

Filamentous organism bulking in nutrient removal activated sludge systems

Paper 7: Exploratory experimental investigations

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Abstract

This paper describes an experimental investigation into the causes of proliferation of low F/M filaments in activated sludge system configurations which expose the mixed liquor to alternating anoxic-aerobic conditions. Using laboratory-scale anoxic-aerobic systems fed defined artificial substrate or municipal sewage, a combination of conditions is identified which results in low F/M filament proliferation; i.e. exposure of sludge to alternating anoxic-aerobic conditions with slowly biodegradable COD (SBCOD) present under both anoxic and aerobic conditions, with an aerobic mass fraction of 30 to 40% of the total, and nitrite (NO_2^-) present at a concentration greater than about 1.0 mgN/l when conditions change from anoxic to aerobic.

List of symbols

a	=	anoxic-aerobic recycle ratio
AOOs	=	ammonia oxidising organisms
COD	=	chemical oxygen demand
DO	=	dissolved oxygen
DSVI	=	diluted sludge volume index
E_h	=	reduction-oxidation (redox) potential
F/M	=	food to micro-organism ratio
FID	=	filament identification
IAND	=	intermittently aerated nitrification-denitrification
IAWQ	=	International Association for Water Quality
MLE	=	modified Ludzack-Ettinger
MLSS	=	mixed liquor suspended solids
MUCT	=	modified University of Cape Town
mV	=	millivolts
NDBEPR	=	nitrification-denitrification biological excess phosphorus removal
NO_x^-	=	combined nitrate and nitrite concentration
NOOs	=	nitrite oxidising organisms
RBCOD	=	readily biodegradable COD
s	=	underflow recycle ratio (Q_r/Q_i)
SBCOD	=	slowly biodegradable COD
t	=	time
TKN	=	total Kjeldahl nitrogen
UCT	=	University of Cape Town
VSS	=	volatile suspended solids

Introduction

In the majority of countries in which sludge settleability in activated sludge systems is sufficiently poor to affect plant performance, application of selector reactor technology has become the promoted method for control of filament proliferation (Pujol and Canler, 1994; Kruit et al., 1994; Eikelboom, 1994). However, in

the preceding papers in this series, it was concluded that induction of the selector effect, either through the application of selector reactors (whether anaerobic, anoxic or aerobic) or via intermittent feeding (sequencing batch reactors) does not control low F/M filaments in intermittent aeration systems (such as Carousel and Orbal type plants) for biological nitrogen (N) removal, or in multi-reactor anaerobic-anoxic-aerobic systems (such as UCT and Bardenpho systems) for biological N and phosphorus (P) removal. These findings placed research in the field back into an exploratory stage and consequently a new research direction needed to be established. In this regard a wide ranging experimental programme was initiated, the main emphasis of which was to investigate aspects identified by Ekama et al. (1996a) as possibly having an influence on proliferation of low F/M filamentous organisms. These aspects were examined and are described in this paper under six sections as follows:

- RBCOD or SBCOD as influent substrate.
- RBCOD as substrate under aerobic and anoxic conditions.
- Continuous aerobic and continuous anoxic conditions.
- Magnitude of the aerobic mass fraction in anoxic-aerobic systems.
- Sludge age.
- Differences between alternating anoxic-aerobic nitrification-denitrification (ND) conditions caused by intermittent aeration in a single reactor (IAND) configuration, or by separate anoxic-aerobic reactors in a 2-reactor (2RND) configuration, i.e.:
 - frequency of alternation between anoxic and aerobic conditions;
 - availability of the RBCOD and SBCOD fractions of the influent under aerobic and anoxic conditions;
 - DO concentration in the aerobic period or reactor;
 - $\text{NO}_3^-/\text{NO}_2^-$ concentrations in the anoxic period or reactor.

This paper summarises the key features of the experimental investigation into the six aspects listed above. For a detailed description of the research the reader is referred to Casey et al. (1994a, b); Hulsman et al. (1992); Ketley et al. (1991); Warburton et al. (1991); De Villiers et al. (1994).

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