TECHNICAL MEMORANDUM
Subtitles D Landfill Leachate

Subject: Advanced Neutralization™ (AN™) Treatment of Subtitle D Landfill Leachate for Coupling with AMEOX™ Processing for PFAS Destruction

Date: August 1, 2019

The application of the Advanced Neutralization (AN) water treatment technology to Subtitle D landfill leachate has shown promise for the removal of total suspended solids and reduction in Chemical Oxygen Demand (COD). Now, with the recent knowledge of the emerging PFAS "forever" chemicals being found in this fluid coupled with the AMEOX™ technology and its ability to destroy these compounds, the pairing of AN and AMEOX provides a sound approach for full treatment of this problematic waste stream and its recalcitrant, highly stable constituents.

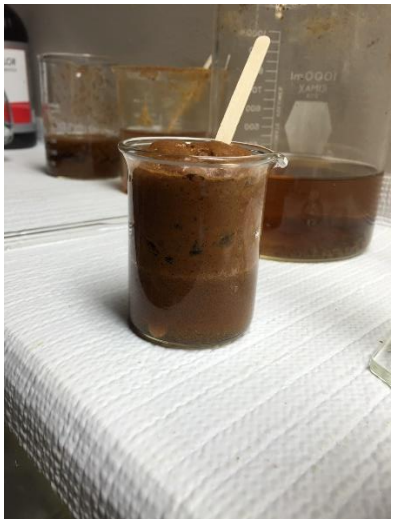
The presence of persistent organic compounds including tannins, humic and fulvic acids, along with acetates from the anerobic degradation of interned waste consisting of food, paper, and other vegetative matter are problematic to conventional treatment methods. Aeration and advanced oxidation-based technologies are common approaches for the pre-treatment of these fluids for management via land application, or at local sanitary waste treatment works. Other constituents in leachate difficult to remove, such as heavy metals, are suitable for treatment using AN.

A treatment viability study was performed on Subtitle D landfill leachate sourced from a municipal solid waste non-hazardous waste landfill near Corvallis, OR during the spring-early summer of 2015. A 250-gallon tote of leachate was obtained from a sump actively collecting leachate from the landfill's leachate storage and conveyance system. The leachate was subjected to a variety of AN system configurations and treatment regimens at both bench and engineering-scale. Samples of untreated leachate and various treatment runs were submitted to Edge Analytical in Corvallis, OR for analyses.

After a series of studies, four (4) treatment approaches on 5-gallon sample quantities processed at 0.25 gpm yielded effluent clarity that merited sample collection and analysis. COD data for untreated and AN treated leachate were as follows:

Sample ID	Result (mg/L)
Untreated	7375
AN-1	2275
AN-2	1650
AN-3	2600
AN-4	225

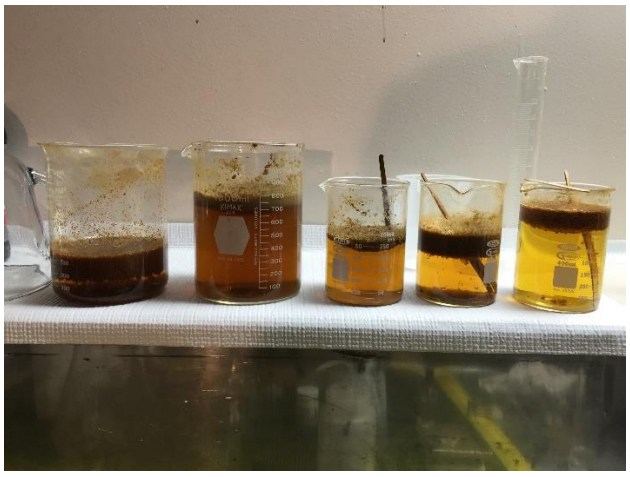
Image 1



First AN Treatment Process (Bench-Scale)

Image 1 shows the first effort of leachate treatment using the AN technology. A heavy, very stiff mousse-like foam formed that was stable and did not dissipate after a period of 24 hours. Considering the recent understanding of PFAS and its affinity for foam, or facilitating its production, it is likely that PFAS presence was in this produced material. At the time of the study in 2015, PFAS analyses was not contemplated or in the optics of the study.

