Bulking control with chlorination in a nutrient removal activated sludge system*

M T Lakay, M C Wentzel, G A Ekama*, and G v R Marais
Department of Civil Engineering, University of Cape Town, Rondebosch 7700, Cape Province, South Africa.

Abstract

This paper deals with control of bulking by chlorination in a laboratory-scale (15 l/d) biological nutrient removal system. Bulking was caused by filamentous organisms characteristic of nutrient removal systems, i.e. Type 0092, Microthrix parvicella and Type 0914. Over a continuous dosing period of 19 d, at 8 mgCl₂/gMLSS.d the diluted sludge volume index (DSVI) decreased from 230 to 48 ml/g. Nitritation-denitrification continued essentially unaffected. The biological P removal initially decreased from its normal 20 mgP/l (influent) to 14 mgP/l but recovered during chlorination to 19 mgP/l. Chlorination was terminated when overdosing became apparent and P removal declined precipitously to 12 mgP/l. After chlorination termination, biological P removal recovered to its normal 20 mgP/l in 5 d. Of the 3 filamentous organisms, Type 0914 was the most and M. parvicella the least susceptible to chlorination. Filamentous bulking in nutrient removal systems can be controlled by chlorination with a relatively minor loss of efficiency of biological N and P removal.

Introduction

Bulking, due to the growth of filamentous organisms, is a problem of considerable proportions in nutrient removal activated sludge plants - in a survey covering about three-quarters of these plants in South Africa, 75% had filament contents in the mixed liquor indicative of a bulking sludge, that is with diluted sludge volume index (DSVI) > 150 ml/g (Blackbeard et al., 1987). The five main causative filaments were identified to be Type 0092, dominant in 82% of plants, Type 0675 in 45%, Type 0041 in 39%, Microthrix parvicella in 33% and Type 0914 in 33%. Proliferation of these organisms in the mixed liquor causes the sludge settleability to deteriorate significantly to DSVTs of 250 ml/g or higher.

The sludge settleability sets upper limits on the maximum overflow rate and biological reactor concentration above which the secondary settling tank cannot achieve satisfactory solid/liquid separation - the poorer the settleability the lower these limits. In South Africa settling tanks are usually designed to comply with the Institute for Water Pollution Control (IWPC) (SA Branch) criterion of 1 m/h maximum permissible overflow rate at peak wet weather flow. This criterion is satisfactory for sludge settleabilities better than 150 ml/g DSVI (or 100 ml/g stirred specific volume index) and a reactor concentration of 3.5 gMLSS/l (Ekama and Marais, 1986).

As a plant approaches its design flow and COD load, the overflow rate and reactor concentration will be approaching the permissible limits. If the DSVI is greater than 150 ml/g, bulking problems are likely to commence, and the higher the DSVI above 150 ml/g the sooner these problems will be manifested. In the settling tank, bulking can cause excessive solids carry-over in the overflow and poor compactability of the sludge on the floor; the former leads to a poor effluent quality and the latter to large accumulations of solids in the settling tank which may lead to flotation of solids by denitrification and difficulties in achieving the required underflow concentrations, necessitating higher underflow recycles. Bulking also causes problems in the sludge handling operations by poorer thickening in the flotation (Bratby, 1977) or gravity thickening units and poorer dewaterability in belt presses and centrifuges (Osborn et al., 1986; Pitman, 1987).

Clearly, amelioration of bulking will greatly facilitate operation of the activated sludge system itself, and the subsequent sludge disposal systems.

- Two approaches can be adopted for bulking control
- non-specific; and
- specific

With non-specific bulking control, the filamentous organisms, irrespective of type, are eliminated by killing these with the addition of a toxicant such as chlorine or hydrogen peroxide. With specific bulking control, the causes for the growth of the dominant filament types need to be identified. Jenkins et al. (1984) have identified a number of causes, i.e. septic influent, low DO (dissolved oxygen) concentration in the aeration basin, nutrient deficiency and low F/M, each of which may stimulate the growth of a particular group of filaments. By appropriate modification of the influent, plant configuration and/or operation, the relevant causes may be removed resulting in a decline in the filament content of the sludge. A manual on the causes and control of filamentous bulking has been compiled by Jenkins et al. (1984).

Non-specific control measures like chlorination can be applied to deal with a crisis situation until a specific control measure can be implemented. Sporadic chlorination also can be a permanent solution for cases where no specific control measures have been developed yet or where it proves to be economical. When a bulking problem develops in a plant, usually it requires immediate attention and dosing a toxicant yields the most rapid results. However, it should be remembered that as soon as dosing ceases, very likely the filaments will regrow because the causes for their growth have not been eliminated. If specific control measures can be found and implemented, these may take a long time to bring about a decline in filament content (2 to 3 sludge ages); also, a considerable degree of experimentation may be required to optimise the measure. During this period excessive bulking may need to be controlled by chlorination. Moreover, the specific measures should be considered effective only if regrowth does not occur. A possible outcome may be that the specific measure(s) are only partially effective in which event the frequencies of chlorination at least can be reduced. Consequently chlorination is an important bulking control measure.

Non-specific and specific measures for bulking control in nutrient removal activated sludge systems are currently being investigated at the University of Cape Town. In this paper implementation of non-specific control measures by chlorination, in a laboratory-scale modified UCT system, is reported in some detail. On specific bulking control measures some progress has

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** To whom all correspondence should be addressed.
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