

Filament identification and dominance of Eikelboom Type 0092 in activated sludge from wastewater treatment facilities in Cape Town, South Africa

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ABSTRACT

Routine characterisation of activated sludge and identification of the filamentous population by microscopic and/or other non-culture dependent techniques can assist in diagnosing the aetiology of poor performance of wastewater treatment works (WWTWs). In South Africa, most facilities rely solely on physicochemical indicators, treating reactors as 'black-boxes', with the result that process adjustments are often delayed, to the detriment of the environment. This study was performed in order to gain insight into the filamentous population found in activated sludge in Cape Town WWTWs, to compare these with other global and local literature findings, and to build capacity in this science. Physicochemical and plant performance parameters, in terms of nutrient removal and settling, were obtained from routine operational data and assessed in conjunction with the microscopic analyses of activated sludge samples taken over a 6-month period. Hypotheses on the links between filament types and/or plant configurations and/or operational parameters were formulated using existing literature. In order of prevalence, the five most common dominant filament species in 96 activated sludge samples were: Eikelboom Type 0092, Eikelboom Type 1851, nocardioforms, *Microthrix parvicella* and Eikelboom Type 021N. In order to compile a statistically significant database, it is recommended that an extensive nationwide study is conducted to link filament types with plant configurations, operational parameters and geographical locations.

Keywords: activated sludge, bulking, identification, filament, Type 0092

INTRODUCTION

The successful treatment of wastewater is reliant on the continued presence of a robust microbial consortium. In activated sludge systems, a variety of bacteria grow in filamentous forms that may or may not form part of the floc structure (Eikelboom, 2000; Jenkins et al., 2004). Some filament types form bridges between flocs or have hydrophobic cell walls that hamper floc settling and cause sludge bulking and/or foaming. Particular process conditions are strongly associated with the proliferation of 'bulking' filament types (Eikelboom, 2000; Jenkins et al., 2004; Lakay et al., 1999).

Most municipalities in South Africa, including the City of Cape Town, treat activated sludge reactors as 'black-boxes' and rely on chemical indicators of system health. Performance problems are thus usually addressed in a reactive and not a proactive manner. Microscopic analysis of activated sludge is a simple, cost-effective procedure that can add value to the arsenal of tests currently performed at laboratories affiliated to WWTWs. At present, expertise in filament identification is only available at the East Rand Water Care company (ERWAT),

and the Institute for Water and Wastewater Technology at Durban University of Technology (DUT). At DUT, ongoing research is being conducted using non-microscopic methods of filament identification.

In a global context, there has been considerable progress in the quest towards accurately identifying the filamentous populations in activated sludge by culture-dependent and culture-independent methodologies (Aruga et al., 2002; Ramothokang, 2003; Yoon et al., 2010). The latter include fluorescent in-situ hybridisation (FISH) with probes targeting the 16S rRNA gene (e.g. Spiers et al., 2009, 2011; Yoon et al., 2010); high throughput pyrosequencing of the 16S rRNA gene (e.g. Guo and Zhang, 2012; Marrengane et al., 2011); compilation of clone libraries (e.g. Yoon et al., 2010), and excision and sequencing of bands obtained from denaturing gradient gel electrophoresis (DGGE) (e.g. Gulez et al., 2009). The application of these methods has resulted in the identification of many morphological filament types, originally characterised using microscopy, to phylum and/or genus and/or species levels. FISH is the most simple and suitable of these technologies for routine use, with many probes being commercially available (Martins et al., 2003; Nielsen et al., 2009). An added advantage of FISH is that it can be used to identify non-filamentous species, including nitrifiers, and phosphorus- and glycogen-accumulating organisms (Eschenhagen et al., 2003). However, the specificity of FISH probes may result in exclusion of particular filaments due to mismatches (Liu and Seviour, 2001). In addition, each filament type requires at least one probe, with more than one probe often being needed for a single morphotype, making the method too expensive and time-consuming for routine use in the South African context.

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