Filamentous organism bulking in nutrient removal activated sludge systems. Paper 2: Stimulation of the selector effect under aerobic conditions

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Abstract

The Monod kinetic based selector theory for filamentous bulking control has guided research and application for the past two decades. This approach, which in its broadest sense recommends modification of system configuration or operation to introduce alternating feed starve conditions, is evaluated for control of the tow F/M filament group which are ubiquitous and cause most of the bulking problems in N and N & P removal systems, in agreement with the literature, it was found that this approach induces in me sludge a rapid uptake of influent readily biodegradable COD and oxygen under batch fed conditions (selector effect), but it could not be demonstrated that this controlled low F/M filament proliferation because the control systems without the selector effect also did not bulk with low F/M filaments. However, the selector effect did control *Sphaerotilus natans* and *Thiothrix* sp. proliferation, the former of which was found to grow in the laboratory systems as a result of seeding from influent feed line wall growths. Batch test results could be adequately interpreted with existing activated sludge kinetic models, and based on these, a design method for aerobic selectors is presented. A selector designed with this method is shown to induce a selector effect and control filaments *S, natans* and *Thiothrix* sp.

List of symbols

ADWF = average dry weather flow
ATV = Abwassertechnischen Vereinigung
b_H = heterotrophic organism endogenous respiration rate (/d)
= 0.24/d at 20°C
CFCM = continuously fed completely mixed
COD = chemical oxygen demand
d = day
DO = dissolved oxygen (mg O/l)
DSVI = diluted sludge volume index
DW = dry weather
f = endogenous residue fraction = 0.20
f_{av} = fraction of VSS mass that is active organisms
f_{cv} = COD/VSS ratio of the sludge mass synthesised
F/M = food to micro-organism ratio
f_s = fraction of the underflow recycled to the selector zone
f_{ts} = fraction of the total influent COD (S) that is readily biodegradable (S_{bsi})
f_{vs} = volume fraction of the selector reactor, i.e. the volume of the selector as a fraction of the total biological reactor volume including the selector
f_{xs} = selector sludge mass fraction, i.e. fraction 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_{OS} = maximum specific substrate utilisation rate [mg COD/(mg AVSS-d)]
K_s = half-saturation coefficient in the Monod equation *(mg/l)*
M_{ratio} = peak to average COD load ratio under dry weather conditions
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 = $V X_p$
MLSS = mixed liquor suspended solids
MLVSS = mixed liquor volatile suspended solids
N = nitrogen
OUR = oxygen utilisation rate in mg O/(lh) or mg O/(g AVSS-h). Subscripts RBCOD and SBCOD denote the OUR for RBCOD and SBCOD utilisation respectively. Subscript Het is the heterotrophic OUR which is the sum of O U R ,
p = phosphorus
PDWF = peak dry weather flow
Q_i = influent flow at ADWF *(l/d)*
Q_r = underflow rate *(l/d)*
RBCOD = readily biodegradable COD
R_s = sludge age (d)
s = underflow recycle ratio (Q/Q_i)
S = general symbol for COD concentration (mg COD/l). Subscripts b and t refer to biodegradable and total respectively and additional subscripts i and s refer to influent and soluble respectively
SBCOD = slowly biodegradable COD
S_{bs} = readily biodegradable COD concentration (mg COD/l)
Additional subscript i denotes influent
SEL = selector
t = time

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