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ELIMINATION OF SULPHUR COMPOUNDS FROM WASTEWATER BY THE ROOT ZONE PROCESS—I. PERFORMANCE OF A LARGE-SCALE PURIFICATION PLANT AT A TEXTILE FINISHING INDUSTRY

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Abstract—Domestic wastewater contains an average of 7.4 g S person⁻¹ day⁻¹ as sulphur compounds which moreover are found in numerous industrial effluents. In conventional treatment processes they are oxidized to sulphate and discharged into the water recipients, ultimately going into the rivers and oceans. There they interfere with the limnic metabolic cycle. Under oxygen deficient conditions, organic matter may be degraded by sulphate respiration. The sulphide thus formed is very odorous, highly toxic and, moreover, mobilizes phosphates from the sediment, accelerating algal growth. The organic matter, which is thus formed in addition, is again reduced by sulphate respiration. The result is an acceleration towards anaerobiosis. A new treatment process, the Root Zone method, opens up a way to remove sulphur from wastewater. Operational experiences in the purification of textile finishing effluent are considered here. In a 0.44 ha section of a Root Zone plant of 19 ha on average 76% of COD and 82% of total-sulphur load, equivalent to 27 t O₂ ha⁻¹ a⁻¹ and 3.5 t sulphur ha⁻¹ a⁻¹, respectively, were removed from the wastewater. Despite of a lack of nutritive salts in the effluent there has so far been no need to use fertilizers to support the process. The Root Zone system could adapt to a different effluent quality in 1-3 weeks. Over the 12-year operational period there has been no breakdown in purification performance despite loading with a broad and often changing variety of industrial chemicals. This can only be explained by the high process stability of complex ecosystems.

Key words—sulphur content of wastewater, sulphate influx into the oceans, sulphide toxicity, phosphate mobilization, eutrophication, textile finishing effluent, Root Zone method, wetland treatment, removal of sulphur compounds, performance profile, process stability

INTRODUCTION

"We may take it, therefore, that the interest in the sulphur cycle is not an academic one, but reflects our awareness that the practices of our modern industrialised society often have profound deleterious effects on the natural recycling of elements to which man and other organisms have become adapted over thousands of years." (Trudinger, 1980).

Domestic sewage contains an average daily amount of 7.4 g sulphur per person equivalent (PE) (Fassbender and Steinert, 1979), most of it in the form of various organic sulphur compounds of which, from human excrement alone, some 2.4 g S PE⁻¹ are derived (Selenka, 1976). In most treatment processes they are discharged, after oxidation, almost completely into the recipient.

To this is added the sulphurous effluent from the different branches of the sulphur processing industry. The sulphur which in conventional treatment works is oxidized to sulphate, flows from the recipients, via the streams and rivers, into the oceans. During the last three decades of industrial development the annual sulphur influx into the oceans via rivers has nearly doubled (183%) and has now reached 1.9×10^8 t S a⁻¹. Another 1.5×10^7 t S a⁻¹ are added

to this arising from gaseous fall-out of anthropogenic origin, but representing only 15% of the total annual influx of sulphur by anthropogenic sources (Dévai *et al.*, 1985).

The oceans already contain 924 mg l⁻¹ SO₄²⁻-S (Pacific) to 1010 mg l⁻¹ SO₄²⁻-S (Atlantic) (ATV, 1973).

The question arises as to what happens to this amount of sulphur compound in the recipients (streams, rivers, lakes) and ultimately in the ocean depths and its sediments.

Of concern is the possibility of further conversion of sulphate in the microbiological cycle. Organic matter which enters the water as an effluent component or as generated during biological production (photosynthesis) in the water, can, after sinking into deeper water layers, only then be aerobically degraded when circulation provides a continuous supply of oxygen from the surface layers. In anaerobic conditions the sulphate-reducing bacteria start to work, breaking down the organic matter by sulphate respiration and so producing hydrogen sulphide. The H₂S-concentration is generally at its greatest close to the sediment (Müller, 1966). The H₂S pursues the