Stability Comparison of REFLEX vs. Perasan A

Background

REFLEX is a new product Enviro Tech has to offer its customers. It is a new peroxyacetic acid one-step, no rinse sanitizer designed for the food, beverage, and dairy industries. It is a combination of peroxyacetic acid, hydrogen peroxide, and nitric acid. REFLEX is typically diluted 1 fl. oz. per 4-7 gallons of water. Inquiries have been made about the stability of REFLEX compared to Perasan A, which is similar in PAA concentration. Customers are questioning the stability of REFLEX once diluted to the labels specifications. A study was completed to compare the decay of PAA in three different dilutions of Perasan A and REFLEX.

Methodology

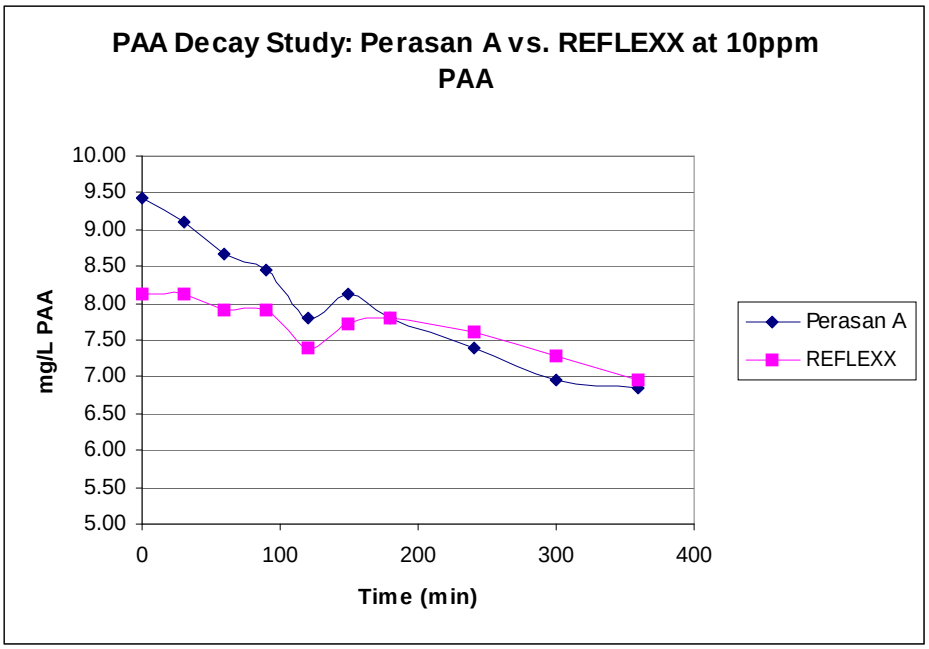
Each product was diluted to three different concentrations with hard water to compare the stability of PAA over time. Each product was diluted according to the label and then at a low concentration of 10 ppm PAA and a high concentration of 500 ppm PAA. The pHs of the solutions differ between REFLEX and Perasan A. REFLEX has a lower pH than Perasan A. The lower pH means REFLEX would be expected to more stable than Perasan A upon dilution. The dilutions are listed in Table 1 below.

Table 1

		pH			pH
Perasan A	10 ppm PAA	7.22	**REFLEX**	10 ppm PAA	7.05
	1fl. oz to 6gal	5.72		1fl. oz to 6gal	3.08
	500 ppm PAA	3.82		500 ppm PAA	2.09

