Full-scale implementation of external nitrification biological nutrient removal at the Daspoort Waste Water Treatment Works

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Abstract

In the external nitrification (EN) biological nutrient removal (BNR) activated sludge (AS) system, the nitrification process is removed from the main BNRAS system to a fixed media system external to the AS system (Hu et al., 2003). The ENBNRAS system provides considerable advantages over the conventional BNRAS system, e.g. reduced bioreactor volumes, secondary settling tank surface area and oxygen demand. Further, the ENBNRAS system provides opportunity for substantial system intensification. The performance and characterization of the ENBNRAS system has been successfully demonstrated at lab-scale (Hu et al., 2000, Sötemann et al., 2002), but has not yet been tested in full-scale implementation. In collaboration between the City of Tshwane Metropolitan Municipality (CTMM) and the University of Cape Town, ENBNR activated sludge is being implemented at full-scale at the Daspoort Waste Water Treatment Works (DWWTW) in Central Pretoria, South Africa. This paper describes the preliminary design of this full-scale plant and initial implementation.

Introduction

In the external nitrification (EN) biological nutrient removal (BNR) activated sludge (AS) system, the nitrification process is removed from the main BNRAS system to a fixed media system external to the AS system (Hu et al., 2003). This resolves the two main constraints of conventional BNRAS systems, i.e. the long sludge age requirement for nitrification and the difficulty in achieving near complete nitrogen removal. Specifically, the sludge age of the system can successfully be reduced from typically 20–25 days in conventional BNRAS systems to 8–10 days in the ENBNRAS system, resulting in a 30% reduction in the activated sludge system volume required (Hu et al., 2000). Additionally, the aerobic mass fraction can be reduced from 50–60%, to less than 30% in the ENBNRAS system, and, concomitantly, the anoxic mass fraction can be increased from 25–35% to 55% (anaerobic mass fraction of 15%). The increase in anoxic mass fraction, together with the fact that nitrification precedes denitrification in the system layout, enables the possibility of near complete denitrification. Moving nitrification to the fixed media system and the increased denitrification significantly reduce (by 2/3rds) the oxygen requirements in the ENBNRAS system compared to the conventional BNRAS system. Further, the ENBNRAS system requires significantly reduced secondary settling tank surface area due to likely amelioration of anoxic-aerobic (AA, or low F/M) filamentous bulking (Casey et al., 1994). Thus, the ENBNRAS system provides opportunity for substantial system intensification. The performance and characterization of the ENBNRAS system has been successfully demonstrated at lab-scale (Hu et al., 2000, Sötemann et al., 2002), but has not yet been tested in full-scale implementation. In collaboration between the City of Tshwane Metropolitan Municipality (CTMM) and the University of Cape Town, ENBNR activated sludge is being implemented at full-scale at the Daspoort Waste Water Treatment Works (DWWTW) in Central Pretoria, South Africa.

This paper describes the design and initial implementation of full-scale external nitrification biological nutrient removal (ENBNR) activated sludge at the Daspoort Waste Water Treatment Works (DWWTW) operated by the City of Tshwane Metropolitan Municipality (CTMM) in Central Pretoria, South Africa. It presents a general description of the DWWTW, an overview of the main elements in the initial evaluation of DWWTW as a candidate site for EN implementation, and a summary of current performance of the EN system at DWWTW.

Daspoort Waste Water Treatment Works plant description

A detailed description of the Daspoort Waste Water Treatment Works (DWWTW) prior to implementation of the ENBNR activated sludge system is presented by WMB and Bigen Africa (2000). In brief, the DWWTW is located on the southern banks of the Apies River on the north-western edge of the Pretoria Central Business District (CBD). Wastewater from the Central Pretoria area is collected in a main outfall sewer that runs alongside the Apies River past the DWWTW to the Rooiwal Waste Water Treatment Works (RWWTW). The DWWTW abstracts raw wastewater from this outfall sewer at two points, to be treated in its older "Eastern" Works, and newer "Western" Works respectively. The influent flows drawn from both locations are controlled by automatic sluice gates maintaining an approximately constant influent flowrate to DWWTW.

The influent wastewater to both Works at DWWTW undergo mechanical screening, grit removal and primary settling in Dort-

This paper was originally presented at the 2004 Water Institute of South Africa (WISA) Biennial Conference, Cape Town, South Africa, 2-6 May 2004.

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