Corrosivity of 2,2-dibromo-3-nitrilopropionamide (DBNPA) in Direct Contact with Mild Steel, Stainless Steel, and Zinc Coupons

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Introduction

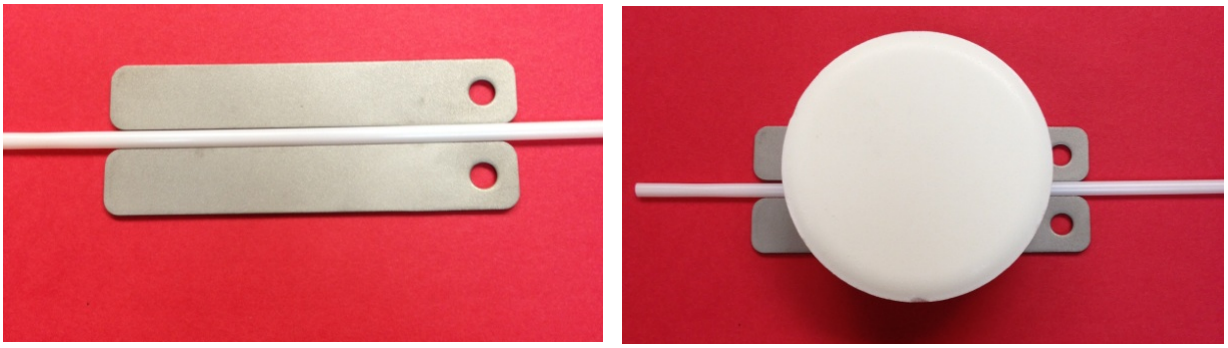
Enviro Tech Chemical Services has recently received U.S. EPA registrations for several of its solid DBNPA products. The 2.125" tablets that are used in the oil & gas, cooling water, and food processing industries may come into contact with a number of different metals, and it is the purpose of this study to determine the corrosive effects on the three most common of these metals. In hydraulic fracturing, fresh and flowback water that sometimes requires disinfection is stored in 500 bbl "frac tanks" made of carbon steel, and loose tablets provide a very convenient method of dosing. Small cooling towers basins to be treated with the tablets are often made of galvanized steel, while floor drains in food plants generally house stainless steel baskets to hold the tablets. Hence, it is of interest to determine the corrosivity of DBNPA in direct contact to with mild steel, stainless steel, and zinc metals.

Materials and Methods

Enviro Tech's Enviro Brom® Tabs contain approximately 95% active DBNPA. Two metal coupons with a nominal size of 3" x ½" were obtained for each of mild steel (C1010), stainless steel (316L), and zinc. Each set of coupons was thoroughly washed with mild detergent and water, dried, and then rinsed with acetone to remove any residual oils. The exact dimensions of each coupon were measured using a caliper, and each coupon was weighed on an analytical balance. The three pairs of coupons were placed in three different pails each containing 5 gallons of Modesto city water at ambient temperature. The two coupons were place side-by-side in each bucket but were separated with a 3 mm plastic rod to prevent the two metal coupons from coming into contact. A 100 gram Enviro Brom® Tab was placed directly on top of the coupons so both coupons were equally covered. Each of the three pails were covered and allowed to sit undisturbed for 30 days, the concentration of DBNPA in each pail being measured on a weekly basis using the Palin modification of the DPD method.

Figure 1 Metal coupons prior to contact with the DBNPA test material. Metals tested were mild steel (C1010), stainless steel (316L), and zinc.

Figure 2 Representation of metal coupon arrangement in the pail relative to the DBNPA tablet test.



Prior to each weekly test, the pails were mixed gently to ensure homogeneity without disturbing the tablet or coupons. See

Table 1 for the average concentration of DBNPA in each of the 3 pails over the 30 day test period.