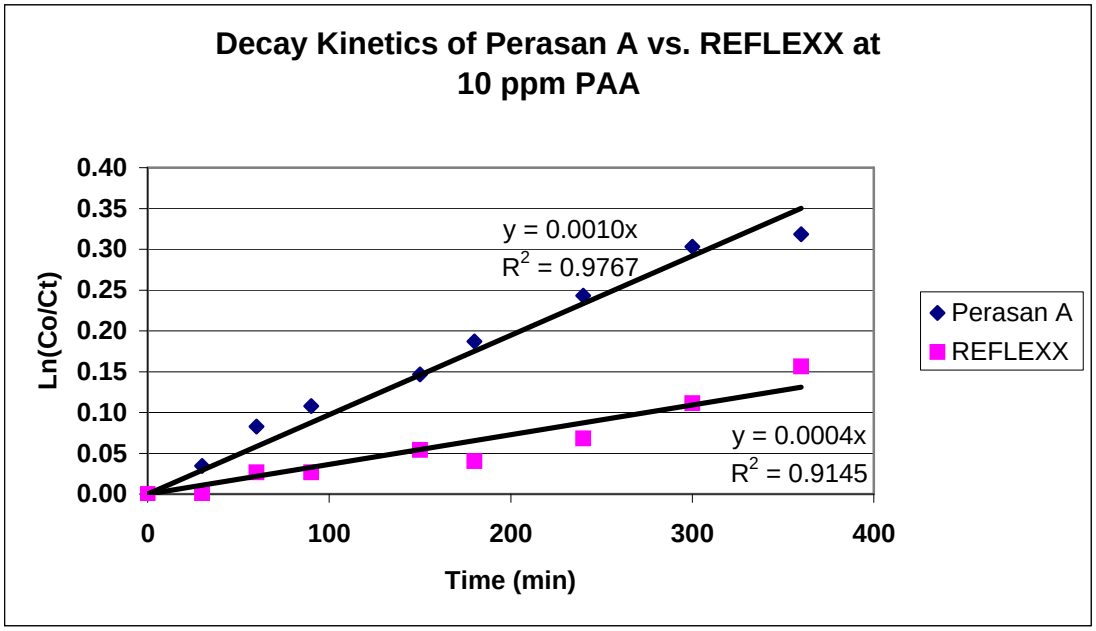
The results for each solution were graphed comparing the decay of PAA of REFLEX to Perasan A. Graph 1 illustrates the degradation of PAA at a low concentration of 10 ppm PAA. Peroxyacetic acid is more stable in an acidic environment. At the low concentration the PAA began to degrade after only one hour for both Perasan A and REFLEX. The high pH of the dilution was responsible for the rapid decay of the peroxyacetic acid in the 10ppm concentration dilution. The pH of the Perasan A was 7.22 and the pH of the REFLEX was 7.05. These pHs are not acidic enough to support the stability of PAA.

Graph 1



Graph 2 illustrates the decay kinetics for REFLEX and Perasan A for the 10 ppm PAA dilution. A linear line was imposed on the data. On the graph, both the equation of the line and the R^2 value (correlation coefficient) are represented. The slope of the line represents the rate constant for the decay reaction. The R^2 value represents how precisely the linear regression line fits the data. An R^2 value of 1 indicates that the linear regression line fits the data perfectly. The slope of the Perasan A is 0.0010 indicating that the solution of Perasan A, diluted to 10 ppm PAA, decayed with a rate constant of $0.0010min^{-1}$. The R^2 value calculated for the 10 ppm PAA solution made from Perasan A was 0.9767. This indicates the decay of PAA corresponds very closely to a mechanism of first order decay. The slope of the REFLEX is 0.0004 indicating that the solution of REFLEX, diluted to 10 ppm PAA, decayed with a rate constant of $0.0004min^{-1}$. The R^2 value calculated for the 10 ppm PAA solution made from REFLEX was 0.9145. This indicates the decay of PAA corresponds closely to a mechanism of first order decay.

Graph 2



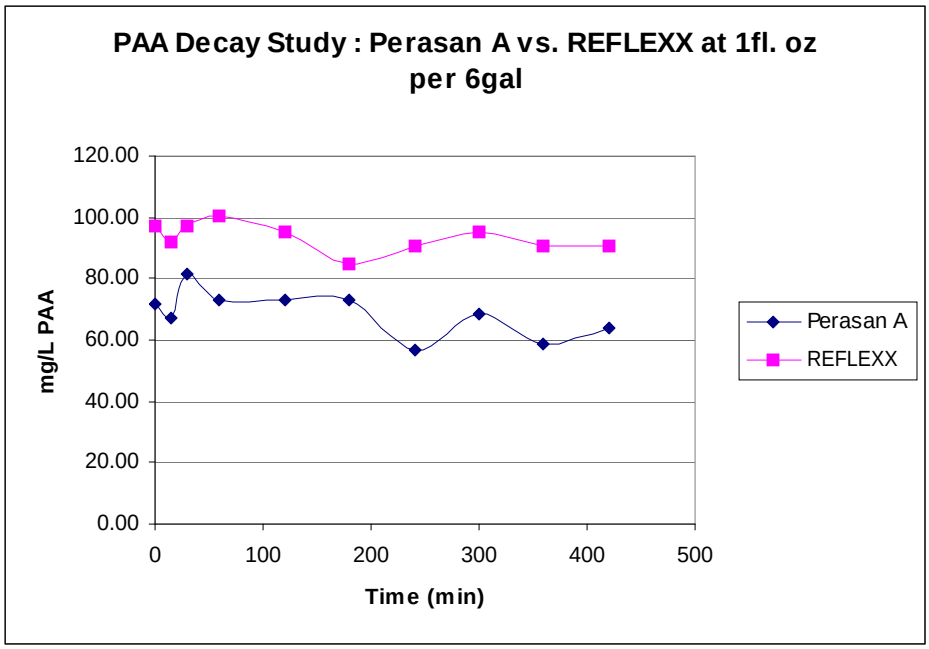
The half-lives for the decay of PAA of the respective solutions (calculated by dividing the slopes of the respective regression lines by 0.692 - the natural logarithm of 2) are displayed in Table 1 below.