Image 2

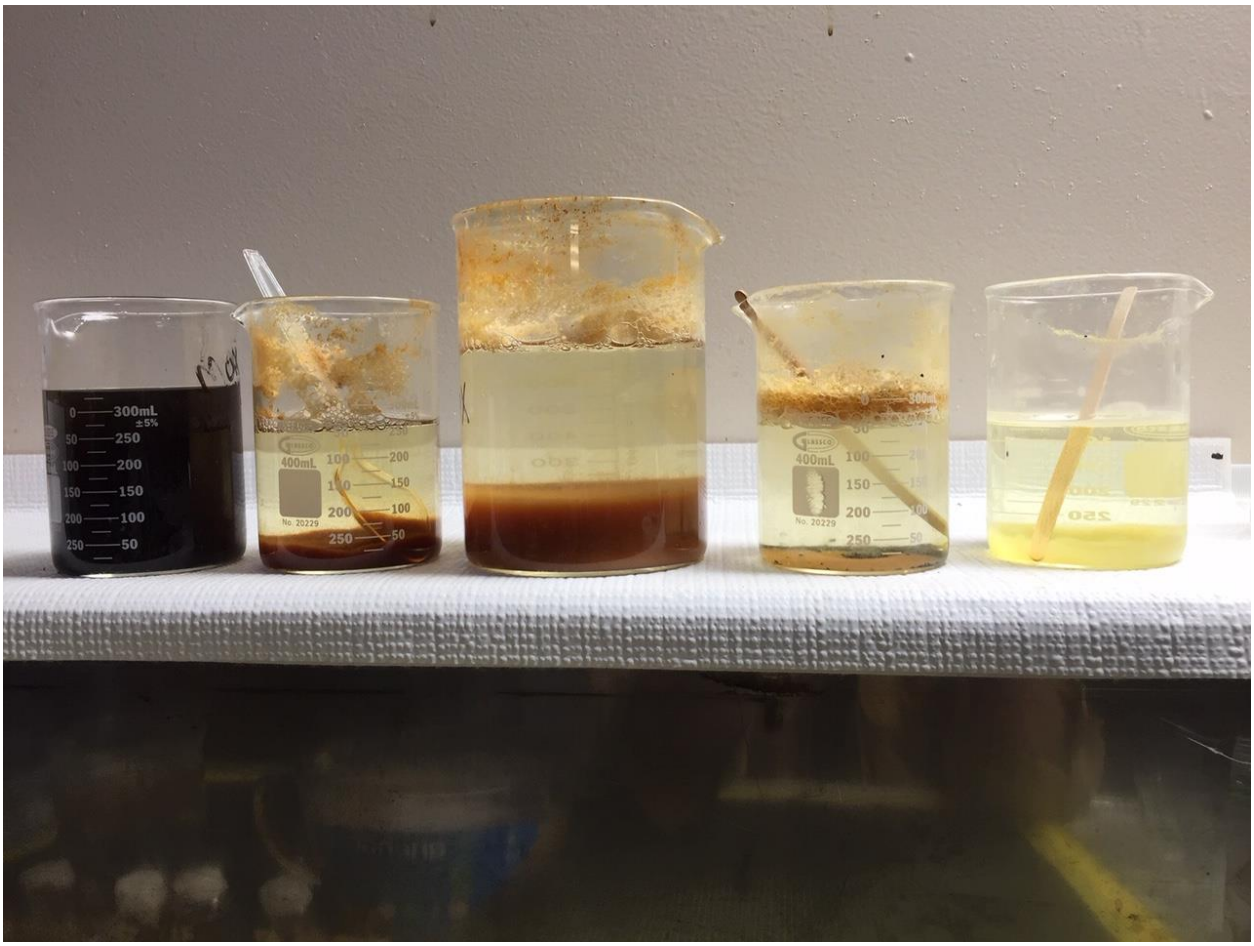


Second Series of Leachate Treatment via AN

Image 2 shows subsequent AN treatment results. While the first treatment in this image (left) still shows significant foam production, the remaining four (4) treatments produced significantly less foam where the floating material was more consistent with dissolved air flotation solids of distinct particles and floc. The treatment represented in the image on the far right was then

