Microbial Addition Technology for Enhanced Biological Wastewater Treatment

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Introduction:

Bioaugmentation involves the addition of commercially prepared microbial blends of cultured bacteria to a wastewater treatment system, to treat and speed up the removal process of target pollutants within a wide variety of industrial and domestic wastewater processes (Gerardi, 2016). Bioaugmentation has the capabilities of improving performance within waters requiring treatment (Raper *et al*, 2018).

In order for bioaugmentation to move forward in terms of research, key gaps need to be addressed, which include full-scale WWTP research, microbial interactions, pre-conditions in WWTP and economic viability of bioaugmentation. However, current studies have mainly focussed on laboratory-scaled research with synthetic wastewater, rather than the process performance directly in a wastewater treatment system (Raper *et al*, 2018; Mrozik, 2021).

Figure 1 – A respirometer used to measure the rate of oxygen consumed by the microorganisms

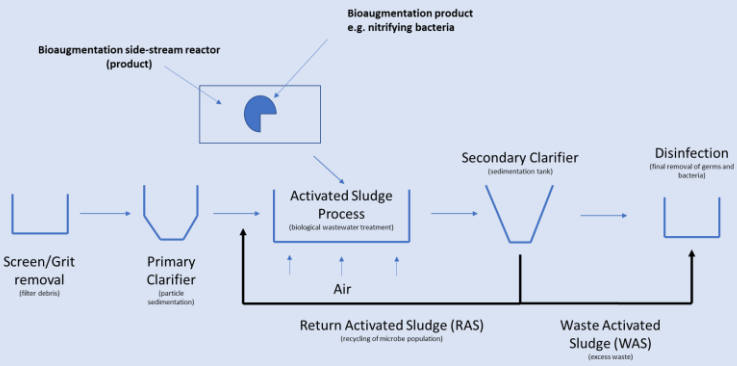

Figure 2 – A simple design of a full-scale wastewater treatment plant and the potential position of where the bioaugmentation product may be inoculated

Hypothesis:

The conditions of the inoculum (bioaugmentation product) before the addition to a biological wastewater treatment process that will impact on its effectiveness/ability to treat (biologically) the target pollutant.

Aims:

- Use Monod kinetics principle to understand the bioaugmentation effectiveness
- Understand whether the pre-conditions of a bioaugmentation product impacts treatment in the main-stream process

Methodological approach:

- Laboratory-based experiments (Respirometer) (Fig 1)
  - Measures the amount of O_2 consumed by the microbes to breakdown organic matter
- Monod Kinetics
  - A mathematical model to describe the growth rate of microorganisms based on substrate concentration
- Full-scale WWTP
  - Thames Water WWTP in Reading
- A side-stream reactor at full-scale WWTP (Fig 2)
  - Addition of bioaugmentation product

Discussion/Findings so far…

- Bioaugmentation has potential as an eco-friendly and economically viable option
- Lots of laboratory work has showed success in the bioaugmentation application
- Few studies on large-scale WWTS with a bioaugmentation product due to:
  - bioaugmented cultures not adjusting to existing operational conditions (temp, pH etc)
  - Inability for bioaugmented cultures to compete successfully with indigenous bacteria (Shan *et al*, 2023)

References:

Gerardi, M. (2016). Wastewater, Bioaugmentation and Biostimulation (1st edition). Lancaster: DEStech Publications, Inc.

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Raper, E., Stephenson, T., Anderson, D.R., Fisher, R., Soares, A. (2018). Industrial wastewater treatment through bioaugmentation. *Process Safety and Environmental Protection*. Vol **118**: 178-187.

Shan, X., Guo, H., Ma, F., Shan, Z. (2023). Enhanced treatment of synthetic wastewater by bioaugmentation with a constructed consortium. *Chemosphere* **338**: pp 1-11.