

**Application of anaerobic membrane bioreactor to treat low strength wastewater using non-woven fabric filter and poly-tetrafluoroethylene (PTFE) composite membrane**. *Jaeho, H., Khanal, S. K., and Sung, S., WEFTEC 78th Annual Conference & Exposition, Oct. 29-Nov. 2, 2005*

**Technologies and Techniques for Early Warning Systems to Monitor and Evaluate Drinking Water Quality: A State-of-the-Art Review**, *United States EPA, EPA/600/R-05/156, Aug. 25, 2005*

**Feasibility study of non-woven filter and poly-tetrafluoroethylene (PTFE) composite membrane for anaerobic treatment of low strength wastewater**. *Ho, J. H., Khanal, S. K., and Sung, S., Proceedings of 1st IWA-ASPIRE (Asia Pacific Regional Group) Conference & Exhibition, Jul. 10-15, 2005*

**Application of Automatic Micro-Flow Imaging™ to Pathogen Detection and Ennumeration**. *D. Thomas, J. Clancy, R. McCuin, T. Matias. Ontario Water Works Association Conference, May 2005.*

**Dynamic Particle Analysis: A New Technology For Optimizing Particle Removal In A Water Treatment Plant**. *I. Douglas, D. Thomas, J. Guthmann, S. Russell, S. Springthorpe. Water Quality Technology Conference, Nov. 2004*

**Water Treatment Plant Particle Characterization Using Digital Imaging Technology**. *P. Moore, D. Thomas. Canadian Water Works Association Annual Conference, Apr 2004*

**Particle Characterization Using Dynamic Digital Image Analysis**. *P. Moore, D. Thomas. Water Quality Technology Conference, Nov 2003*

**Dynamic Digital Image Analysis: Emerging Technology for Particle Characterization**. *G. Rabinski, D. Thomas. International Water Association, Sept. 2003*

**Beyond Turbidity – A Quantifiable Analysis of Solids in Drinking Water**. *G. Rabinski, D. King. ICWH, Sept 2002*

## Summary

As more utilities explore UV disinfection for drinking water applications, instrumentation which can assist in validating reactor performance by characterizing source water particle populations and assessing the impacts of different pretreatment/irradiation protocols will be increasingly important. MFI™ offers a new level of understanding of the behavior and affects of particles and particle populations for UV applications.