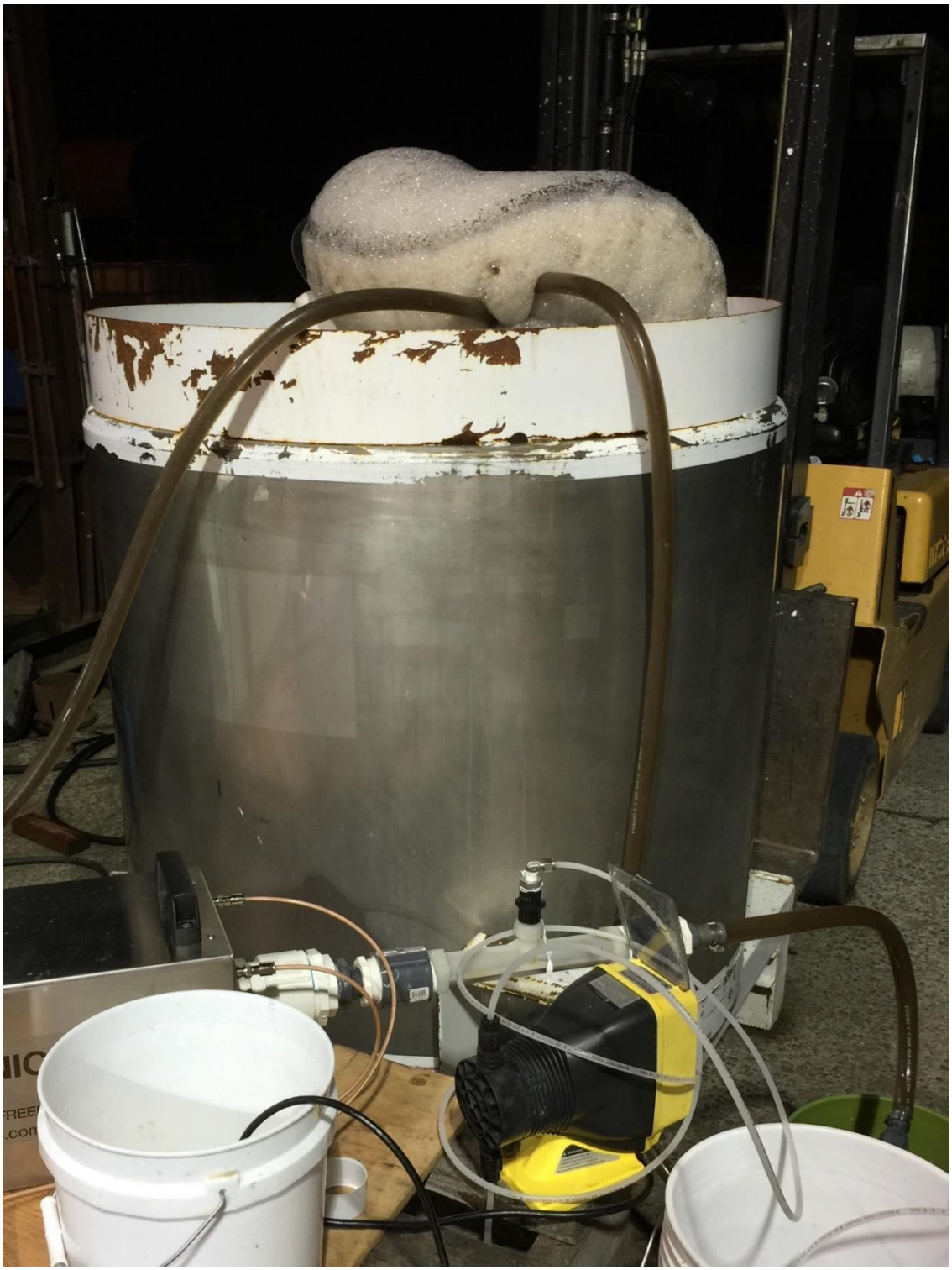
upscaled. In the upscaled processing, the generated solids were removed by clarification settling. Final effluent was then sampled and analyzed with the result reported above, as AN-4, at 225 mg/L (Image 3). Image 4 shows foam generation during initial an application of a typical Advanced Oxidation Process (AOP) to reduce COD without AMEOX™ treatment.

Image 3



The upscale regime AN-4 was then optimized at a treatment production flow rate of 5 gpm. COD for that treated effluent was <100 mg/L (not shown).

AN™ and AMEOX™ are patent-pending with the U.S. Patent Office



AOP Processing of RCRA Subtitle D Landfill Leachate without

AMEOX™ Treatment for Foam (and PFAS) Management

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