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Benchmarking produced water treatment strategies for non-toxic effluents: Integrating thermal distillation with granular activated carbon and zeolite post-treatment

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What's the Problem?

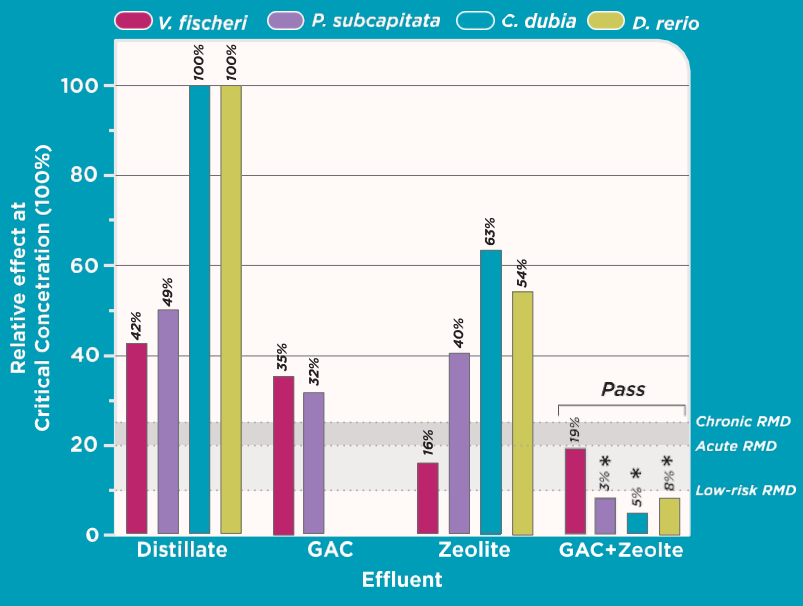
The treatment of produced water using desalination processes like thermal distillation does not fully remove certain pollutants like small organic compounds and ammonia, which cause short-term (acute) and long-term (chronic) effects on aquatic life and humans. Granular activated carbon (GAC) and zeolite filtration were proposed as a post-treatment to remove residual compounds in the thermal distillate. This study fills in the knowledge gap to investigate the effectiveness of an integrated treatment process to reduce potential risks for PW beneficial reuse.

How Was the Study Done?

Real and desalinated produced water (distillate) from an operating pilot system in the Permian Basin was collected, analyzed, and used to determine the impact on survival, growth, and development of four aquatic organisms, including marine bacteria, freshwater green algae, water flea, and zebrafish embryo. Distillate was further treated by GAC, zeolite, or a combination of GAC + zeolite. The integrated chemical characterization and whole effluent toxicity (WET) testing were employed to assess effluent hazards and the effectiveness of the treatment processes.

What Were the Results?

Results showed that aquatic organisms exposed to the distillate, GAC-treated, or zeolite-treated had lower survival rates than those exposed to produced water distillate treated by the combination of GAC + zeolite (Figure 1). This work suggests that it is possible to treat raw produced water to a non-toxic level.



What's Next?

Although this work demonstrated that post-treating the produced water distillate using GAC + zeolite could result in passing the whole effluent toxicity (WET) testing, the treatment processes used were not optimized for full-scale treatment. Subsequent research should focus on optimizing the treatment process to increase treatment efficiency and reduce cost, without sacrificing performance.

Figure 1: Test of Significant Toxicity (TST) analysis of the effluents. Acute RMD: Acute TST regulatory management decision (20% effect); Chronic RMD: chronic TST regulatory management decision (25% effect); Low-risk RMD: Low- risk regulatory management decision (10% effect); Pass: toxicity levels in the effluent are considered acceptable.

* Effects not significantly different from the control.
RMD: Regulatory Management Decisions.