# Hydrolysis of Explosives in Sea Water

by
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In a previous paper we described a method for the quantatitive analysis of TNT (2,4,6-trinitrotoluene), RDX (1,3,5-trinitro-1,3,5-triazocyclohexane) and tetryl (N-methyl-N-nitro-2,4,6-trinitroaniline) by vapor phase chromatography (1). Solutions of sea water containing TNT, RDX and Tetryl were made: (a) to obtain an approximate value for the solubility; and (b) to determine the benzene extraction efficiency in the analytical procedure (1). A few months later we observed a coloration in the tetryl solution. Therefore, these solutions were reexamined with the results reported below.

## Results and Discussion

TNT, RDX and tetryl were each added to sea water and stirred at least six hours, after which they were filtered through glass fiber filter paper. The solutions were analyzed by vapor phase chromatography (1), with results reported in Table I.

TABLE I
Solubility in Sea Water ( ~ 25°C)

| | mg/l | (ppm) |
|---|---|---|
| TNT | 94.4; | 95.6 |
| | Av. | 95.0 |
| RDX | 56.0; | 55.2 |
| | Av. | 55.6 |
| Tetryl | 25.7; | 27.2 |
| | Av. | 26.4 |

The solutions should not be considered as saturated, but probably are reasonably close to saturation. These solutions were made up at room temperature ( ~ 25°C ) and were stored at this temperature in actinic glassware.

A few months later the tetryl solution was analyzed again using the same procedure, as it had developed a light yellow coloration. Only 12% of the tetryl remained after 101 days. In the spectrophotometer, the solution had a $\lambda$ max of 352 nm. This is



Bulletin of Environmental Contamination & Toxicology,
Vol. 10, No. 2 © 1973 by Springer-Verlag New York, Inc.

characteristic of picric acid, an expected hydrolysis product. Our optical density value was calculated to yield 80.5% picric acid using the molar absorbency $\epsilon = 14,130$ (2). The conversion of tetryl to picric acid shown by the spectrophotometric measurement is in good agreement with the change in tetryl concentration shown by the gas chromatographic analysis. Tetryl heated with dilute alkali is known to produce picric acid, methylamine and nitrous acid (as Nitrite) (3). As ocean water has a pH around 8.1 (4), the formation of picric acid from tetryl dissolved in sea water appears reasonable.

The RDX solution was analyzed by vapor phase chromatography 112 days after the first analysis was made. It showed an 11.6% decrease in concentration. RDX is known to hydrolyze when heated with dilute alkali (5). Apparently, RDX is hydrolyzed by sea water.

TNT dissolved in sea water showed no change in concentration by vapor phase chromatography after 108 days at room temperature. Although TNT also is known to hydrolyze with alkalis (6), the rate of hydrolysis in the sea water must be very slow.

Our results are summarized in Table II.

TABLE II
Hydrolysis in Sea Water ( ~ 25°C )

| | Time, days | Hydrolysis, % |
|---|---|---|
| TNT | 108 | 0 |
| RDX | 112 | 11.6 |
| Tetryl | 101 | 88 |

## References


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