

Survey of filamentous bacteria in activated sludge plants in KwaZulu-Natal

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Abstract

The objective of this investigation was to conduct a survey of filamentous bacteria present in activated sludge plants in Durban and surrounding areas (KwaZulu-Natal, South Africa). A diverse population of filamentous bacteria was identified. Dominant filamentous bacteria identified from mixed liquor samples in descending order of frequency included: (1) *Nocardia* spp., (2) Type 0041, (3) Type 0675, (4) Type 1851, (5) Type 021N, (6) *Nosticola limicola II*, (7) *Sphaerotilus natans*, (8) *Thiothrix I* and *II* and (9) *Beggiatoa*. *Nocardia* spp. were the only dominant filamentous bacteria present in foam samples, while Type 0914, *Microthrix parvicella* and *Sphaerotilus natans* occurred incidentally. All filamentous bacteria identified were present throughout the year. *Nocardia* spp. and *Microthrix parvicella* were found to be dominant during winter months. It can be concluded that filamentous populations are significantly affected by seasonal and influent variations.

Introduction

Activated sludge comprises a diverse population of micro-organisms which include eubacteria, filamentous bacteria, rotifers, protozoa and algae (Jenkins et al., 1984). In order for the activated sludge process to operate successfully, it is essential that the resident microflora form flocs which settle out readily, thereby producing a clear effluent with a low suspended solids concentration (Curds and Hawkes, 1983). Filamentous bacteria form the floc macrostructure that facilitates adhesion to floc forming bacteria. Most activated sludge plants around the world suffer from bulking and/or foaming, operational disorders caused by the proliferation of certain filamentous bacteria. Foaming is a well-recognised problem originally thought to be caused by *Nocardia amarae* (Lechavalier and Lechavalier, 1975; Pipes, 1978). However, more recent surveys in South Africa (Blackbeard et al., 1986) and Europe (Lemmer and Kroppenstadt, 1984; Goddard and Forster, 1987) have identified a wider range of filamentous bacteria in foam samples. These include other Nocardioforms, *Microthrix parvicella* and several Eikelboom morphological types (Eikelboom, 1975). In a study conducted by Blackbeard et al. (1988) on filamentous bulking in 33 South African nutrient removal plants, approximately eight plants experienced such problems. The five most frequently dominant filamentous organisms isolated from mixed liquor samples during the study included: Type 0092, dominant in 82% of plants, Type 0675 in 45%, Type 0041 in 39%, *M. parvicella* and Type 0914, both in 33%.

These five filamentous organisms were also the most frequently dominant in foam samples in 18 of the plants (Blackbeard et al., 1988). Type 0092 had the highest frequency of dominance in foam at 78%, followed by *M. parvicella* in 50%, Type 0041 in 33%, and Types 0675 and 0914 in 22% each. Only *M. parvicella* and *Nocardia* spp. and Type 0092 were found to accumulate in foam selectively (Blackbeard et al., 1988).

Domestic and industrial activated sludge plants in South Africa have been extensively studied yet little quantitative infor-

mation describing filamentous populations has been communicated. KwaZulu-Natal wastewater treatment installations have received scant attention regarding their filamentous populations, resulting in the need for this study to be conducted. The objectives of this study were therefore to:

- identify filamentous bacteria from mixed liquor and foam;
- determine the effect of seasonal variations on filamentous bacteria; and
- determine the frequency of dominance and occurrence of the various filamentous bacteria identified.

Materials and method

Sample collection and handling

Grab samples of mixed liquor (1 000 ml) and foam (250 ml) were collected in sterile bottles from aeration tanks at the following nutrient removal activated sludge systems: Amanzimtoti, Northern Works, Kwa-Mashu, Umbilo, Darvill and Hammarsdale. The plants were sampled on a fortnightly basis from May through to October. Samples were stored at 4°C and microscopically analysed within 24 h of collection. Triplicate samples of 100 ml liquid sludge were dried overnight at 105°C on pre-weighed filter paper to determine the mixed liquor suspended solids concentration.

Identification techniques for filamentous bacteria

Activated sludge wet mounts and smears were prepared for examination (triplicate). Wet mounts were studied under direct illumination at 1000x magnification to determine morphological characteristics of various filaments. Smears were stained using Gram and Neisser staining techniques. Stained smears were examined under oil immersion and direct illumination at 1000x magnification. The individual abundance level of each filament was determined using the scoring technique outlined by Jenkins et al. (1984). Each filament was scored on a scale between 0 and 6 (integer scores had the following meanings: 0 = none; 1 = few; 2 = some; 3 = common; 4 = very common; 5 = abundant; and 6 = excessive). The system rated filament abundance on an average "per floc" basis. Filamentous bacteria with individual abundance

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