Filamentous organism bulking in nutrient removal activated sludge systems. Paper 3: Stimulation of the selector effect under anoxic conditions

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Abstract

Intermittently fed, fill and draw (IFFD) systems and continuously fed completely mixed (CFCM) systems, both having anoxic/aerobic mass fractions of *25* and 76% respectively, did not develop low F/M filament bulking sludges. Although the IFFD conditions induced a selector effect it could not be concluded thai the selector effect controlled low F/M filament bulking in the system because the CFCM system, which did not induce a selector effect, also did not bulk. The selector effect induced in the IFFD system controlled *Sphaerotilus natans* proliferation, but this filament is not found in South African full-scale activated sludge plants. From anoxic balch tests a design procedure for anoxic selectors, fully integrated into current activated kinetic models, is presented. Because the low F/M Filaments prevalent in full-scale N and N & P removal plants did not develop in the laboratory-scale systems, no conclusion can be made regarding the role of selectors fanoxic or aerobic) in control of these filaments.

List of symbols

a = mixed liquor recycle ratio from the aerobic to the primary anoxic reactor with respect to Q_{iADWF}

a_{opt} = a-recycle ratio that loads the primary anoxic reactor to its denitrification potential

ADWF = average dry weather flow

AVSS = active heterotrophic organism VSS concentration (mg AVSS/l)

b_H = heterotrophic organism endogenous respiration rate (/d)

= 0.24/d at 20°C

BT = batch test

CFCM = continuously fed completely mixed

COD = chemical oxygen demand

d = day

DO = dissolved oxygen (mg *O/l)*

D_p = denitrification potential - concentration of nitrate that can be biologically denitrified in an anoxic reactor (mg N/*l* influent)

D_{ps} = denitrification potential of anoxic selector (mg N/l influent)

DSVI = diluted sludge volume index

f_{av} = fraction of VSS mass that is active organisms

f_{bs} = influent RBCOD fraction with respect to the biodegradable COD

f_{xl} = primary anoxic sludge mass fraction

f_{xlmin} = minimum f_{xi} to ensure that all the influent RBCOD is utilised

f_{cv} = COD/VSS ratio of the sludge mass synthesised

F/M = food to micro-organism ratio

f_{ts} = fraction of the total influent COD (S_{ti}) that is readily biodegradable (S_{bsi})

f_{xv} = selector sludge mass fraction, i.e. traction of the mass of VSS in the system that is in the selector reactor(s)

h = hour

IAWQ = International Association for Water Quality

IFFD = intermittently fed fill and draw

K, = initial rapid rate of denitrification in the primary anoxic reactor utilising RBCOD in mg NO3-N/ (mgAVSS-d)

K_2 = second slower rate of denitrification in the anoxic reactor utilising SBCOD in mg NO_3-N/(mgAVSS-d)

K_{ms} = maximum specific substrate utilisation rate [mg COD/(mg AVSS-d)]

L_r = peak to average COD load ratio under dry weather conditions

min = minute

M = symbol denoting mass of compound following it, i.e. MS_{ti} = mass of COD load per day = $Q_i.S_{ti}$; MX_v = mass of VSS in biological reactor = V_pX_v

MLE = modified Ludzack-Ettinger N removal system

MLSS = mixed liquor suspended solids

MLVSS = mixed liquor volatile suspended solids

mV = millivolts

N = nitrogen

N_c = nitrification capacity - concentration nitrate generated by nitrification (mg *N/l* influent)

NUR = nitrate utilisation rate as mg NO_3^--N/(l.h) or mg NO_3-N/(g AVSS-h)

OUR = oxygen utilisation rate in mg O/(l.-h) or mg *O/l* AVSS-h)
Subscripts RBCOD and SECOD denote the OUR for RBCOD and SBCOD utilisation respectively. Subscript Het is the heterotrophic OUR Which is the sum of OUR_{RBCOD} and OUR_{SBCOD}

p = phosphorus

PDWF = peak dry weather flow

Q_i = influent flow *(L/d)*

Q, = underflow rate *(lid)*

RBCOD = readily biodegradable COD

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