

Review of treatment performance at Hammarsdale Waste-water Works with special reference to alum dosing

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Abstract

The treatment process at Hammarsdale Waste-water Works has been heavily influenced by the nature of the influent, which is largely of industrial origin, as well as by certain design features of the extended aeration 5-stage Bardenpho process present. In particular, dissolved phosphate, chemical oxygen demand (COD) and colour removal have proved problematic. Limitations of the activated sludge process have been seen as the underlying origin of these problems.

Change from a diffused to surface aeration system in 1987 to 1990 conferred greater stability on the biological process but did not prove adequate to produce enhanced phosphorus removal to the extent that the special phosphate standard (1 mg P/l as dissolved orthophosphate) could be met. This paper examines the benefits at full scale of simultaneous precipitation using aluminium sulphate (alum) dosed into either the anaerobic zone or return activated sludge. Apart from producing consistent phosphorus removal to below 1 mg P/l as dissolved orthophosphate, alum dosing at 150 mg/l (relative to raw influent) has given significantly improved sludge settleability. COD and colour removal have not improved significantly (contrary to laboratory-scale tests), although the effect of sludge age in this respect was not investigated. Increased alum dosing (200 mg/l failed to produce statistically lower effluent COD or colour in a full-scale trial. This study highlighted the need for a more reliable sludge wasting/dewatering practice in order to improve control of sludge age. Theoretical predictions of sludge production were compared to Works data.

The unbiodegradable particulate fraction of the influent COD proved to be a critical unknown especially in view of the likely contribution of textile and chicken abattoir waste from local industries. Limited full-scale data suggest that the increase in sludge production due to alum is less than the 30% projected from laboratory trials.

Introduction

Chemical dosing as a means of supplementing activated sludge processes has become common practice in waste-water treatment. Yeoman et al. (1988) reviewed this practice for a number of plants in Europe, Canada and the United States of America, reporting that alum and iron salts are most widely used, with phosphorus removal being the prime motivation for adding chemicals. Metsch et al. (1985) compared pre- and simultaneous coagulation/precipitation effects at 2 different full-scale facilities and found that with both processes a total phosphorus effluent concentration of 1 mg P/l can be expected, but that simultaneous precipitation gave a small saving in coagulant dosage. Both methods enhanced the removal of COD and BOD, with simultaneous precipitation giving improved stability to the activated sludge process (viz. improved phase separation in secondary clarifiers resulting in a lower effluent suspended solids content and a lower sludge volume index). On the other hand, pre-precipitation can give additional removal of suspended solids and COD in primary clarifiers, with resultant savings in plant operating or capital costs (along with the potential for increased biogas production by anaerobic digestion) and can be used to relieve oxygen demand at seasonally overloaded plants (Metsch et al., 1985).

The introduction of a special phosphate standard (< 1 mg P/l dissolved orthophosphate) in certain catchments in South Africa, resulted in major municipalities such as Johannesburg adopting simultaneous precipitation in modified activated sludge processes as a means of supplementing biological phosphorus removal (Lötter, 1991). In the Umgeni Water area, the Umlaas River catchment upstream of Shongweni Dam is subject to the special

phosphate standard. Hammarsdale Waste-water Works is situated in this catchment and based on hydrological data for 1976, during the dry season (winter) may contribute up to 12 to 19% of the flow into Shongweni Dam (Archibald and Warwick, 1980). Hammarsdale Works was designed as a 5-stage modified Bardenpho plant for biological nutrient removal but final effluent soluble reactive phosphate (SRP) concentrations averaged ca. 5 mg P/l prior to alum dosing (Healey et al., 1989).

It is beyond the scope of this paper to consider possible reasons for the inability of this plant to meet the 1 mg P/l standard by biological means alone. However, the nature of the influent waste water (over 90% of industrial origin with textile and poultry abattoir wastes as the major constituents) and the size of the anaerobic zone are probably of critical importance (Wentzel et al., 1991).

A permanent alum dosing system at Hammarsdale Works was commissioned in October 1989, with full-scale trials having been carried out in the period March 1988 to September 1989. Laboratory-scale experiments (Healey, 1987; Healey et al., 1989) had indicated that simultaneous precipitation with alum has the potential to give not only improved phosphate removal but also improved colour and COD removal, and possibly improved sludge settleability as well. Using fully aerobic bench-scale fill-and-draw reactors operated at a 4-d sludge age, Healey (1987) reported optimal colour and COD removal at alum dosages of 150 to 200 mg/l. Good phosphate removal was recorded at these dosages (effluent SRP ranging 0,4 to 0,8 mg P/l). Colour was reduced to 28 to 37°H (86°H in control reactor receiving no alum). (H denotes Hazen, where 1°H = 1 mg Pt/l as defined by *Standard Methods*, 1985).

COD was reduced to 60 to 101 mg/l (124 mg/l in control reactor). Healey et al. (1989) also reported that residual alkalinity in the secondary effluent was sufficiently high (ca. 100 mg/l as CaCO₃) not to warrant lime addition. Nevertheless, precautionary measures were taken including continuous pH monitoring and provision of a dry lime feeder at the head of works.

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