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Enhanced Degradation of Fats, Oils and Greases in Domestic Wastewater Sewer Networks and Grease Interception Systems Using Peat Humic Substances

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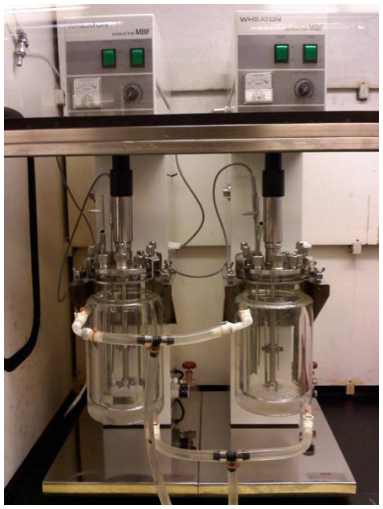
ABSTRACT

The efficacy of peat humic substances in enhancing the degradation of fats, oils and greases (FOG) was investigated. An experimental design was used to evaluate the effects of temperature and peat humic substance (PHS) concentration on FOG degradation in domestic wastewater. Factors and interactions significantly affecting the rate of FOG degradation were identified to predict degradation rates as a function of PHS concentration and temperature. Results indicate that PHS can enhance FOG degradation by a factor of 2, and microbial growth rates by up to a factor of 5. Atmospheric hydrogen sulfide generation increased with high PHS concentration at high temperature. The rate of FOG degradation using grease interceptor material was studied at 25°C and a PHS concentration of 500 ppm (v). In these systems, PHS was observed to increase the rate of FOG degradation by up to a factor of 2, and microbial colony growth rates by a factor of 5. This work indicates that PHS can enhance FOG degradation rates and increase microbial growth rates in wastewater treatment systems and have significant implications for wastewater treatment applications.

MATERIALS & METHODS

A 10% concentration of PHS and two bioreactors with glass wall temperature regulating jackets and water circulators with an operating range of -10°C to 70°C providing uniform temperature.



Each Bioreactor was docked to a main unit that will control agitation speed in a range of 100 RPM to 1200 RPM and for system runtimes that are greater than 24 hours and up to a speed of 1500 RPM when runtimes less then 24 hours

Microbial Quantification

For quantification of viable, colony-forming, microbiological units (CFU) present at the start and end of the bioreactor trials, liquid assays for colony-forming cell counts from each bioreactor were drawn in triplicate.

Domestic Wastewater Study

Samples were obtained in January and July from Monroe Township Utility Authorities two pumping stations. Samples from January were used in 18-days and samples from July were used within 23-days.

EXPERIMENTAL DESIGN

An experimental design was developed to investigate the effect of two factors, temperature and PHS concentration on the rate of FOG degradation with FOG, pH and ORP were measured in 24-hour intervals from each bioreactor. To measure the atmospheric hydrogen sulfide concentration an environmental sample-draw detector was mounted between the two main units.

Grease Sample Analysis

Grease collector sample material was provided contained FOG removed from a restaurant grease interceptor. Samples were collected from the grease interceptor before business hours of operation and stored in mason jars and stored in a 4°C refrigerator at the university laboratory when not being used.

Wastewater FOG Sample

Both water temperature and PHS concentration had a significant effect on FOG degradation in each analysis, with water temperature being more significant. It's noteworthy that to indicate that interactions between water temperature and PHS concentration (C x T) is significant in the January sample and July sample.

RESULTS

FOG concentration as a function of time for a typical wastewater experiment indicates, there is an increase in FOG concentration at the start of the experiment. The FOG concentration subsequently decreases and one possible explanation for the reduction may be extracellular enzymes such as lipases or hydrolases, initially reduced FOG particle size and increased the concentration of free lipids and fatty acids.

Dissolved Oxygen and pH The dissolved oxygen concentration was initially observed to be under aerobic conditions and proceed to or approach anaerobic conditions for bioreactor trials in which DO was measured and may have contributed to high chemical and biological oxygen demand. The pH was observed to range between 5.3 and 6.9 with an average pH of 5.77 indicated the biodegradation

Aqueous and Atmospheric Hydrogen Sulfide PHS provided a degree of stimulation by three mechanisms. Initially, PHS functioned as an electron acceptor, replacing sulfate as a terminal electron acceptor for microbial respiration. In the second mechanism, PHS increased the solubility of sulfur-containing organic compounds, and created PHS sulfur organic compound complexes. Once reduced, PHS functioned as a thermodynamically favorable electron donor, thus increasing the short term availability of fermentable sulfur substrates when high rates of PHS are added.

Cell Counts results of the grease material study have indicated that PHS shown to stimulate the rate of cellular growth on grease material substrates by a factor of 4 to 5, relative to a control. Large variations were observed between trials; most are considered to be a function of sample preparation.

CONCLUSION

It was found that FOG degradation rate increased with temperature and PHS concentration and ranged from 10% to 110% relative to control experiments. The data suggest that FOG degradation in these systems proceeds by a two-part biological mechanism involving increasing FOG bioavailability and FOG consumption. For grease interceptor material experiments at constant temperature, peat humic substance enhanced FOG degradation rates by up to 120% relative to control experiments. The addition of PHS also increased the growth rate of microorganisms during both wastewater and grease interceptor experiments by up to a factor of 3 and 4, respectively.