1.0 Introduction

This thesis is focusing on the wastewater stabilisation ponds (WSP) and their mechanisms of nitrogen removal, in particular ammonia volatilisation, from wastewater in facultative and maturation ponds.

1.1 Conventional sewage treatment in the United Kingdom

Wastewater consists of domestic sources and industrial wastewater. These components have to be considered when assessing the level of treatment required to reach an acceptable quality of wastewater discharge, both environmentally and to ensure the protection of public health.

In the UK there are 9000 sewage treatment works which supply the vast majority of the UK population (Water UK, 2004). Traditionally, these sewage treatment works consists of seven treatment processes. These include preliminary, primary, advanced primary, secondary, secondary with nutrient removal, tertiary and advanced. Preliminary treatment deals with the removal of bulk constituents such as rags, grit and any other floatables which may cause maintenance and operational problems in the successive treatments. Primary treatment removes a portion of the suspended solids and organic matter from wastewater, while advanced primary removes the same but is typically accompanied by chemicals or filtration. Secondary treatment deals with the removal of biodegradable organic matter and suspended solids, the secondary treatment with nutrient removal performs the same but with the addition of nutrients such as nitrogen and phosphorus. Tertiary treatment removes any residual suspended solids after the secondary treatment, this also included a disinfection section and nutrient removal. Finally, advanced treatment is used when the wastewater is required for water reuse applications; it continues with the removal of dissolved and suspended solids after biological treatment (Metcalf & Eddy, 2003).

1.1.1 Nitrogen removal in conventional sewage treatment

In relatively recent years, biological nutrient removal has become an integral part of conventional sewage treatment. There are a number of advantages to it including: lower use of chemicals compared with the equivalent chemical treatment; it reduces the production of waste solids and has lower energy consumption. The biological removal of nitrogen from sewage has either been incorporated into new biological treatment systems or as an add-on process to an existing plant (Metcalf & Eddy, 2003).

The biological nitrogen removal process includes a combination of nitrification and denitrification. This is supplied by creating an aerobic zone in which biological nitrification can take place. This is followed by a volume or time period of anoxic conditions for denitrification to take place, so that way total nitrogen is removed by NH_4-N oxidation and NO_3-N and NO_2-N reduction to nitrogen gas. Typical systems in which this process occurs are shown in Figures 1.1- 1.3 (Metcalf & Eddy, 2003).

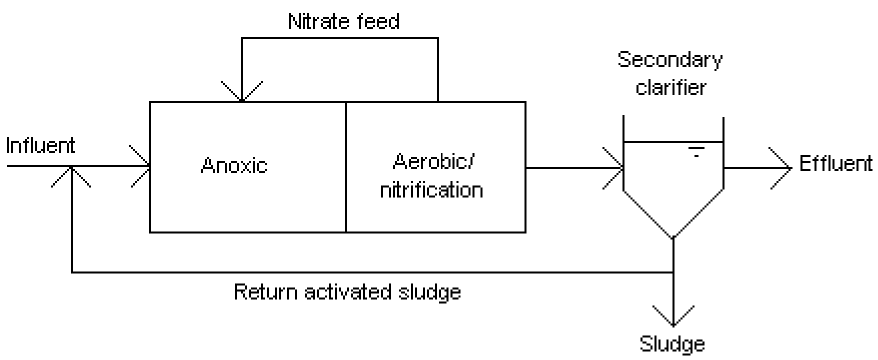

Figure 1.1 Schematic diagram of a basic preanoxic nitrogen removal process configuration

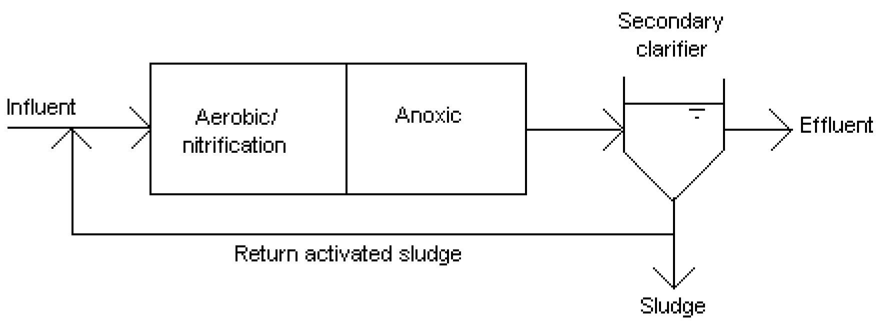

Figure 1.2 Schematic diagram of a basic postanoxic nitrogen removal process configuration

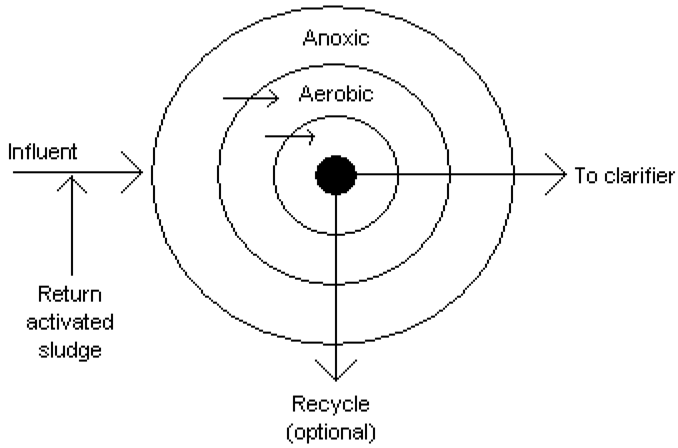

Figure 1.3 Schematic diagram of a basic simultaneous nitrogen removal process configuration

There is a combination of orders in which these biological processes may occur: preanoxic (Figure 1.1) starts with an anoxic section which receives a nitrate feed from the later aerobic section; postanoxic (Figure 1.2) where wastewater enters an aerobic zone following into the anoxic zone; and simultaneous nitrification/ denitrification (Figure 1.3) where both occur in the same tank.

1.2 Wastewater stabilisation ponds (WSP)

Wastewater stabilisation ponds have been used extensively in tropical climates for the last 3000 years (Middlebrooks *et al*., 1999). It is only in more recent times that the full extent of the benefits of wastewater stabilisation ponds has become apparent. They are simple to construct, operate and maintain, so less skilled labour is necessary. Their low cost is an important factor. Electrical energy is not needed as solar energy is the only energy requirement. No machinery is required, so keeping maintenance, construction and skilled labour costs to a minimum. The high efficiency of the ponds and quality of the effluent produced is also a significant benefit. These advantages are what make waste stabilisation ponds a very attractive option, especially in developing countries (Mara *et al*., 1992).

Although the design and construction of WSPs is simple in comparison to conventional sewage treatment works, the biological processes occurring in the ponds are not. The microbial ecology of the ponds is not fully understood (Mara *et al*., 1990), nor are some of the processes involved in achieving the excellent effluent quality, such as nitrogen removal.

1.3 Objectives

The main objective of this investigation is to determine how much nitrogen is removed from facultative and maturation ponds by ammonia volatilisation, including a comparison of the proportions of ammonia volatilisation with the conditions in the ponds, particularly pH, temperature and dissolved oxygen. The secondary objective of this study is to assess the difference in the rate of ammonia volatilisation from the two different ponds.