**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**WASHINGTON, DC 20460**

OFFICE OF PREVENTION, PESTICIDES, AND TOXIC SUBSTANCES

9/25/07

MEMORANDUM

SUBJECT: ENVIRONMENTAL FATE SCIENCE CHAPTER ON SODIUM FLUORIDE FOR RED PROCESS

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**ENVIRONMENTAL FATE ASSESSMENT OF SODIUM FLUORIDE**:

## EXECUTIVE SUMMARY

The Agency did not require and no fate data were submitted for sodium fluoride. However, because sodium fluoride is used as a supplemental wood preservative (non-pressure-treatment application) and in agricultural settings as an inert, environmental fate assessment has been made and to this end the Agency has conducted a published literature search. There are not many studies published on environmental fate chemistry of sodium fluoride.

A. Hydrolysis:

Sodium Fluoride is an inorganic substance which does not undergo hydrolysis typically like an organic compound. Sodium fluoride is water soluble and dissociates in water:

$$NaF \text{ ----------> } Na^+ + F^- \text{ ---------- (1)}$$

and further, fluoride ion undergoes hydrolysis: $F^- + H_2O$ ----------> $HF + OH^-$ ----- (2)
Because HF acid is a weak acid and OH ion is a strong base, it shifts the pH to the alkaline side.

B. Aqueous Photolysis:

Sodium fluoride is transparent to ultra violet light and hence aqueous photolysis is not likely to occur.

C. Biodegradation Processes:

1. A monitoring study reported in AWPA [a] showed that leaching of supplemental wood preservatives (including sodium fluoride) from treated wood poles indicated no ground water pollution with these supplemental wood preservatives and the background level of fluoride ions is not elevated.

2. Surface water monitoring data showed that fluoride ion concentration does not increase any higher than the concentration at the background level.

   The background level in ground water does not exceed 0.4 ppm level which is much lower than allowed in the drinking waters (0.7 ppm for Southern United States and 1.2 ppm for the Eastern/Northern United States).[b] Surface water also does not appear to be contaminated. Sodium fluoride does not appear to pose any environmental concerns in surface and ground waters.
   [b](Water and Wastewater Calculations Manual by Shundar Lin, pp 461-463, McGraw Hill , 2001)

3. Soil monitoring data from the same study showed an increase in the concentration of fluoride ions up to 10 cm distance away from the pole from which the wood preservative has leached out, but by the end of study (18 months duration), the concentration of fluoride becomes equal to the background levels. Most of the downward migration of fluoride ions was up to 10 cm depth and is non-detect at 50 to 100 cm deep into the ground around the poles.
   NaF does not appear to be mobile in soil and slowly attains background level concentrations.
4. Sodium fluoride does not appear to adversely affect the soil biomass, microflora and macro invertebrate of soil system.
5. A monitoring study on wood preservative Osmoplastic was commissioned by Osmose Wood Preserving, Inc. and conducted by Envirologic Data, Inc. of Portland, Maine and Ground Water Technology, Inc. of Albany, New York, and was completed in 1989. This study showed that if 100% of sodium fluoride leached out into soil and all of it reached ground water (NaF = 400 ppm per release from one treated pole), the predicted concentration of 1.44 mg/L would not exceed the Maximum Concentration Limit (MCL) as established by National Primary Drinking Water Act of EPA, 1988.
6 OPPT's Modeling Program (EPI SUITE) estimated log $K_{ow}$ of sodium fluoride = -0.77 and it being dissociating in aqueous medium, it is not likely that sodium fluoride would be bioaccumulative.

## Appendix

### A Field Study of Mobility of Supplemental Wood Poles Preservatives in Adirondack Wetlands

(By: Edward M. Michalenko, Ph.D., Swiatoslav W. Kaczmar, Ph.D., and Bryant A. Browne, Ph.D.) ( AWPA: Vol 97, 1993, pp 22-50)

Empire State Electric Energy Research Corporation (ESEERCO) sponsored a research project to conduct an environmental risk assessment on supplemental wood preservatives used on utility transmission poles. Moreover this study was conducted to evaluate eco and human health impact of these wood preservatives. The study was performed by O'Brien & Gere Engineers.

