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Energy & Environmental Research Center

**IMPACT OF EXPEL® ON WASTEWATER
TREATMENT OPERATIONS AT THE
MOORHEAD, MINNESOTA, FACTORY OF
AMERICAN CRYSTAL SUGAR COMPANY**

Final Report

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BACKGROUND

Expel® is used to control odors in some areas of American Crystal Sugar (ACS) Company's Moorhead, Minnesota, factory and perhaps at other ACS facilities as well. Concerns were raised about the potential toxic impacts of this product on wastewater treatment operations, specifically the anaerobic contactor and the activated sludge unit. Initial concerns focused on the aeration basin portion of the treatment train, as water containing Expel® is generally treated aerobically at the conclusion of the processing campaign. Toxicity impacts are very difficult to assess as there are a number of components that may be impacted. A simple but comprehensive method of analysis was selected to demonstrate the response of the entire microbial community to the Expel® product within the aeration basin. This method is based on interference in the respiration of the microbial community. By monitoring background oxygen uptake rates and comparing the difference in this rate as a function of the dose of Expel®, we could identify the resulting toxic response.

METHODS

On July 12, 2000, a sample of mixed liquor from the aeration basin of the Moorhead ACS plant was obtained at the point where it flows into the clarifier. This sample was maintained with a headspace and placed on ice for transport to the Energy & Environmental Research Center (EERC). A sample of the Expel® product was obtained at the same time from a tote bin at the plant. This sample of Expel® was identified as the concentrate.

Testing procedures were begun at the EERC within 4 hours of sample collection. A Yellow Springs Instruments Model 53 biological oxygen monitor was used for testing. The sample chamber was maintained at 30°C throughout the testing. The oxygen probe was calibrated to 100% with air-saturated distilled water. During testing, a 5-mL sample of well-mixed mixed liquor was placed in a chamber and incubated for 1 minute, allowing the sample to come to the 30°C temperature. The oxygen probe was placed in the chamber, and a background oxygen uptake rate was obtained. After 1 to 2 minutes of background, an aliquot of Expel® was added to the chamber via a syringe through a slot along the length of the probe. After dosing the sample with Expel®, the oxygen uptake rate was monitored for an additional 2 to 5 minutes. Doses of Expel® from 0 to 1.5% by volume were tested. All tests were performed in duplicate. These tests were designed to provide an indication of acute toxicity if present.

An additional set of tests were performed to examine the potential for longer-term toxicity. For these experiments, equal quantities of mixed liquor were placed into three flasks, and Expel® was added at doses of 0, 0.5%, and 1.0% by volume. These samples were shaken at 50 rpm on an

orbital shaker at room temperature. At 4 and 24 hours of incubation, the oxygen uptake rate of each dose was determined using the Model 53 analyzer, as described above.

RESULTS

The results of oxygen uptake rates for the mixed liquor under the acute toxicity testing conditions are shown in Figure 1. The mean oxygen uptake rate of the undosed mixed liquor was $7.0 \pm 0.7\%$ per minute. The oxygen uptake rate of dosed samples was more variable, but it did not show a dose-response, suggesting that the product is nontoxic under these conditions.

The results of the longer-term incubations with Expel[®] are shown in Figure 2. At 4 hours of incubation, the undosed control showed the same oxygen uptake rate as the 0 hour undosed mixed-liquor sample (see 0% Expel[®] dose, Figure 1). Dosed samples at 4 hours of incubation exhibited somewhat lower oxygen uptake rates, but no dose-response is noted. At 24 hours of incubation, the undosed control had a significant drop in activity as expected due to the consumption of available organic matter. The dosed samples at 24 hours showed activities that were less than that at 4 hours, but much more than was found in the undosed sample.

