Hazard Control Technologies, Inc.

Clemson Final Report

Excerpt – Smoke and Carcinogenic Toxin Reduction

Hazard Control Technologies, Inc.
150 Walter Way
Fayetteville, GA 30214
Phone: 770-719-5112
Fax: 770-719-5117
Email: info@hct-world.com
Website: www.hct-world.com

FINAL REPORT: TIWET PROJECT – 09440

A STUDY OF THE PHYSICAL PROPERTIES, BIOLOGICAL EFFECTS AND POSSIBLE USAGES OF F-500 IN ENVIRONMENTAL PROTECTION AND RESTORATION

Submitted by:
The Institute of Wildlife and Environmental Toxicology
Clemson University
Pendleton, SC 29670
George P. Cobb, Section Leader
Analytical Toxicology
July 24, 1997

Overview

This is an excerpt from the *Clemson Report*, focusing on the effect of F-500 Encapsulator Agent on smoke, specifically, smoke reduction, toxicity and light transmittance. The entire report is available, including all testing conducted; corrosivity, soil leaching, critical micellar concentration, temperature determinations, electrical tests, vapor reduction, biodegradation, microbial toxicity and rat toxicity tests.

Hazard Control Technologies was not allowed to make any changes to the report, so terms may be used that HCT would not use. The product tested is referred to as “F-500.” The actual product name is “F-500 EA” or “F-500 Encapsulator Agent.” Also, there may be references to F-500 EA as “foam.” F-500 EA is an “Encapsulator Agent,” which is very different from foam. This classification of fire suppression agent is now recognized by NFPA 18A 7.6, with capabilities different from foam or wetting agents.

SMOKE REDUCTION

Smoke Reduction Methods

Tests were conducted using containers of burning toluene placed beneath an inverted glass funnel. Above this funnel was a Teflon housing that contained a centered glass thimble packed with florisil. A high volume air sampler (Anderson Prod.) was used to draw smoke from the toluene fire through the funnel and into the thimble where smoke. Other combustion products were trapped on the florisil. Separate toluene containers, glass funnels and collection thimbles were used for each burn. Toluene smoke from each trial was timed at between one and two minutes. Nine burns were performed. Three burns were allowed to proceed normally. Water was sprayed through the smoke plume during three burns and F-500 was sprayed during three others. Toluene was ignited and allowed to burn for 15 seconds before placing them beneath their respective funnel/thimble. Quantitative assessments of smoke reduction were performed by weighing toluene smoke that deposited on glass funnels during the two minute test periods.

Florisil sorbents were then exhaustively extracted and concentrated for toxicity determinations. H4IIE rat hepatoma cell assays were used to determine carcinogenicity. Toxicity evaluations were performed with portions of soot extracts. The solvent from a 1 ml extract aliquot was exchanged with dimethylsulfoxide (DMSO) and diluted to 1 ml with DMSO. Rat hepatoma cell lines (H4IIE) were grown to uniform coverage in a growth media and exposed to each extract and to a 2,3,7,8 tetrachloro dibenzo-p-dioxin control. Toxic responses were measured as induction of ethoxyresorufin-o-deethylase, one of the P450 mixed function oxidases.

Light transmittance: Interference with light transmission was measured in a glass chimney two inches in diameter. Perpendicular to the main cavity of the chimney a viewing portal was constructed with 1 inch glass tubing that extended 2 inches and quartz windows were mounted at the end of both tubing extensions. This viewing portal was placed one foot from the bottom of the glass chimney. Wide spectrum light transmission was determined using a spectrophotometer with a fiber optic cable mounted at each window of the chimney. The fiber optic cable and spectrometer were constructed in the Department of Chemistry at Clemson University. Five spectra were acquired for each experiment.

Smoke Reduction/Visibility Results and Discussion

Visual observations showed that less soot was deposited on funnels when the smoke was treated by F-500. This visual observation was confirmed by weighing the amount of soot collected on each funnel. Mean and standard error values for soot collected above the toluene fire was 1.5±0.3 mg/sec, 0.67±0.13 mg/sec and 0.24±0.13 mg/sec for control, water and F-500 treatments, respectively. F-500 and water introduction into the smoke plume reduced soot/smoke significantly ($p<0.009$). Furthermore, F-500 reduced soot/smoke significantly compared to water ($p=0.016$). These data are significant since surfactant treatment was to the smoke plume not the fire itself. This information along with vapor reduction experiments suggest

an interruption of vapor phase combustion possibly by inhibiting radical coalescence into soot particles.

Smoke Toxicity

Many products of incomplete combustion were found as would be expected for the sooty smoke produced. Known toxicants were found in all smoke samples. For example, toluene, pentanone, phenol, methylphenol, indene derivatives, biphenyl, azulene, fluorene derivatives, anthracene derivatives phenanthrene derivatives, chrysene, benzopyrenes, benzoperlyene, and indenopyrene were identified in both samples. Smoke treated with F-500 contained a smaller quantity of many toxicants than did other treatments. This was the case for compounds such as: benzo(a)pyrene, terphenyls, fluorene derivatives, cyclohexanols, indene derivatives, and several higher molecular weight polynuclear aromatic hydrocarbons. Several compounds found during F-500 treatment of the flame were unique to that sample. Cleavage of constituents in the fire fighting formulation produced such compounds as: dibenzofuran, hexanoic acid derivatives, heptadecane, octadecanate esters, hexadecanate esters, and ethoxy benzenes.

Toluene fires, with or without suppressant addition, produced contaminants that were vastly less toxic than TCDD. This was expected, but was used as a verification of relative enzyme induction. The toluene fire extinguished by F-500 produced smoke and combustion by-products that were 98.6% less toxic than compounds released from untreated fires (Table 1). This is only one measure of toxicity. However, the H4IIE assay provides an indication of carcinogenic potential of tested compounds and responds well to most products of incomplete combustion. Further tests are needed to establish confidence limits around the observed toxicity reduction.

