Toxicological Study of Treated Produced Water for Water Conservation, Reclamation, and Reuse

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Produced water (PW) generated during oil and gas production is primarily disposed of through deep-well injection, which is costly and induces seismicity. PW treatment and reuse can enhance environmental sustainability and provide an alternative water supply. However, PW is saline with numerous organic and inorganic constituents that exhibit significant toxicological behaviors and need treatment before reuse. This study aims to evaluate the toxicity of PW samples with bioassays using aquatic organisms microalgae (Selenastrum capricornutum) and zebrafish embryos (Danio rerio) to determine whether the treated water met national pollutant discharge elimination system (NPDES) discharge standards. Two PW samples were assessed, one from the Permian Basin treated by thermal distillation and another from the San Juan Basin treated by reverse osmosis. Thermal distillate of the Permian Basin PW had chronic inhibition (IC25) in microalgae at 57% and acute lethality (LC50) for zebrafish at 18.7%. Post-treatment with granular activated carbon and zeolite adsorption effectively removed the toxic organic compounds and ammonia in the distillate, meeting water quality requirements for discharge and reuse (IC25> 100% and LC50>100%). For the San Juan Basin PW, seawater reverse osmosis effectively removed the compounds with toxicological effects, improving IC25 of microalgae to >100% and LC50 of zebrafish to >100% in permeate. This study provides an understanding of the most significant concern for reuse - toxicological behavior. Effective treatment and toxicity assessments are critical to ensure the safe use of treated PW while alleviating significant freshwater demand.

Awards Won:
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