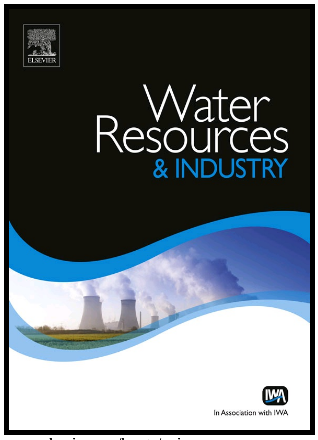
Author's Accepted Manuscript



www.elsevier.com/locate/wri

In-plant real-time manufacturing water content characterisation

D. Patrick Webb, George Skouteris, Shahin Rahimifard

PII: S2212-3717(18)30039-8
DOI: https://doi.org/10.1016/j.wri.2018.08.003
Reference: WRI99

To appear in: *Water Resources and Industry*

Received date: 27 April 2018
Revised date: 20 July 2018
Accepted date: 27 August 2018

Cite this article as: D. Patrick Webb, George Skouteris and Shahin Rahimifard, In-plant real-time manufacturing water content characterisation, *Water Resources and Industry,* https://doi.org/10.1016/j.wri.2018.08.003

In-plant real-time manufacturing water content characterisation

D. Patrick Webb, George Skouteris*, Shahin Rahimifard

Centre for SMART, Wolfson School of Mechanical and Manufacturing Engineering, Loughborough University, Leicestershire, LE11 3TU, UK

d.p.webb@lboro.ac.uk

g.s.skouteris@lboro.ac.uk

s.rahimifard@lboro.ac.uk

*Corresponding Author: g.s.skouteris@lboro.ac.uk

To trial the concept of in-plant real-time manufacturing water content characterisation, a commercial optical system for measuring light absorption and backscatter intensity was used with samples of food industry wastewater, and the results compared with conventional laboratory based water analysis. It is shown that the instrumentation is capable of coping with the range of turbidities presented by the wastewater and that there is some correlation between the absorption and backscatter measurements with the conventional parameters COD and TSS. It is suggested that combining backscatter and absorption data may provide an optical fingerprint of effluent that can be used as a management parameter, for example to identify unexpected contamination events. Potential uses of the instrumentation are discussed, including to provide rapid feedback on effects of system changes on effluent production, and in a feedback control loop to allow reuse of water without compromising product safety.

Keywords: industrial water sustainability; food industry; water quality; in-line instrumentation; turbidity; optical fingerprint

1 Introduction

The pressure on fresh water availability for human use is exacerbated by the changing climate and increasing population, particularly where this results in a mismatch between water demand and availability on a local scale. This is because water is not easily transportable in large volume, and, unlike energy, there are no sustainable large-scale new sources. For example the energy cost of distillation of saline water is prohibitively high at 2-4 kWh per cubic metre (Raluy, Serra and Uche, 2006). In high income countries industry is the majority user of limited water supplies (see Figure 1) (Gleick, 2003). As the economies of mid to low income countries develop, this pattern is likely to be reproduced. Thus with significant growth in global manufacturing activities, manufacturing water consumption is set to increase by a factor of more than 5 by 2050, over a year 2000 baseline, from 245 to 1552 billion m^3 (OECD, 2015), and it has been estimated that global demand for fresh water by 2030 will be 40% above current water supplies (Addams *et al.*, 2009). Therefore, the lack of freshwater supply is predicated to act as a restriction on sustainable economic development and improvement in living standards. Simultaneously disposal of industrial wastewater is becoming increasingly costly due to tightened legislation, for example the European Directives on a European Water Policy Framework (European Community, 2000) and on Integrated Pollution Prevention and Control (European Community, 2008).

Against this background use of water has become an important part of commercial sustainability strategies, along with use of energy and materials. Water management measures were classified by Puigjaner et al. (Puigjaner, Espuña and Almató, 2000) into reactive (which they termed Specific Actions') and proactive (which they termed 'General Methodologies'). Low risk, low cost reactive measures involving little change to process or product are generally the first port of call for manufacturing companies seeking to improve their water profile. Examples include automatic taps in employee facilities, use of grey water hygiene processes such as vehicle washing, and detection and reduction of leaks. However proactive measures involving more fundamental changes are essential for long-term gains, see for example Seneviratne (Seneviratne, 2006). More generally, a radical