Table 1. Toxicity of smoke from toluene fires as determined through H4IIE cell culture assays.

Extinguishment Method	ED50	TCDD Equivalents
None	$4x10^{-4}$	$7.0x10^{-9}$
F-500 EA	$5.6x10^{-2}$	$5.4x10^{-11}$

Reduced smoke quantity and smoke toxicity are important safety considerations for those trying to escape or extinguish fires. Smoke inhalation often causes fatalities during fires. Moreover, repeated exposure to toxicants in smoke is hazardous. Reducing such exposures to fire fighting professionals should reduce long term health effects of repeated smoke inhalation.

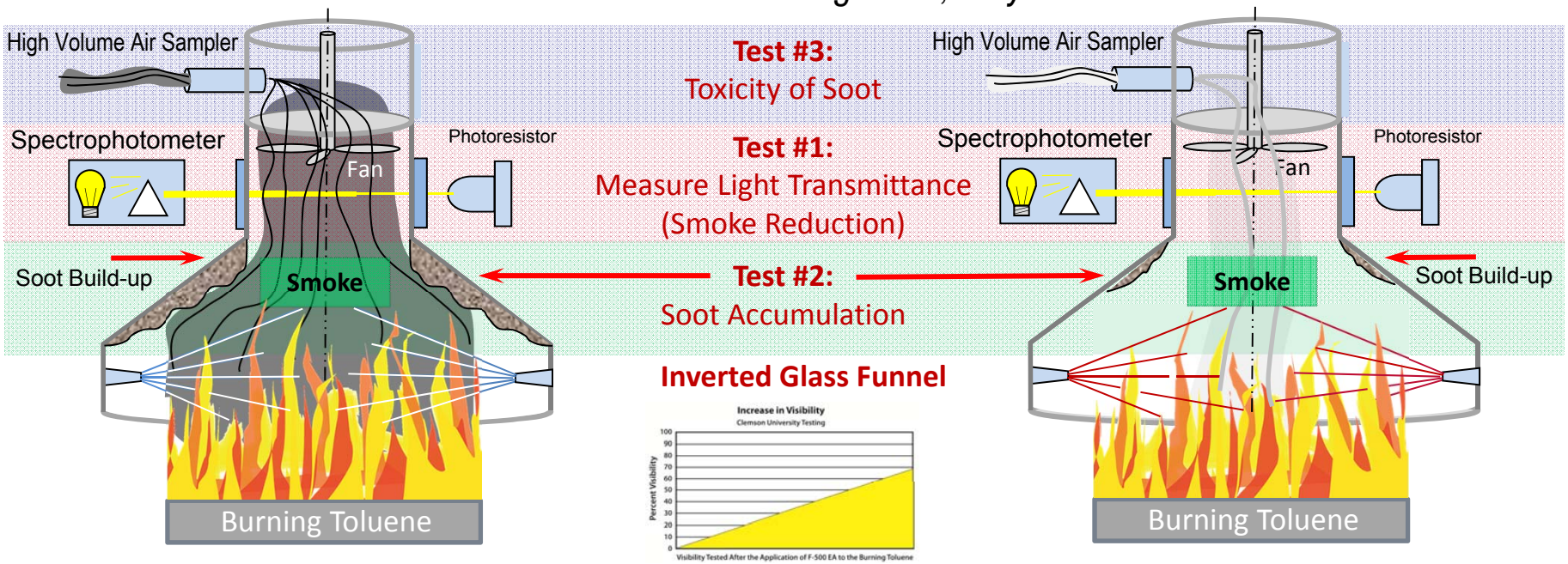
Light Transmission: Visibility across the constructed chimney was not totally obscured by smoke rising from the small piece of burning rubber. The smoke produced was sprayed with aqueous F-500 and visible light transmission was increased by 68±3%. Assuming similar molar extinction coefficients for the smoke components before and after F-500 treatment, this translates into a 97% reduction in products of incomplete combustion.

HAZARD CONTROL TECHNOLOGIES, INC.
FIRE, VAPOR, AND CONTAMINATION CONTROL SOLUTIONS

F-500 ENCAPSULATOR TECHNOLOGY

Interruption of Free Radicals*

** When free radicals combine or "come together", they form soot and smoke*



Inverted Glass Funnel

Water Spray
First Test Series
Water Sprayed
Through Smoke Plume

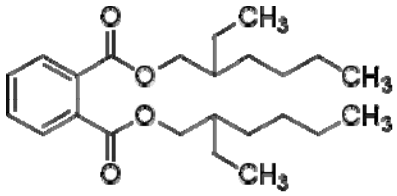
Plain Water vs. 3% F-500 EA	
1. Light Transmittance (Smoke Reduction)	68% Increase in Visibility
2. Soot Accumulation	97% Reduction in Soot
3. Soot Toxicity	98.6% Reduction in Toxicity

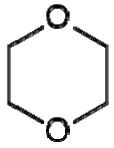
Clemson University Study – Pendelton, SC

F-500 EA Spray
Second Test Series
F-500 Encapsulator Agent @3%
Sprayed Through Smoke Plume

F-500 EA Reduces Carcinogenic Toxins in Smoke 98.6%

- Benzo(a)pyrene
- Terphenyls
- Fluorene derivatives
- Indene derivatives
- Bis(ethylhexyl)phthalate
- 1,4 Dioxane
- Cyclohexanols
- Several higher molecular weight polynuclear aromatic hydrocarbons





Clemson University Report – Pendelton, SC
FAI Material Testing Lab – Marietta, GA
Analytical Services – Norcross, GA