

Batch test for measurement of readily biodegradable COD and active organism concentrations in municipal waste waters

MC Wentzel*, A Mbewe and GA Ekama

Department of Civil Engineering, University of Cape Town, Rondebosch 7700, South Africa

Abstract

In terms of the current mathematical models for activated sludge systems, it is necessary to categorise the influent COD into five fractions: unbiodegradable soluble and particulate, readily and slowly biodegradable, and heterotroph active biomass. Methods available to quantify these fractions are complex and time-consuming or require activated sludge seed acclimated to the waste water which may not be available. The results of this study present a batch test procedure to quantify two of the influent COD fractions - readily biodegradable COD (RBCOD) and heterotroph active biomass. The batch test method is relatively simple and requires neither acclimated activated sludge seed nor independent determination of unbiodegradable COD. For RBCOD concentrations, results from the batch test correlate closely with those from conventional methods.

Introduction

The objectives of the activated sludge system have expanded to include progressively COD removal, nitrification, denitrification and biological excess P removal (BEPR). Concomitantly, to provide reliable predictions of expected system performances, mathematical models of increasing complexity have been proposed (Dold et al., 1980; Van Haandel et al., 1981; Henze et al., 1987; Dold et al., 1991; Wentzel et al., 1992). In terms of the framework of these models, it is necessary to divide the influent COD into a number of fractions. The currently accepted division of the influent COD is depicted in Fig. 1. The COD of municipal waste waters is divided into three main fractions, viz. unbiodegradable, biodegradable and heterotroph active biomass. The unbiodegradable COD has two subfractions, unbiodegradable particulate and unbiodegradable soluble. The biodegradable COD also has two subfractions, slowly biodegradable (SBCOD) and readily biodegradable (RBCOD); this latter subdivision is based wholly on the dynamic response observed in activated sludge systems (Dold et al., 1980), that is, the division is a biokinetic one **not** a physical separation. Thus, for complete characterisation of a municipal waste water, the five COD fractions need to be quantified.

In this paper a simple experimental procedure is presented to quantify two influent COD fractions - RBCOD and heterotroph active biomass.

Background

Measurement of RBCOD

The RBCOD has been identified as being of fundamental importance in design and operation of N (Van Haandel et al., 1982) and N and P (Siebritz et al., 1983; Wentzel et al., 1990; Pitman, 1991) removal systems; the magnitudes of both N and P removal have been linked to the magnitude of the influent RBCOD.

Various methods have been proposed for measurement of RBCOD. These can be categorised as physical or bioassay methods.

*To whom all correspondence should be addressed.

(021)650-2583; 0(021) 650-2603; e-mail markw@cerecam.uct.ac.za

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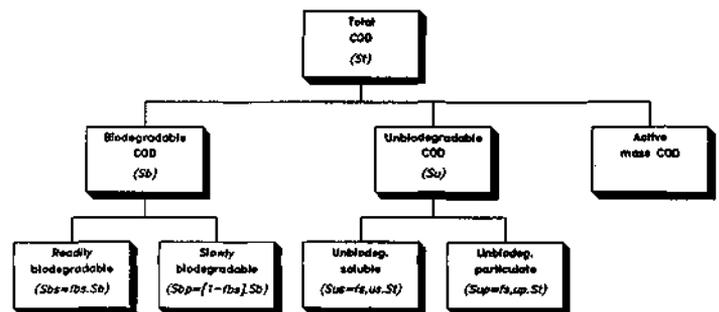


Figure 1

Division of influent COD into its constituent fractions (Dold et al., 1991)

Physical methods: It has been hypothesised that the difference in biokinetic response of activated sludge to RBCOD and SBCOD is due to differences in molecule size - RBCOD consists of relatively small molecules that are readily transported into microbial cells whereas SBCOD comprises larger and more complex molecules that require extracellular breakdown (hydrolysis) to smaller units before uptake and utilisation (Dold et al., 1980; Dold et al., 1986). Accordingly, physical separation of the two biodegradable COD fractions on the basis of molecular size has been proposed as an approximation of the biokinetic division. For physical separation, filtration methods with various filter pore sizes have been used (e.g. Dold et al., 1986; Lesouef et al., 1992; Mamais et al., 1993; Bortone et al., 1993; Torrijos et al., 1993). In evaluating the effect of pore size, Dold et al. (1986) found that for domestic waste water, membranes with cut-off < 10 000 molecular mass gave RBCOD that closely correlated with those determined by the conventional bioassay methods. In contrast, Bortone et al. (1993) found that with an industrial (textile) waste water, membranes with cut-off < 10 000 molecular mass gave RBCOD very much lower (13% of total COD) than that measured in bioassay batch tests (20% of total COD). Recognising that facilities for this type of ultrafiltration were not widely available, Dold et al. (1980) evaluated 0.45 μ m filters and found that with domestic waste water a fraction of the SBCOD passed