

BIODEGRADATION (BOD/COD)

TEST SUBSTANCE

Identity: A mixture containing perfluorooctanesulfonate, which may also be referred to as PFOS, FC-95, or as a component of FC-203. (1-Octanesulfonic acid) (CAS # 2795-39-3).

Remarks: The 3M production lot numbers were not noted. The test sample is FC-203. Current information indicates it is a mixture of 1.34% PFOS, 35% diethylene glycol butyl ether, 37.85% water, 20% ethylene glycol, 2.66 % Sultone foamer, 3% sodium octyl sulfate, 0.1% sodium lauryl sulfate, and 0.05% tolyltriazole.

The following is an abbreviated summary of multiple biodegradation studies on FC-203. These studies apply to a mixture with incompletely characterized concentrations of impurities. Data does not accurately reflect the degradation potential of the fluorochemical component of the test sample.

METHOD:

Method: Various methods, most not noted.

Type: BOD and Dichromate Reflux COD

GLP: No

Year completed: 1973 - 1980

Contact time: 20 days

Inoculum: Seed from various sources.

RESULTS

Chemical Oxygen Demand (COD) range: 420,000 – 1,070,000 mg/kg

Biochemical Oxygen Demand (BOD) range:

5-Day:	206,250 – 560,000 mg/kg
10-Day:	450,000 – 646,875 mg/kg
12-Day:	660,000 – 830,000 mg/kg
15-Day:	426,312 – 604,687 mg/kg
18-Day:	660,000 mg/kg
20-Day:	426,562 – 1,100,000 mg/kg

Remarks: Testing was conducted on the mixture as described in the Test Substance Remarks field. The values reported apply to that mixture and not the fluorochemical proportion alone.

CONCLUSIONS

No reliable conclusions can be derived from these studies. The indication is that the majority of the product components are readily biodegradable.

Submitter: 3M Company, Environmental Laboratory, P.O. Box 33331, St. Paul, Minnesota, 55133

DATA QUALITY

Reliability: Klimisch ranking = 3. Study lacks description and records of the method followed. The inoculum is not properly characterized. The testing was conducted on a mixture with chemicals having varying degrees of biodegradability, leading to potential misinterpretation of the results. The sample purity was not properly characterized and the study lacks analytical confirmation of the amount of fluorochemical proportion in the solution.

REFERENCES

The studies were conducted by the 3M Company, Environmental Laboratory, St. Paul, MN, Lab Request numbers 1940 and 5360S in 1973.

OTHER

Last changed: 6/28/00

PRODUCT ECOLOGICAL ASSESSMENT
REQUEST FOR LABORATORY WORK

Ref: ENVIR. ASSESS. INQ., # FC-203 Commercial Chem DIVISION
PRODUCT: FC-203
(E-5919, LOT-1)

LAB REQUEST NO. 53605

REQUESTER

Name: Eric Reiner Phone No. 5079
Request Date: 1-24-80
Project No.: _____ Prob. No. _____
Code No.: _____
Sample Date: New Sample to be sent Date Needed: TOC ASAP
Description: Redo BOD/COD Study of FC-203
Purpose of Tests: Previous results are not consistent.
use new sample

LABORATORY

Date Received Sample: 1-29-80
Analyst: WAS, APR
Date Completed: 2-26-80 2-26-80
Hours Spent: 8 hrs W.A. Schind
Y _____ B _____ P _____
Please Call Requester If Delays Are Encountered.

PHYSICAL & CHEMICAL PROPERTIES

Heat of Combustion Cal/G (BTU/Lb.)

Density

Ash

Other

FC-203
Concentrate

FC-203
3% solution

WATER POLLUTION

~~at~~ COD - mg/kg } duplicate

COD - mg/kg } analysis

BOD₅

BOD, Ultimate

TOC % (w/w)

~~66~~ Density - g/ml

Oxygen Uptake

Dehydrogenase Activity (TTC)

Other

X 1,120,000

X 1,110,000

X

X

X

X

X

X

X

(SEE BELOW)

27.5

1.04

264,000 mg/l

mg/l COD
1,070,000

0.825
calculated
from concentrate
value. WAS

Send a copy of
the TOC Protocol
so it can be sent to
International contact
To show German
government officials
how we do this test.

NOTES: TOC VALUE BASED ON AN AVERAGE
OF FIVE (5) SEPARATE TOC
ANALYSES.