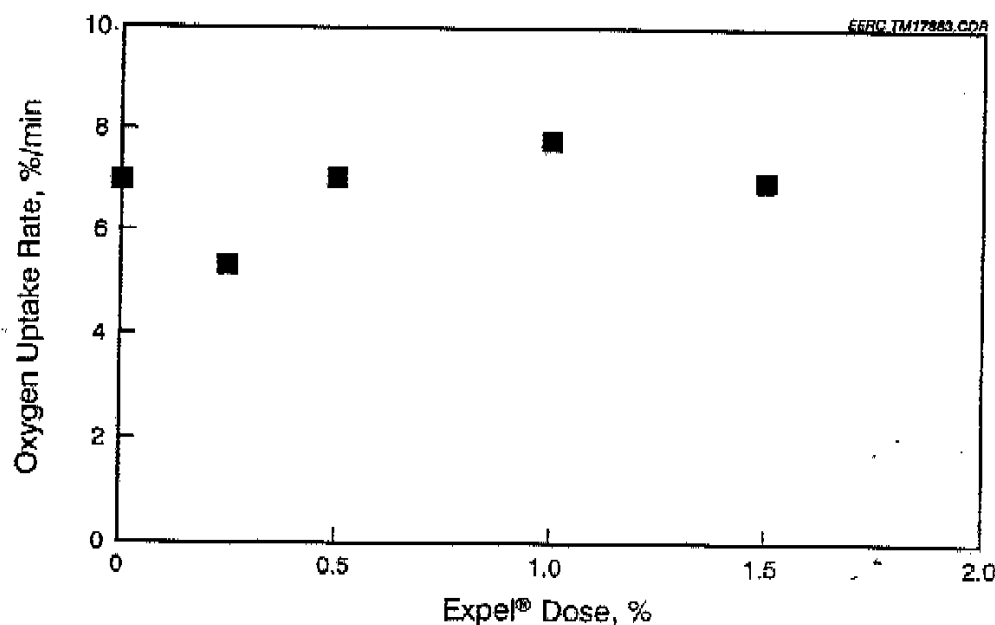


Figure 1. Mean oxygen uptake rate as a function of the dose of Expel[®].

SUMMARY AND CONCLUSIONS

Aeration basin mixed liquor collected from the Moorhead, MN, ACS factory was tested to evaluate the potential for microbial toxicity due to the addition of an odor-neutralizing product frequently used by the factory. No acute toxicity of the mixed liquor sample, as measured by an immediate change in oxygen uptake rates, was found as a result of addition of Expel® at rates as high as 1.5% (by volume). An assessment of longer-term toxicity was also performed by measuring oxygen uptake rates at 4 and 24 hours of product exposure at two separate doses compared to an undosed control. This assessment showed that the dosed samples had a higher oxygen uptake rate than the undosed sample at 24 hours of exposure. Although this could represent a toxic response, it is more likely that this response represents biological oxidation of components in Expel® and hence does not suggest the potential for toxic effects on ACS activated sludge. It is expected that a dose response would accompany any toxic effects produced by addition of the odor-neutralizing agent.

Based on oxygen uptake analysis, two types of toxic response might be noted. The toxicant could affect the cells such that respiration is inhibited in some way, resulting in a dose-related decrease in the rate of oxygen consumption. Alternatively, the toxicant could affect the cells such that respiration becomes uncoupled, resulting in a very high rate of oxygen uptake. If high rates of oxygen uptake are noted, it can be difficult to determine whether it is due to uncoupling or to biological oxidation of the toxicants. Generally, a clear dose-response is found. The results of this testing procedure suggest that there are no toxic effects from the Expel® product on ACS activated sludge mixed liquor at addition rates up to 1.5% by volume.

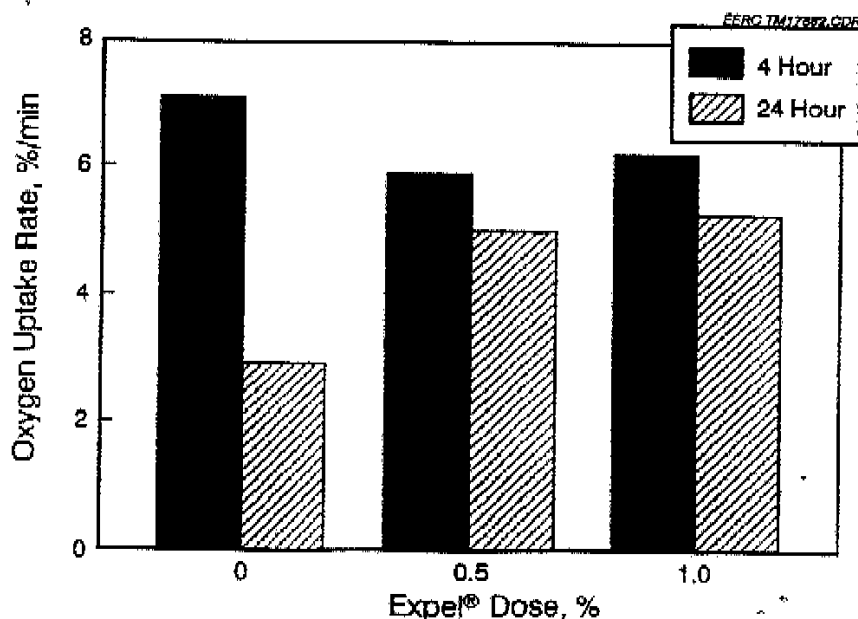


Figure 2. Oxygen uptake rates for dosed and undosed samples of aeration basin mixed liquor at 4 and 24 hours after exposure to Expel®.