Supplemental Wood Preservatives are used to arrest the ground line decay of wood poles already in service and have been primarily treated with existing pressure-treated preservatives. Supplemental wood preservatives are more cost effective than replacement poles.

Field Site: New York State Adirondack Park was selected because it has seasonally high water tables and nature of soil is sandy, which are conducive to creating wetland environmental conditions and help in environmental release and migration of the supplemental wood preservatives. This in turn makes the detection of these wood preservatives in soil and water easy. Supplemental Wood Preservatives selected for this field study, along with their active ingredients are shown in Table 1

Table 1

| Supplemental Wood Preservative Type/Treatment | Active Ingredients ( Reported as % by Volume) |
|---|---|
| Copper Naphthenate | Copper naphthenate (80%) |
| WoodFume ( Vapam) | Sodium methyldithiocarbamate(32.7%) |
| Dursban | Chloropyrifos (0.50%) |
| Hollow Heart | Sodium fluoride (10.9%), sodium dichromate (4.8%), sodium arsenate (5.36%) |
| OsmoPlastic | Sodium fluoride (43.7%), creosote (40.0%), potassium dichromate (3.1%), 2,4-dinitrophenol (2.0%) |

This review will extract and summarize data, analysis and conclusions from the last two wood preservatives in Table 1 (OsmoPlastic, and Hollow Heart) as these two contain sodium fluoride which is the subject of this environmental fate assessment

**Methodology:**

A multilayer field study was conducted:

1. Chemical Migration was monitored from the treated wood into the nearby ground and surface water. This was done by collecting data through four chemical sampling events.
2. Soils were analyzed by conducting three chemical sampling events.
3. Four biological sampling events were conducted to test for the changes in soil respiration (any mineralization?), soil microbial biomass (changes in microcosm), and soil-macro-invertebrates.
4. Overall Sample Size of the Entire Study: 20 treated poles were selected.
5. Method of Application of the Supplemental Wood preservatives was:

    a. Ground line bandage treatment
    b. Internal treatment
    c. Internal fumigant treatment

6. **Distribution of Wood Preservatives for Pole Treatments**

a. In all 20 poles was selected for supplemental wood preservative treatments. Of these nine were located in the Low lying areas (so-called wetland area) and 11 in the so-called 'upland' areas.
b. Of the nine poles in the wetland area, three were treated with copper naphthenate, three with Hollow Heart, and three with a mixture of Osmoplastic, Dursban and WoodFume
c. Of these nine wetland poles, six contain sodium fluoride along with other actives.
d. Of the 11 upland poles, three were treated with copper naphthenate, three with the mixture of Osmoplastic, Dusrban, and WoodFume and the remaining five were treated with Hollow Heart.
e. Of the 20 poles, 14 (wetland, upland) were treated with ingredients containing sodium fluoride (70% of the poles).
f. Irrespective of the method of application each pole was treated only once.

**Data Collections and Results:**

**I. Ground Water Monitoring**:

1. In all 138 wells existed or created around these 20 poles.
2. Up to 8 wells existed around each poles

3. Typically 4-5 poles were selected for ground water monitoring
4. O f these 3-4 poles were situated down gradient and 1-2 poles up gradient with respect to each pole.

**II. Chemical Monitoring**:

Over a period of eighteen months, four sampling events were carried out at the rate of 4.5 months/event for both surface and ground water monitoring.
For the same time period 3 monitoring events were conducted for soil sampling.
For both cases first monitoring sampling was done prior to supplemental wood treatment.
Analyses of the water and soil samples were done using EPA Methods, series 600 and 800, APHA, AWWA and WPDV Methods series 200, 300 and 700.