BIOASSAY

Specify Organism and Method:

BOD RESULTS - mg/kg

mg/l
BOD

LEACHATE FROM LEACHING TEST

pH

COD

BOD₅

BOD, Ultimate

TOC

GC

Bioassay

Other

BOD₅ - 560,000

538,000

BOD₁₂ - 830,000

798,000

BOD₂₀ - 1,100,000

1,060,000

(see attached worksheets)

OTHER

Bioaccumulation

Persistence

Degradation Products

3M

Sample Description	
FC-203 (F-5919, LOT-1)	
Initial Dilution	0.250 g of Sample diluted to 250 ml with DI water
Initial Dilution Factor	1000 (Dilution factor = 1 if undiluted)

Note:

1. Conc. = Concentration of sample (ml/l or mg/l) in BOD bottles.
2. Sample Size = ml or g of sample or diluted sample added to BOD Bottle.

Form 19756 PWO

Sample Description		FC-203 (F-5919, LOT-1)
Initial Dilution	0.250 g	of Sample diluted to 250 ml with DI water
Initial Dilution Factor	1000	(Dilution factor = 1 if undiluted)

[illegible]

Note:

1. Conc. = Concentration of sample (ml/l or mg/l) in BOD bottles.
2. Sample Size = ml or g of sample or diluted sample added to BOD Bottle.

[illegible]

Environmental Laboratory

b Req. No. 5360S		BOD Run No. 80-5	
Analyst	Date Started 1-30-80	20 - Day BOD Readings	
W. A. Schind		Analyst Wade A. Schind	Date 2-19-80

Sample Description		FC-203 (F-5919, LOT-1)	
Initial Dilution	0.250 g	of Sample diluted to	250 ml with DI water
Initial Dilution Factor	1000	(Dilution factor = 1 if undiluted)	

[illegible]

- Note:**
1. Conc. = Concentration of sample (ml/l or mg/l) in BOD bottles.
 2. Sample Size = ml or g of sample or diluted sample added to BOD Bottle.

Comments
*0.50-ml dilution omitted from average BOD value. W. G. Schil
2-26-80

Environmental Laboratory
BOD Work Sheet - Blanks,
Controls, and Standards

3M

file original

Lab Request No. 5364/53605		BOD Run No. 80-5	
Analyst W.A. Schil		Date Started 1-30-80	
Seed Type & Source Chemical sewage		Seed Concentration 6ml/l	
Analyst M. Roberts		Date 2/4/80	

Nonseeded Dilution - Water Blank

SAVE

Bottle No.	Initial D.O. (A ₁)	Present D.O. (A ₂)	D.O. Depletion (A ₁ - A ₂)	Average D.O. Depletion ($\bar{A}_1 - \bar{A}_2$)
75	8.95	8.70	0.25	0.2
16	8.90	8.70	0.20	
128	8.90	8.75	0.15	

Seeded Dilution - Water Blank (optional)

SAVE

Bottle No.	Initial D.O. (C ₁)	Present D.O. (C ₂)	D.O. Depletion (C ₁ - C ₂)	Average D.O. Depletion ($\bar{C}_1 - \bar{C}_2$)
13	8.95	8.60	0.35	0.30
22	8.95	8.70	0.25	
1	8.90	8.60	0.30	

Seed Controls

SAVE

Bottle No.	Sample Size	Initial D.O. (B ₁)	Present D.O. (B ₂)	D.O. Depletion (B ₁ - B ₂)
118	20	8.60	6.95	1.65
55	40	8.40	5.10	3.30
66	80	7.75	0.70	7.05

Glucose - Glutamic Acid Standard

SAVE (207 ± 20% / l)

Bottle No.	Sample Size	Initial D.O. (D ₁)	Present D.O. (D ₂)	Total D.O. Depletion (D ₁ - D ₂)	Depletion Due To Standard	$\frac{5}{BOD}$ - Day	Average $\frac{5}{BOD}$ - Day
115	3.0	8.95	6.70	2.25	2.10	210 191	210 200
3	5.0	8.90	5.30	3.60	3.45	207 195	
90	7.0	8.95	4.00	4.95	4.80	206 192	

correction for nonseeded bottles

Potassium Hydrogen Phthalate Standard (optional)

Bottle No.	Sample Size	Initial D.O. (D ₁)	Present D.O. (D ₂)	Total D.O. Depletion (D ₁ - D ₂)	Depletion Due To Standard	$\frac{5}{BOD}$ - Day	Average $\frac{5}{BOD}$ - Day

Request No. 53605		BOD Run No. 80-5	
Analyst M. Roberts, W.A. Schil		Date Started 1-30-80	12 - Day BOD Readings
Seed Type & Source Chenille sewage	Seed Concentration 600/l	Analyst Wade A. Schil	Date 2-11-80

Nonseeded Dilution - Water Blank

Bottle No.	Initial D.O. (A ₁)	Present D.O. (A ