

[SRNL-L3100-2016-00142 Rev 0: Evaluation of Photocatalytic Oxidation for the Degradation of Ammonia](#) Report Summary

The Hanford Site stores over 50 million gallons of chemical waste, containing over 1800 compounds, in 177 tanks (both actively and passively ventilated). As Savannah River National Laboratory (SRNL) noted in the report, *SRNL-L3100-2016-00142 Rev 0: Evaluation of Photocatalytic Oxidation for the Degradation of Ammonia*, each tank contains a unique and complex mix of chemicals that is “continually catalyzing both known and unknown chemical reactions in all layers, and continually generating gases.” The headspaces of these tanks have the potential to emit their contents into the atmosphere. There may also be other sources of chemical vapor emissions throughout the Hanford Site that are not a part of the tank farm system. This makes predicting and understanding these emissions difficult. In response to these conditions, the Hanford Site has implemented protective measures such as engineering controls and respiratory protection equipment.

The primary chemical of potential concern (COPC) identified in the tank farms is ammonia, which has been identified at two to three orders of magnitude of the Occupational Exposure Limit (OEL) within the tank headspaces and exhaust effluents. Ammonia naturally degrades in the atmosphere after absorbing high-energy radiation such as ultraviolet and gamma radiation. In this process, ammonia degrades to form nitrogen gas as the primary product and nitrous oxide and water as the secondary products. This production of nitrous oxide, known to be a potentially harmful compound, motivated scientists to improve ammonia conversion and product selectivity for nitrogen gas. The majority of these studies focused on techniques such as batch reactors or very slow flow rate reactions that would not be practical for addressing ammonia degradation at the Hanford Site.

WRPS contacted SRNL to investigate the suitability of using photocatalytic oxidation (PCO) to degrade ammonia to non-noxious compounds under the conditions found at Hanford. Photocatalytic oxidation has been studied since the 1960's and has shown promising results in the treatment and degradation of chemicals that are known to be present at Hanford in the tank farms. The process involves the activation of a catalyst using an ultraviolet light. The catalyst then promotes the generation of reactive species that can then undergo a reduction/oxidation reaction (redox). The most common catalyst used for this process is Titanium Oxide (TiO_2). This study focused on applying the PCO technique to the conditions found at Hanford.

As a result of this study, several things were determined. First, oxygen must be present with TiO_2 and ultraviolet light in order for the reaction to occur. Ozone-generating UV lights are required in this system. In this specific reaction setup, the highest detected ammonia degradation was 57% conversion of 523 parts per million (ppm) ammonia. In order to increase degradation efficiency and reduce noxious byproducts, the system requires high reaction rates, high reaction selectivity, and enhanced interactions between the catalyst and ammonia. Additionally, ozone and hydroxyl generators, which produce reactive intermediates, should be used in addition to UV lights and photocatalysts to ensure the ammonia degradation is complete.

The study recommended additional studies be conducted to allow for a more thorough evaluation of the variables of each system design, as well as to establish and validate test results. Examples of additional study variations would include the use of Fourier-Transform Infrared analyzers to evaluate any potential secondary byproducts formed during the reactions, and evaluating the use of different catalysts with

higher surface area and porosity. Finally, the system should be used to determine the effectiveness of photocatalytic oxidation on other volatile organic compounds and COPCs.

[To read the full report, click here.](#)