

Fate and Biodegradation of Nonylphenol NP in Process Wastewater Treatment Systems

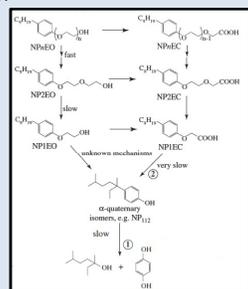
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Background

- Nike's sustainability initiative aims to guide manufacturing partners to consider waste stream environmental implications
- Nonylphenol ethoxylate (NPEO) surfactants are used in the laundering process of textile manufacturing
- NPEO degradation products, especially nonylphenol (NP), can be toxic to aquatic environments
- NPEOs are biodegradable by the reaction pathway:¹



- NPEOs and NP can be removed from water with biological treatment, but efficiencies vary between 12-95%²
- Optimal operating conditions for biological treatment of NPEOs and NP

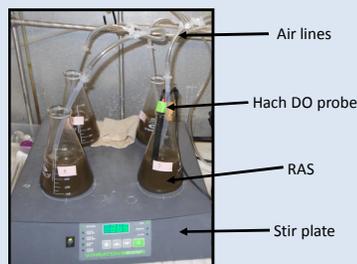
Objectives

Develop a method to characterize biodegradation of NPEOs in activated sludge treatments at textile manufacturing facilities. The main parts were threefold:

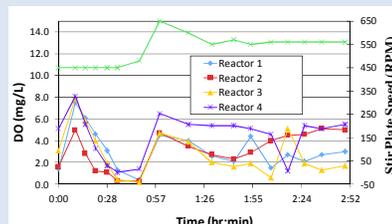
- Determine an experimental setup to determine effectiveness in biodegrading NPEO
- Perform an experiment to determine reduction in NP concentration over a typical activated sludge retention time
- Evaluate an amino assay test kit for accurate detection of NP

Methods and Plots

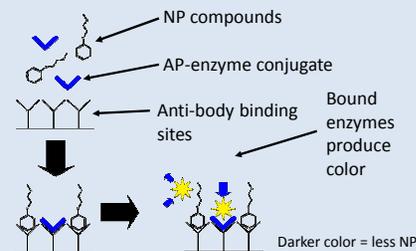
- Erlenmeyer flasks were filled with 400 mL of diluted return activated sludge (RAS) and microbial substrate
- Two reactors were dosed with 3 mg/L NP
- Stir plates and sparged air were used to keep reactors well mixed and aerated



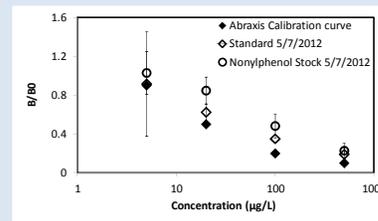
- Dissolved oxygen (DO) was measured during the duration of the experiment with a Hach DO probe
- The target DO concentration is 3 mg/L



- An Abraxis AP ELISA assay was used to quantify the concentration of NP and NPEOs in the reactor
- Test kit uses a competitive reaction to quantify NP concentrations via spectrophotometric analysis
- The following schematic shows the competitive reaction that occurs in coated wells that are provided with the test kit



- A calibration curve of optical density readings with known concentrations was produced:



- B/B₀ is the optical density of the sample over the optical density of NP = 0

Progress to Date

- DO determined to be difficult to keep constant during run
- RAS results in inconsistent measurements of dry weight solids
- Determined ELISA test kit can only be used to test for NP, not NPEOs
- ELISA test provides inconsistent results
- Nonylphenol readily adsorbs onto plastic, which needs to be considered in experimental set-up and measurement

Conclusions

- A continuous bioreactor containing a cultured microbial population would result in more conclusive data
- The AP ELISA test kit from Abraxis is not an appropriate assay to use to determine NP concentration in the field
- Test kits that measure other NPEO compounds are needed for use at textile manufacturing facilities

Future development

A set of 15 vials were mixed with 3 mg/L NP. Vials were pulled and put on ice at 0.5, 1, 2, 4, and 20 hours. These samples were sent to CH2M Hill for analysis. These results should give insight to the partitioning of NP to the RAS.

References

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- McAdam, E. J.; Bagnall, J. P.; Soares, A.; Koh, Y. K. K.; Chiu, T. Y.; Scrimshaw, M. D.; Lester, J. N.; Cartmell, A. Fate of alkylphenolic compounds during activated sludge treatment: impact of loading and organic composition. *Environ. Sci. Technol.* **2011**, *45* (1), 248-254

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