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Fault Detection in the Activated Sludge Process using the Kohonen Self-Organising Map

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Abstract: *This paper addresses the detection of faulty situations that develop in activated sludge wastewater treatment plants (ASWWTP). The Kohonen Self-Organising map (KSOM) has been utilised to detect and track changes in different parameters for real data collected from the Seafield wastewater treatment plant, Edinburgh, UK. The results demonstrate that this method is simple, computationally efficient and provides useful information for the process engineer who is faced with improving the performance of the WWTP.*

Keywords: *Wastewater treatment, Fault detection, activated sludge, Kohonen Self Organising Map*

1. Introduction

Increased regulations which protect the environment and water bodies, have led to a growing demand for the improved performance of wastewater treatment plants. This reality has encouraged environmental engineers to use innovative techniques to improve plant operation and control through designing systems that describe the dynamic behaviour of the treatment plant through both qualitative and quantitative methods. Such systems help the process engineer to convert unsatisfactory dynamic behaviour to satisfactory behaviour, thus reducing operational costs and meeting the requirements of regulatory agencies while minimising any adverse effects on the environment [1].

However, controlling the activated sludge system is very complex due to factors such as: a high temporal variability in flow and concentrations of the influent; complex and poorly known relations between the variables; the variation over time of living microorganisms in quality and the number of species; the limited detailed knowledge of biological treatment mechanisms; scarce and often unreliable use of online analysis; delays in obtaining the analytical results of some parameters; difficulty of using human experts as the knowledge and experience gained from operational complications of one wastewater treatment plant, cannot be easily applied to another. These characteristics make it difficult to control the activated sludge process. Hence, it has been necessary to develop methods to improve the robustness of monitoring and fault detection [2][3].

Fault detection is the process by which a fault is identified, whereas diagnosis involves identifying the type of fault and its cause [4]. However, due to the highly complex activated sludge process, process disturbances are usually difficult to detect. For example, under normal operating conditions, the principal aim of the plant is to maintain the effluent concentration below a certain reference value. However, there are many situations that can inhibit the plant from achieving this aim, including (but not limited to); changes in the mixed liquor suspended solids, the presence of heavy metals and/or filamentous, bulking phenomena, problems in the piping system and a high concentration of dissolved oxygen. These changes must be detected and diagnosed quickly to prevent faults in the WWTP. Moreover, the measurement system itself can be defective due to the hostile and highly