

# Effect of solids retention time on *Microthrix parvicella* growth

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## Abstract

The objective of this study was to evaluate the effect of solids retention time (SRT) on *M. parvicella* growth and to calculate growth kinetic parameters of this filamentous species. Bench-scale continuous-flow experiments showed that *M. parvicella* growth can be significantly suppressed at an SRT of lower than 5.7 d for temperatures of between 14 and 18°C. According to the continuous-flow experiments the maximum sludge age for the avoidance of filamentous foaming problems caused by *M. parvicella* is 6 d for temperatures lower than 18°C. At this sludge age *M. parvicella* loses its hydrophobicity and therefore its foaming potential. However, even lower SRTs are required in order to achieve a significant suppression of its growth. At SRT values of less than 5.7 d *M. parvicella* initially forms a shorter filament (< 150 µm) with clear spaces inside filaments and variable Gram stain reaction and eventually is eliminated from activated sludge biocoenosis. According to kinetic studies presented in this paper, *M. parvicella* is a slow growing bacterium with a low maximum specific growth rate of 0.67 1/d and 0.53 1/d under aerobic and anoxic conditions respectively. Maintenance energy requirements of *M. parvicella* were found to be significantly lower than the maintenance energy of floc forming micro-organisms as well as other filamentous species, thus providing the micro-organism with a significant advantage under starvation conditions prevailing at the majority of the extended aeration activated sludge systems.

**Keywords:** bulking, filamentous micro-organisms, foaming, growth kinetics *Microthrix parvicella*, solids retention time (SRT)

## Nomenclature

BNR	biological nutrient removal
BNRA	experimental system
BNRB	experimental system
BNRC	control system
COD	chemical oxygen demand (mg COD/l)
DO	dissolved oxygen concentration (mg O <sub>2</sub> /l)
DSVI	dissolved sludge volume index (ml/g TSS)
f <sub>av</sub>	active fraction of the MLVSS
f <sub>cv</sub>	COD/VSS ratio of activated sludge (mg COD/mg VSS)
FI	filament index
K <sub>d</sub>	decay coefficient (1/d)
m	maintenance coefficient (mg COD/mg COD·d)
MLSS	mixed liquor suspended solids concentration (mg SS/l)
MSTW	Metamorphosis Sewage Treatment Works
NH <sub>4</sub> -N	ammonia nitrogen concentration (mg N/l)
NO <sub>3</sub> -N	nitrate nitrogen concentration (mg N/l)
NUR	nitrate – nitrogen uptake rate (mg NO <sub>3</sub> -N/ l·d)
NUR <sub>i</sub>	initial nitrate – nitrogen uptake rate (mg NO <sub>3</sub> -N/ l·d)
OUR	oxygen uptake rate (mg O <sub>2</sub> /l·d)
OUR <sub>i</sub>	initial oxygen uptake rate (mg O <sub>2</sub> /l·d)
P	total phosphorus concentration (mg P/l)
SFI	specific filament index
S <sub>o</sub>	initial substrate concentration (mg COD/l)
SRT	solids retention time (d)
TSS	concentration of total suspended solids (mg TSS/l)
[VSS]	concentration of volatile suspended solids (mg VSS/l)

VSS	volatile suspended solids (mg/l)
X <sub>o</sub>	initial biomass concentration (mg VSS/l)
X <sub>t</sub>	biomass concentration at time t (mg VSS/l)
Y <sub>H</sub>	yield coefficient of heterotrophic biomass (mg VSS/mg COD)
μ <sub>max</sub>	maximum specific growth rate (1/d)

## Introduction

*Microthrix parvicella* is the most common filamentous species responsible for bulking and foaming problems in biological nutrient removal systems. So far only a few studies on *M. parvicella* pure cultures have been reported (Slijkhuys 1983; Slijkhuys et al., 1984; Seviour et al., 1994; Blackall et al., 1996; Tandoi et al., 1998; Rossetti et al., 2002), due to difficulties in maintaining the micro-organism in culture.

Kinetic experiments on pure and mixed cultures indicate that *M. parvicella* is a slow-growing bacterium with a μ<sub>max</sub> rate of between 0.3 and 0.66 1/d (Slijkhuys, 1983; Slijkhuys et al., 1984; Tandoi et al., 1998; Rossetti et al., 2002), which is able to proliferate in BNR systems, especially when operated in the extended aeration mode.

Richard (1989) postulates that the operation of an activated sludge system at sludge ages of greater than 10 d promotes *M. parvicella* growth and thus stimulates filamentous bulking and/or foaming problems. Based on full- and laboratory-scale experiments Knoop and Kunst (1998) suggest that *M. parvicella* growth and occurrence of settling and foaming problems will appear at wastewater treatment plants operating at a sludge loading rate of less than 0.1 kgBOD<sub>5</sub>/kgSS·d and at low temperatures (<15°C). However, no systematic study on the effect of sludge age on *M. parvicella* is available, nor have the lower SRT limits of *M. parvicella* been determined. In view of the above, the objectives of this study were to:

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Received 31 January 2006; accepted in revised form 19 April 2006.