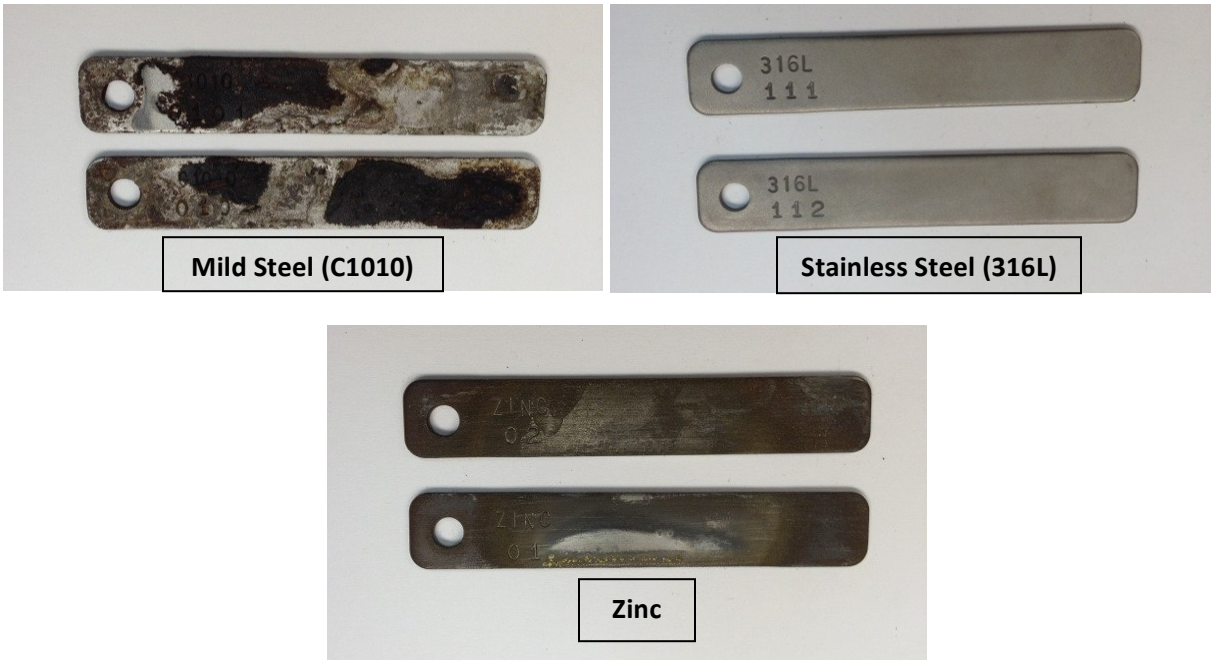
Table 1 Average concentration of DBNPA measured over the 30 day time interval for each pail.

Description	Avg. Conc. DBNPA (ppm)
Pail Containing Mild Steel (C1010)	598.1
Pail Containing Stainless Steel (316L)	517.6
Pail Containing Zinc	503.1

After 30 days, the coupons were removed from the pails and thoroughly cleaned to remove loose corrosion deposits. Acetone was again used as a final rinse on the coupons. The coupons were reweighed on the analytical scale and the final masses recorded.

Results

Figure 3 Final cleaned coupons after 30 day contact time with the DBNPA test material.



The corrosion rate was calculated using the following equation:

$$Corrosion\ Rate\ (mpy) = 534 \times \left(\frac{W}{DAT}\right)$$

Where:

W = Average weight loss of the two coupons over the 30 day interval (*mg*)
D = Density of the specific metal (g/cm^3)
A = Area of exposed surface of the coupon (in^2)
T = Contact time of the coupon to the DBNPA test material (*hours*)

Table 2 shows the average mass loss of the three sets of coupons and the corrosion rate

Description	Avg. Mass Loss (mg)	Density (g/cm^3)	Corrosion Rate (mpy)
Mild Steel C1010	897.6	7.872	28.23
Stainless Steel 316L	0.0	7.99	0.00
Zinc	161.1	7.14	5.58

One common guideline for metal corrosion rates is:

- <5 mpy very good
- 5-10 mpy acceptable/marginal
- >10 mpy unacceptable

Conclusions

- Mild steel C1010, stainless steel 316L, and zinc were submerged in three separate pails each with one, 100 gram Enviro Brom® Tab. The metal coupons were allowed to stay in contact with the tablet for 30 days. The corrosion rates were calculated based on the weight loss of the coupons and average between two samples:
    - Mild steel C1010 corrosion rate of 28.23 mpy
    - Stainless steel 316L corrosion rate of 0.00 mpy
    - Zinc corrosion rate of 5.58 mpy
- DBNPA was most corrosive towards the mild steel (C1010). The high corrosion rate of 28.23 mpy indicates that this may not be an appropriate material for contact with DBNPA. This study represents a worst-case situation in which the solid DBNPA remains in direct contact with the metal. In situations where DBNPA is suspended above the metal, or only dilute solutions contact the metal, a lower corrosion rate would be expected.
- Zinc proved to be marginally acceptable when in contact with DBNPA. A corrosion rate of 5.58 mpy indicates that a galvanized coating may provide adequate protection to

steel structures exposed to dilute solutions of DBNPA, but may not be appropriate for direct contact with the DBNPA tablets. Again, an alternative would be to suspend the tablets above or away from the metal surfaces.

- DBNPA was not corrosive to stainless steel 316L, as indicated by the 0.00 mpy corrosion rate. This would be the preferred metal for direct contact with the product in a floor drain basket.