

A Comparative Study for the Treatment of Sulfide within Municipal Wastewater Using Hydrogen Peroxide Alone Versus VTX Catalyzed Hydrogen Peroxide

Objective

Repeated bench scale tests were conducted using various treatment dosages of hydrogen peroxide alone against the combination of hydrogen peroxide and VTX catalyst in the treatment of sulfides within municipal wastewater. The comparison was done to understand the benefits, if any, for treatment rates and overall efficiency of treatment between hydrogen peroxide alone versus VTX catalyzed peroxide.

Treatment Conditions

Municipal wastewater collected from a City of Melbourne, Florida lift station was used to conduct the studies. Sulfide within the wastewater was low at the times of the sampling events so levels were adjusted to more significant concentrations using technical grade sodium sulfide.

Four levels of treatment were selected for testing which reflected mass of hydrogen peroxide to sulfide ratios of 1.5:1, 2.5:1, 3.0:1 and 4.0:1, respectively. Each test ratio was conducted using the prescribed hydrogen peroxide dosage for peroxide alone against four levels of VTX/hydrogen peroxide.

The four levels of VTX treatment reflected volume:volume ratios of 50% hydrogen peroxide to concentrated VTX catalyst. The ratios of peroxide to VTX were 40:1, 20:1, 10:1 and 5:1. The level of peroxide added to the VTX treatments was identical in each case to “hydrogen peroxide alone” samples for individual test ratios. To clarify by way of example, if 1.0 milliliters of 50% peroxide were needed to accomplish a treatment then VTX concentrate would be added at one of the above ratios (i.e. VTX at 1/40th, 1/20th, 1/10th or 1/5th of 1.0 milliliter).

Tests for total sulfide were conducted for each treatment level at times 0, 5, 10, 15, 20, 25 and 30 minutes. Each test received a dosage at time 0 (after confirming start level) and was well mixed for one minute to assure complete mixing of the ingredients with the wastewater. Discrete sub-samples were taken at each time level and immediately tested for sulfide using a HACH Chemical DR 2000 spectrophotometer with the EPA Method 4500 – S²⁻ (Methylene Blue Technique). Treatment goals for a successful test in this study were set at 1 ppm.

Results and Discussion

The following graphs depict the comparative results over the 30 minutes of testing for each of the various test levels.

Graphic results at all test levels indicated that VTX had a significant effect on both the rate and overall efficiency of treatment of sulfide within the municipal wastewater tested.

The literature suggests that effective sulfide treatment using hydrogen peroxide requires dosage of hydrogen peroxide in the range of 2.5 to 4.0 times the mass of the target sulfide (e.g. 1 ppm sulfide requires 2.5 to 4.0 ppm H₂O₂). Test results in this study indicate that slightly more than a ratio of 4.0:1 of hydrogen peroxide to total sulfide would be required to reduce sulfide in test samples to below the acceptable treatment goal of 1 ppm sulfide. An analysis of the data indicates that the VTX process resulted in improved overall efficiency of treatment after 30 minutes. Naturally, higher hydrogen peroxide additions improved performance as a single additive but the effect was much more pronounced for the VTX/H₂O₂ treated samples, particularly as relates to the rate of treatment.

The following tables show comparative percentage of destruction results after 5 minutes and 30 minutes of treatment, respectively.

Table 1. Percentage Destruction of Total Sulfides after 5 Minutes of Treatment

Treatment Level	H ₂ O ₂ Alone	H ₂ O ₂ /5xVTX	H ₂ O ₂ /10xVTX	H ₂ O ₂ /20xVTX	H ₂ O ₂ /40xVTX
1.5	18.6%	63.4%	54.0%	32.2%	28.8%
2.5	32.1%	92.5%	87.2%	81.6%	71.4%
3.0	33.6%	93.0%	91.4%	82.2%	71.0%
4.0	56.1%	99.0%	98.4%	97.9%	97.8%

Table 2. Percentage Destruction of Total Sulfide after 30 Minutes of Treatment

Treatment Level	H ₂ O ₂ Alone	H ₂ O ₂ /5xVTX	H ₂ O ₂ /10xVTX	H ₂ O ₂ /20xVTX	H ₂ O ₂ /40xVTX
1.5	62.2%	93.5%	86.5%	77.7%	70.6%
2.5	81.8%	97.3% ¹	98.8%	98.3%	97.0%
3.0	89.6%	98.4% ²	97.3% ³	97.3% ⁴	94.1%
4.0	93.9%	99.0% ⁵	98.4% ⁵	97.9% ⁵	97.8% ⁵

¹ After 15 minutes ² After 10 minutes ³ After 15 minutes ⁴ After 20 minutes ⁵ After 5 minutes

Table 1 results of sulfide destruction after five minutes of contact show dramatic percentage reductions in sulfide in all VTX treated samples as compared to peroxide alone, particularly in those samples treated with peroxide at 2.5, 3.0 and 4.0 times sulfide mass. The rate of destruction after five minutes was between 45% and 60 % better than peroxide alone at the 2.5 and 3.0 dosages and between 10% and 38% better at the 1.5 treatment level. The treatment at a peroxide ratio of 4.0 was particularly impressive with

all VTX treatments exceeding 97.9% within five minutes of contact. Treatments using peroxide alone lagged far behind VTX at the 4.0 treatments level with 56% removal after five minutes.

After 30 minutes of treatment the overall percentage of destruction was improved over peroxide alone in VTX treatments as can be noted in Table 2 and Figure 1. Overall efficiency improvements were noted at all levels of VTX treatment over peroxide alone. The effect was most pronounced at the 2.5 treatment ratio where an improvement of 15% was noted. Improved efficiency of 8%, 5% and 4% were noted for levels 1.5, 3.0 and 4.0, respectively.

It should be noted that peroxide alone did not meet the 1 ppm goal at any level of treatment. That goal was met for all levels of treatment using VTX with the exception of the lowest treatments at level 1.5.

Conclusions

The VTX catalyst with hydrogen peroxide significantly improved the efficiency and rate at which hydrogen peroxide alone treated total sulfide within a municipal wastewater sample.

Treatments using VTX allowed for successful treatment of sulfides within the wastewater in less than five minutes. Treatments with peroxide alone lagged far behind this rate at all test levels.

Overall efficiency of treatment after 30 minutes was improved with VTX treatment at all levels of study. An improvement of up to 15% was noted in one study. Improvements in the remaining studies ranged from 4% to 8%.

Figure 1: Comparative Treatment of Sulfides in Wastewater H2O2 vs. VTX Process

