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Study Title

**MODELING RELEASES OF
AMMONIUM PERFLUOROOCTANOATE INTO THE OHIO RIVER**

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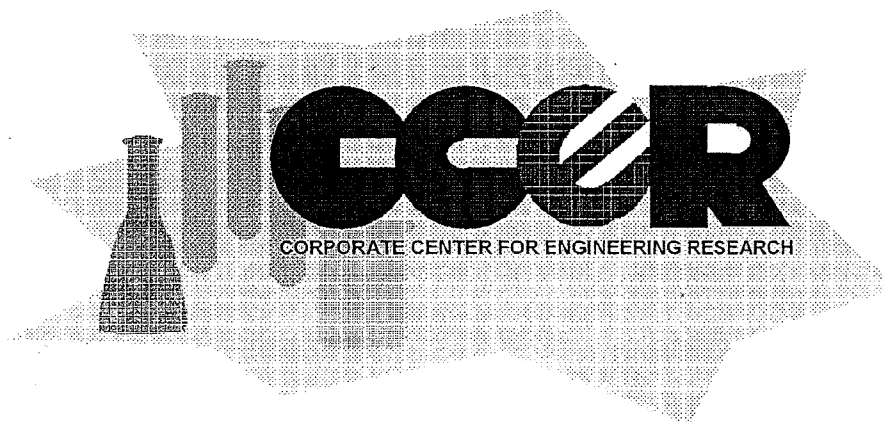
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Performing Laboratory

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GENERAL INFORMATION

Chemical Studied: Ammonium perfluorooctanoate

Synonyms/Codes: APFO, C-8, FC-143

DuPont Notebook No.: Not Applicable

Sponsor; Robert Pinchot
E. I. du Pont de Nemours and Company
BARLML CRP-711/2210-B

Study Initiated/Completed: September 1999 to May 2000

**MODELING RELEASES OF
AMMONIUM PERFLUOROOCTANOATE INTO THE OHIO RIVER**

SUMMARY

PDM indicated that APFO concentrations of 1.0 µg APFO/L would be exceeded about 50% of the time during the year. APFO concentrations of in the river would exceed 0.1 µg APFO/L 90% of the time during the year and 10 µg APFO/L about 2.2% of the time during the year.

Average annual APFO concentrations in the Ohio River calculated by using a Microsoft® Excel spreadsheet was 0.423 µg APFO/L. Modeled APFO concentrations in the river ranged from a low of 0.199 µg APFO/L in March to a high of 0.965 µg APFO/L in September, which correspond to high and low river flows, respectively. Average Ohio River flows and volume data calculated from the US Geological Survey was collected at the Belleville Dam and used in the spreadsheet model. The Belleville Dam is on the Ohio River 13 miles downstream of the Washington Works Plant. This river flow data is the closest location downstream from the plant where this type of information is available.

Study Conducted and
Report Prepared by:

William R. Berti
Senior Research Biologist

(date)

INTRODUCTION/PURPOSE

APFO (ammonium perfluorooctanoate) is a fluorinated surfactant used in the manufacturing of Teflon® at Washington Works. A portion the APFO (18,416 kg in 1996) was released to the Ohio River as part of an NPDES permitted release for the facility (WV0001279). The molecular weight of APFO is 431.098 g/mole. Other properties of APFO are listed below.

- Made by 3M Company
- Health rating of 2
- Exposure limits 0.01 mg/m³ skin 8 hr
- LD₅₀ acute oral rat = 680 mg/kg
- BOD₂₀ = nil
- Biodegradation = nil
- BCF = 1.8
- Molecular formula CF₃(CF₂)₆COO⁻NH₄⁺
- pH ~ 5 (0.5% aqueous)
- pKa = 2.8 (-COOH)
- Melting point = 56-58°C (-COOH)
- COD = 700 mg/kg
- Koc = 25
- Water solubility > 1000 mg APFO/L
- Vapor pressure (at 22C) = 7.1×10^{-5} mm Hg

Our objective was to calculate the concentrations of APFO that could reasonably be expected to occur in the Ohio River downstream of the NPDES permitted outfall at the DuPont Washington Works.

MATERIALS/METHOD

Releases of ammonium perfluorooctanoate (APFO) to the Ohio River from the DuPont Washington Works Plant were modeled using the Probabilistic Dilution Model (PDM Beta Version 4.0 Beta June 11, 1999, US EPA Office of Pollution Prevention and Toxics) and a constructed Microsoft® Excel spreadsheet model. APFO release data for 1996 were used in both modeling exercises.

PDM inputs included the NPDES number of WV0001279. This corresponds to a reach number of 05030202039, a mean streamflow of 4.75E+04 million liters per day (MLD), a low streamflow of 9980.47 MLD and an effluent flow of 216.75 MLD. We assumed that APFO was released 335 days/year, the loading was 55.138 kg/day, and the wastewater treatment efficiency was 0%. We then varied the APFO concentration as the Concentration of Concern (COC) from 0.1 to 50 µg APFO/L to determine the COC percent of year exceedence.