**III. Biological Monitoring**:

Four sampling events were conducted for biological monitoring. First sampling was carried out prior to the supplemental wood preservative treatment.

**IV Results of Ground Water Monitoring**:

For all poles ( 8) treated with Hollow Heart (containing sodium fluoride), ground water monitoring results indicated fluoride was present at the background level only and background level of fluoride determined in this area was between 0.15 to 0.4 ppm. Similarly, six poles treated with Osmoplastic wood preservative (contains sodium fluoride) and also Dursban (does not contain fluoride), did not show any residues above the background level.

**V. Results from Surface Water Monitoring:**

Fluoride ions were detected only at one pole, in both up gradient and down gradient samples (in first, second, and third monitoring events) but at the background level only which was determined around this area to be at 0.2 ppm In the fourth monitoring event, fluoride was non-detect.

**VI. Soil Monitoring Results:**

Soil sampling was done at two levels: 1) Surface and at 50 cm depth around the pole, and 2) at, 10, 50 and 100 cm distance away from the poles.

a. Organic constituents of Osmoplastic were non-detectable in the soil sampling.
b. Fluoride ion was detected from all six poles treated with Osmoplastic, Hollow heart and Dursban mixture treatments at the background level of < 25 ppm.
c. 16/23 soil samples collected before the preservative application showed the presence of fluoride ions.

d. 5/6 poles sampling at the 10 cm distance showed the presence of fluoride ions between 9-29 ppm. The concentrations of fluoride ions increased with time (second, third sampling events). Third soil sampling event showed the presence of fluoride ions in all six Osmosplastic, Dursban and Hollow Heart treated poles at a level of 13, 650, 180, 150, and 63 ppm levels at a 10 cm distance away from the poles. Beyond the 10 cm distance sampling, fluoride ion concentration attained the background level.

e. Deep soil sampling (50 cm deep, 10 cm away from the poles), the concentration fluoride ions = 44 ppm. A second sampling event showed the presence of fluoride ion between 20-100 ppm (at 10 cm distance away from poles). Third sampling event showed (50 cm depth, and 10 cm distance from poles) the presence of fluoride ions between 11-17 ppm.

f. 5/6 poles treated with Hollow Heart showed the presence of fluoride ions above background levels. Background level fluoride ion concentration in this are were between 2-110 ppm. However, no residues of fluoride ions were detected at 50 and 100 cm distance away from the treated poles. In general, above ground level residues of fluoride ions were restricted to an area within 10 cm distance away from the treated poles.

**VII: Biological Monitoring Results:**

a. 14 poles treated with OsmoPlastic, Dursban, Hollow HeartWoodFume, and copper naphthenane were tested for soil respiration levels and no sustained impact was noted in the soil respiration levels ( no increase in carbon dioxide level was noted).

b. Soil micro flora was not impacted in the area around the treated poles with all five supplemental wood preservatives.

c. Soil samples from 15 supplemental wood preservatives were collected and tested for soil-macro-invertebrates and no chemical impact was noted on these samples.

The duration of the entire study - chemical and biological monitoring was 18 months.

**Conclusions:**

In general, organic and inorganic ingredients of the supplemental wood preservatives when leached from the treated wood did not show any chemical or biological impact in water, and soil around the treated poles. Most of the constituents (including fluoride ions) did not migrate more than 10 cm from the pole and not more than a 50 cm depth around the poles. Most of the ingredients (including fluoride ions) attained the background level concentrations by the fourth and last monitoring event in soil and in ground water sampling most of the ingredients were at the background level and in the surface water sampling events, most of the ingredients were non-detectable.

**Bibliography**


1. E. M.Michalenko et al., AWPA, Volume 89, 1993, pp22-50
2. Handbook of Physics and Chemistry, 74th Edition
3. Merck Index, 12 Edition
4. Water and Wastewater Calculations Manual by Shundarin Lin, McGraw Hill, 2001, pp 461-463