In-Situ Generated Stannous Oxide — A Powerful Germicidal Solution for Effective Produced Water Treatment

The oil and gas industry generates vast quantities of produced water—often exceeding several barrels per barrel of oil extracted—containing a complex mix of hydrocarbons, heavy metals, salts, and microbial contaminants. Managing this wastewater is not only a logistical challenge but also a critical environmental and regulatory concern, as untreated or improperly handled produced water can lead to soil contamination, aquifer depletion, and ecological disruption. Current treatment methods, including mechanical separation, chemical oxidation, and biological processes, have demonstrated effectiveness but often come with high operational costs, energy demands, and secondary waste generation.

SafeGuard™ H2O is a newly developed advanced solution that mitigates environmental impacts and enhances the viability of produced water for discharge or reuse, ultimately fostering a more sustainable approach to resource management in the industry. This patented technology generates a stannous reagent on-site and on-demand through an electrolytic process, offering an effective reagent delivery method.

Due to the unstable, corrosive, and toxic nature of industrially produced stannous-based bulk reagents, the implementation of stannous species as a treatment reagent has been limited. However, now, with the ability to produce a non-toxic reagent in-situ, the limitations of bulk stannous are eliminated and the germicidal power of stannic (tin), in its oxidative state of stannous dioxide (SnO_2) can be fully explored.

The germicidal power of stannic (tin) in its oxidative state of SnO_2 is well documented. Stannous dioxide as a germicidal agent arises primarily from its potential to reactivate oxygen species that damage bacterial cellular walls. Studies have demonstrated that SnO_2 in the form of nanoparticles can be incorporated into antimicrobial coatings, suggesting the reagent can have applications as a corrosion inhibitor in flowlines, tanks, and other such oil/gas-related lease assets.

The SafeGuard H2O system generates and 'captures' the high oxidative state of SnO_2, which can be used over an extended period or generated as needed. This green chemistry solution was evaluated for its germicidal potential in oil/gas-produced water samples. Produced water samples, with varying water matrices (Table 1), were obtained from the Permian Basin, Texas.

Table 1. Water Quality Parameters of Produced Water Samples

Water Quality Parameter	PW-A Sample Measurement	PW-B Sample Measurement
Alkalinity as $CaCo_3$	3012.0 ppm	2541.0 ppm
COD	1700.0 ppm	979.0 ppm
TOC	955.5 ppm	803.1 ppm
Ammonia	400.0 ppm	310.0 ppm
TDS	128,400 ppm	111,030 ppm
pH	6.6 S.U.	6.8 S.U.

The SafeGuard H2O system generated SnO_2 on-site at a concentration of approximately 600 ppm. Using varying SnO_2 dose rates, the germicidal efficacy of the SnO_2 reagent was undertaken during a 30-day evaluation by dosing the two produced water samples (PW-A, PW-B) and performing 4-day, 14-day and 30-day kill study assays (Table 2).

The onsite generated SnO_2 reagent demonstrated a significant germicidal effect by reducing log-growth over the 30-day growth study. Moreover, the SnO_2 reagent maintained its germicidal residual in the produced water samples utilized in this study. Through microbiological assessments, the effectiveness of the SnO_2 reagent in biofilm degradation and preventative application capacities for produced water treatment, storage and reuse was proven.

Table 2. Germicidal Efficacy of SnO_2 in Produced Water – Kill Study Results

Sample		SnO_2 Dosage (ppm)	Int. BQ	4-Day BQ	% BQ Reduction + Kill	14-Day BQ	% BQ Reduction + Kill	30-Day BQ	% BQ Reduction + Kill
6/8/24	PW-A	2	45356	56.38	99.87 + High	61.34	99.86 + High	60.3	99.86 + High
	PW-A	10	45356	50.55	99.89 + High	53.65	99.91 + High	50.11	99.88 + High
	PW-A	15	45356	45.36	99.9 + High	50.1	99.87 + High	50.09	99.87 + High
	PW-A	50	45356	210.3	99.54 + High	107.4	99.76 + High	90.01	99.80 + High
7/6/24	PW-B	2	29064	868.1	97.01 + High	244.5	99.15 + High	251	99.13 + High
	PW-B	5	29064	733.8	97.47 + High	179.4	99.38 + High	203.7	99.3 + High
	PW-B	10	29064	510.7	98.27 + High	337	98.84 + High	310.4	98.93 + High
	PW-B	2.5	29064	743.2	97.49 + High	391	98.68 + High	441.6	98.51 + High
	PW-B	3	29064	549.4	98.14 + High	416.8	98.59 + High	520.7	98.24 + High
	PW-B	3.5	29064	600.9	97.97 + High	588.5	98.01 + High	514	98.26 + High

By integrating SafeGuard H2O into produced water management practices, the oil and gas industry can achieve a more sustainable, cost-effective, and scalable approach to water treatment. This innovative solution aligns with industry trends toward water reuse, reducing reliance on freshwater sources, and minimizing environmental liabilities associated with wastewater disposal. Additionally, the ability to generate a non-toxic reagent on-site enhances operational flexibility while reducing chemical handling risks, making SafeGuard H2O a transformative tool for the future of produced water treatment.

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