Microsoft® Excel spreadsheet used river flow data from the US Geological Survey (USGS: <<http://waterdata.usgs.gov/nwis-w/WV/data.components/hist.cgi?statnum=03159530>>). This is the mean daily river flow in cubic feet/sec measured at the Belleville Dam from 10/1/1974

to 9/30/1985. The Belleville Dam is on the Ohio River 13 miles downstream of the Washington Works Plant. This river flow data is the closest location downstream from the plant where this type of information is available. This river flow data compares well with Ohio River monthly average flows at Pittsburgh, PA, Huntington, WV, and Cincinnati, OH from the US Army Corps of Engineers (ftp://www.lrd-wc.usace.army.mil/Monthly_html/). The average daily river flow for the month was calculated from available data between those two dates. This was then converted to the average measured flow per month. We assumed the APFO was discharged to the river at a constant rate except for the month of October when production at Washington Works is usually suspended for annual maintenance. We assumed that the total discharge of was 18,416 kg APFO (40,600 lbs APFO) divided by 11 months. Table shows the results of this spreadsheet model.

RESULTS/DISCUSSION

PDM indicated that APFO concentrations of 1.0 µg APFO/L would be exceeded about 50% of the time during the year. APFO concentrations of in the river would exceed 0.1 µg APFO/L 90% of the time during the year and 10 µg APFO/L about 2.2% of the time during the year (Table 1). Figure 1 shows model input/output.

Average annual APFO concentrations in the Ohio River calculated by constructing and using a Microsoft® Excel spreadsheet model was 0.423 µg APFO/L (Table 2). Modeled APFO concentrations in the river ranged from a low of 0.199 µg APFO/L in March to a high of 0.965 µg APFO/L in September, which correspond to high and low river flows, respectively. Average Ohio River flows and volume data calculated from the US Geological Survey was collected at the Belleville Dam and used in the spreadsheet model. The Belleville Dam on the Ohio River 13 miles downstream of the Washington Works Plant. This river flow data is the closest location downstream from the plant where this type of information is available.

TABLE 1: Probabilistic Dilution Model (PDM) results of APFO concentrations and percent of year that the concentration of APFO will be exceeded in the Ohio River.

Concentration of APFO	Percent of year concentration exceeded
$\mu\text{g/L}$	%
0.1	90.9
0.5	71.6
1	51.0
3	17.8
6	6.1
10	2.2
25	0.2
50	0.0

Table 2. Microsoft Excel spreadsheet calculations of modeled APFO concentrations in the Ohio River.

Month	Measured flow	Measured flow	APFO discharge to Ohio River in 1996	Estimated APFO concentration in Ohio River
	<i>ft³/sec</i>	<i>L/mo</i>	<i>kg</i>	<i>µg/L</i>
January	64,001	4.69E+12	1,674	0.357
February	88,909	6.74E+12	1,674	0.248
March	111,236	8.43E+12	1,674	0.199
April	94,017	6.90E+12	1,674	0.243
May	67,107	5.09E+12	1,674	0.329
June	47,379	3.48E+12	1,674	0.482
July	30,989	2.35E+12	1,674	0.713
August	30,502	2.31E+12	1,674	0.724
September	25,339	1.73E+12	1,674	0.965
October	33,030	2.50E+12	0	0.000
November	42,330	3.11E+12	1,674	0.539
December	78,986	5.99E+12	1,674	0.280
Average		4.44E+12		0.423
Total	713,824	5.33E+13	18,416	0.345

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FIGURE 1: Probabilistic Dilution Model (PDM) Beta Version 4.0 input and output screen.

PDM Site Specific Screen									
Chemical ID:		C-8							
Scenario #:		1							
Reach number		05030202039		Facility name		E.I. DU PONT DE NEMOURS & CO.			
Gaging station		▼		Facility location		PARKERSBURG, WV 26102			
Period of record		1996		Receiving stream name		OHIO R			
# of observations		NA		NPDES Number		WV0001279			
Mean streamflow		4.75e+04 MLD		Facility on reach?		☒ Direct			
Low streamflow		9980.47 MLD		Discharge type		☐ Indirect			
Effluent flow		216.75 MLD		Data source		☐ MFG ☐ PRO ☐ IND USE ☐ COMM USE ☐ CONS USE			
Release days		335 days/year		FacSrch - Direct		▼			
Loading		55.138 kg/site/day		Results (COC Exceedence)		2.24 %			
Concentration of Concern (COC)		10 ug/L		Percent of year		8.17 days/year			
Wastewater treatment efficiency		0 %		Days per year		8.17 days/year			
Results History									
COC (ug/L)	# YEAR COC EXCEEDED	# DAYS COC EXCEEDED	RELEASE DAYS (kg/site/day)	LOADING (kg/site/day)	WASTE WATER TREATMENT				
0.1	90.9	331.6	335.	55.1	0.				
0.5	71.6	261.5	335.	55.1	0.				
1.	51.	186.	335.	55.1	0.				
5.	8.4	30.6	335.	55.1	0.				
10.	2.2	8.2	335.	55.1	0.				
Submit		Done		Save		Print			