Filamentous organism bulking in nutrient removal activated sludge systems
Paper 1: A historical overview of causes and control

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Abstract

The presence of filamentous organisms in the activated sludge system has been problematic since early this century and has been noted in systems operating asaerobic or incorporating anoxic oranaerobic zones. Early attempts to control bulking in overtly aerobic systems were at best *ad hoc* measures, often based on anecdotal evidence and usually were unsuccessful. Non-specific control methods such as chlorination have been found successful but these do not remove the causes for bulking. Identification of problematic filament types and association of these with specific operating conditions and influent characteristics were the first important steps taken toward establishing specific methods of control. The kinetic selection approach, first proposed by Chudoba et al. (1973a; b) has provided a basis for developing strategies for specific bulking control in aerobic systems, most notably the selector reactor for control of bulking in low food to micro-organism (low F/M) systems. The development of Systems for the removal of nitrogen (N) and phosphorus (P) resulted in an increase in the occurrence of filament types not associated with bulking sludges in aerobic systems. The majority of these filaments have been categorised as low F/M types and therefore the kinetic selection approach was adopted as the starting point for developing specific control procedures for bulking in nutrient removal plants.

Introduction

This paper is the first in a series of 12 papers that summarise the work conducted by the Water Research Group at the University of Cape Town (UCT) over the past decade into the problem of low F/M (food/micro-organism ratio) filamentous organism bulking in nutrient removal activated sludge sewage treatment plants. A brief description of the 12 papers including this one is as follows:

Paper 1: A historical overview of causes and control.

Paper 2: Experimental examination of the rote of the "selector effect" in controlling low F/M filament bulking in aerobic systems and comparison with experimental work conducted by other research groups.

Paper 3: Experimental examination of the role of the anoxic zone in controlling low F/M filament bulking.

Paper 4: Determination of experimental conditions necessary for the development of low F/M filament bulking in laboratory-scale systems.

Paper 5: Experimentalexamination of aerobic selectors in anoxic-aerobic (N removal) systems.

Paper 6: Review, evaluation and consolidation of research into specific control of low F/M filaments to establish directions for further research.

Paper 7; Exploratory experimental investigation into the effect of various influent characteristics and operating parameters on low F/M filament proliferation.

Paper 8: An experimental programme to examine the role of nitrate and nitrite as electron acceptors in proliferation of low F/M filaments.

Paper 9: A review of the biochemistry and microbiology of facultative heterotrophic organisms.

Paper 10: A conceptual model for the microbiological and biochemical processes mediated by facultative heterotrophic organisms in activated sludge systems.

Paper 11: A conceptual model for the proliferation of low F/M filaments in systems incorporating sequential anoxic and aerobic conditions.

Paper 12: A review of international experience in application of selectors, and upgrading from aerobic to nutrient removal activated sludge systems.

Background

Since its development by Ardern and Lockett in 1914, the activated sludge system has gained increasing importance in the treatment of municipal waste waters. This is a consequence of its adaptability to variation in waste-water composition, high rates of removal of organic material and ability to remove the nutrients nitrogen (N) and phosphorus (P) to low levels without chemical addition.

Its initial development as an aerobic process was a consequence of its greater economy and surety of effluent quality than the trickling filter, especially with regard to nitrification. Significant developments in the activated sludge system were introduced by Barnard in 1973 and 1975. By incorporating anoxic and anaerobic zones he demonstrated that a high percentage of the influent N and P could be removed by biological mechanisms in the system without the aid ofchemical addition. It was later demonstrated that through the imposition of specific environmental conditions and substrate supply, the growth of certain species can be promoted so as to fulfil some desired function. Examples are:

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