

## ANAEROBIC DIGESTION OF THE AQUEOUS PYROLYSIS CONDENSATE

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**Key Words:** Aqueous pyrolysis condensate, anaerobic digestion, pyrolysis, biochar, methane

Fractional condensation of biomass pyrolysis vapors allows the segregation of different pyrolysis fractions and a separation of an aqueous pyrolysis condensate from an organic rich dry bio-oil fraction. Aqueous pyrolysis condensate is often referred to as "wood vinegar" or "pyroligneous acid" since it contains 70-80% water together with 10-20% acetic acid, and smaller quantities of acetone and methanol mixed with hundreds of other chemicals in small concentrations. Such aqueous pyrolysis condensate cannot be easily disposed of, and it may represent a valuable resource. For example, the significant percentage of acetic acid offers the opportunity to attempt its conversion into methane by anaerobic digestion.

Aqueous pyrolysis condensate produced by fractional condensation of vapors generated from the pyrolysis of birch bark at 500 °C has been characterized (elemental composition, pH, COD, volatile fatty acids (particularly acetic acid), ammonia, hydrogen sulfide, minerals, and phenolics), inoculated with a consortium of bacteria from an organic waste anaerobic digester, and digested over several weeks. Biogas production has been progressively monitored and methane and CO<sub>2</sub> concentrations experimentally measured.

We performed a large number of experiments to investigate the effects of (a) dilution of the aqueous pyrolysis condensate, (b) nutrients addition, and (c) addition of bio-char on the production of biogas and on its methane concentration.

The results clearly show that the anaerobic digestion of aqueous pyrolysis condensate is possible and leads to the production of biogas and on the reduction of the COD of the original feedstock to make it suitable for disposal. However, the high phenolic content of the condensate, together with possibly other chemical species, creates considerable inhibition of microbial methane production. Such inhibitory effects, however, can be mitigated by gradual adaptation of the bacteria population to the feedstock composition. The results show that 50 to 60 days are required before significant biogas production is observed when raw anaerobic pyrolysis condensate is processed. The addition of bio-char to the process is beneficial in shortening the lag phase to approximately 20 days and is triggering a higher volume of biogas production with an increased methane content, compared to similar conditions without bio-char. This is attributed to the ability of bio-char to adsorb inhibitory compounds as well as to create more favorable environmental conditions for the digestion process. Similarly, but less effectively, the addition of selected nutrients is shown to benefit the anaerobic process by shortening the lag phase to 40 days.