Filamentous organism bulking in nutrient removal activated sludge systems. Paper 5: Experimental examination of aerobic selectors in anoxic-aerobic systems

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Abstract

Incorporation of correctly sized selector reactors at the head of an intermittently aerated (70% anoxic, 30% aerobic) system did not control the proliferation of low food to micro-organism ratio (F/M) filaments, viz. *Micrathrixparvkella,* type 0092 and type 0914, even though the criteria indicating the induction of a selector effect had been met, i.e.:

- removal of essentially all the influent readily biodegradable chemical oxygen demand (RBCOD);
- the presence of a significant number of *Zooglea* colonies; and
- a high initial oxygen utilisation rate (OUR) and RBCOD uptake rate under batch test conditions.

List of symbols

COD	=	chemical oxygen demand
CFCM	=	continuously fed completely mixed
d	=	day
DO	=	dissolved oxygen
DSVI	=	diluted sludge volume index
F/M	=	food to micro-organism ratio
f_{ts}	=	fraction of the total influent COD (S_{ti}) that is readily biodegradable (S_{bsi})
h	=	hour
IAND	=	intermittent aeration nitrification-denitrification
1FFD	=	intermittently fed fill and draw
LF	=	load factor (mg COD/g VSS)
min	=	minute
MLSS	=	mixed liquor suspended solids
MLVSS	=	mixed liquor volatile suspended solids
N	=	nitrogen
OUR	=	oxygen utilisation rate in mg O/(/-h) or mg O/(g AVSS-h)
P	=	phosphorus
RBCOD	=	readily biodegradable COD
RBCODUR	=	RBCOD utilisation rate [mg RBCOD/(g AVSS-h)]
TKN	=	total Kjeldahl nitrogen
VSS	=	volatile suspended solids
μm	=	micro (10^{-6}) meters

Introduction

Up to this point in the investigation it has not been possible to come to a definitive conclusion regarding the efficacy of selectors (aerobic or anoxic) in controlling bulking by low F/M filaments because it has not been possible to develop sludges with high proportions of low F/M filaments in laboratory-scale systems other than N & P removal ones. However, in Gabb et al. (1996) a system configuration and operating conditions were described which induce in laboratory-scale systems the proliferation of the tow F/M filaments most common in South African full-scale systems (i.e. types 0092, 0914, *Microthrix parvicetta*, type 1851, type 0675 and type 0041). The configuration and conditions are CFCM single-reactor systems operated with intermittent aeration with 30% aerated and 70% unaerated. These systems, called IAND systems, provide an opportunity to test the effect of selector reactors on low F/M filament proliferation in laboratory-scale systems.

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Experimental set-up

Two systems were set up, both IAND with volume 7.*5l*, receiving a constant 10l/d influent flow of Mitchell's Plain raw sewage with a mean COD of 500 *mg/l.* The systems were operated at a sludge age of 20 d and temperature 21 °C with an aeration pattern to induce aerobic conditions for 3 to 4 min and an anoxic state for 6 to 7 min in a 10 min cycle. This set-up was the same as that in the IAND systems described by Gabb et al. (1996). The design and operating parameters are given in Table 1. For further details see Gabb et al. (1989).

To start up the systems, the two sludges from the IAND systems described by Gabb et al. (1996) (experimental and control) were mixed and divided equally between the two systems. The initial DSVIs in both systems were 190 ml/*g* (Fig. I). The two systems were operated for 130 d. The day-to-day performance of the two systems i.e. influent and effluent COD, total phosphorus (as P), nitrate (as N) and TKN concentrations, is shown in Fig. 2. Also the DSVI was measured daily and microscopic evaluation of the sludge undertaken regularly, i.e. every 20 d (1 sludge age) (Fig. 1). In operation, nitrification was virtually complete, and to ensure that sufficient nitrate was present so that the systems remained anoxic throughout the unaerated periods, ammonia was added to the influent to give an average TKN of 60 to 100 *mgN/l* (see Fig. 2). Test methods were conducted in accordance with the procedures as set out in Still et al. (1996) and Gabb et al. (1996).

After 21 d of operation, the DSVI in both systems had increased from 190 to 340 ml/*g* (Fig. 1). On day 21, two 250 *ml* aerated