Table 1: Half-Life of a 10 ppm solution

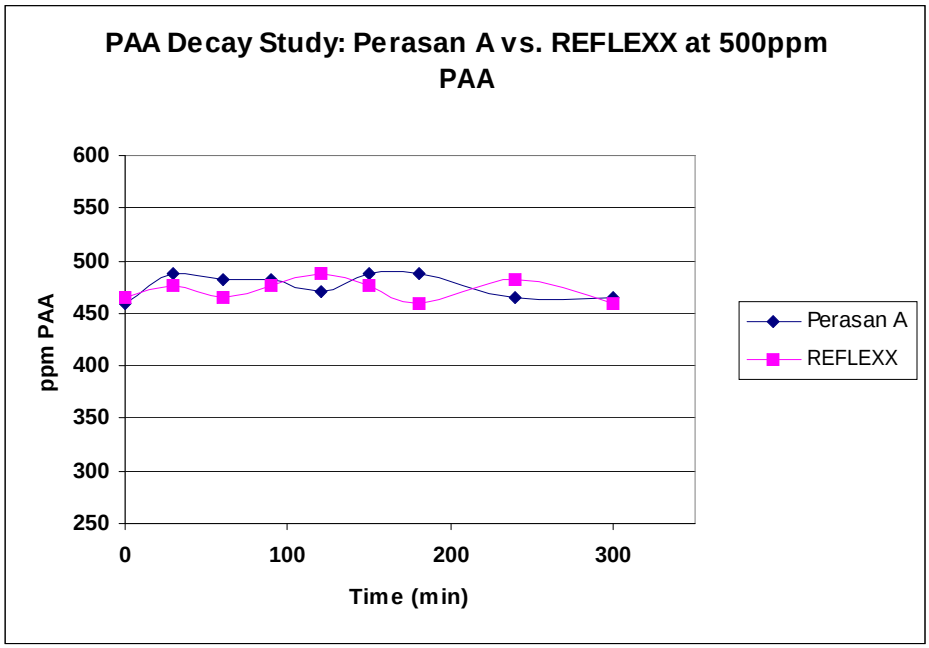
	Half-Life of PAA (hrs)
Perasan A	12.8
REFLEX	28.8

Graph 3 illustrates the decay of PAA when diluted to the labels specifications. The label states dilute 1fl. oz. to 4-6 gallons of hard water. For this study, 1fl. oz. to 6 gallons was chosen for the dilution. The study was conducted over a seven-hour period of time. The PAA was relatively stable at this concentration (approximately 100 ppm PAA). The activity of the diluted Perasan A was 71.7 ppm PAA. After seven hours, the PAA only decreased to 64.2 ppm PAA. The activity of the REFLEX started a little higher, 97.4 ppm PAA and decreased to 91.0 ppm PAA after the seven hours. The PAA was more stable at this concentration due to the pH of the solutions. The pH of the Perasan A dilution was 5.72 while the REFLEX dilution's pH was 3.08. The lower pH of the REFLEX allows the PAA to be slightly more stable than the Perasan A when diluted according to the labels specifications.

Graph 3



Graph 4



Represented in Graph 4 is the 500 ppm PAA dilution. Both products remained stable over the six-hour period of the study. The activity of the diluted Perasan A was 460.1 ppm PAA. The PAA had not decayed after six hours. The activity of the REFLEX started at 465.5 ppm PAA and after six hours 460.1 ppm PAA was recovered. The PAA was most stable at this concentration due to the pH of the solutions. The pH of the

Perasan A dilution was 3.82 and the REFLEX dilution's pH was 2.09. The pH of both dilutions was acidic enough to prevent PAA decay. The enhanced stability of both solutions at these dilutions meant first-order or pseudo first order plots could not be constructed in order to predict the half-live of PAA.

Conclusions

- PAA is more stable in dilutions with lower pH ranges. The pH for the Perasan A dilutions ranged from 7.22 for 10 ppm PAA to 3.82 for 500 ppm PAA. The pH for the REFLEX dilutions ranged from 7.05 for 10 ppm PAA to 2.09 for 500 ppm PAA. The REFLEX has a lower pH than Perasan A, therefore, the pHs were consistently lower in the dilutions made with the REFLEX than Perasan A.

- REFLEX had a longer half-life at 10 ppm PAA. The half-life for 10 ppm PAA from REFLEX was about two times longer than the half-life for Perasan A at the same concentration. At the higher concentration, 500 ppm PAA, Perasan A and REFLEX had comparable due to the low pH, 3.82 and 2.09 respectively.

- The enhanced stability of 500 ppm and 1 to 6 gallon dilutions meant first-order or pseudo first order plots could not be constructed in order to predict the half-live of PAA.

- REFLEX is more stable than Perasan A at lower concentrations due to the product's initial lower pH. REFLEX is also comparable to Perasan A at higher concentrations because their pHs are quite low (below 4).

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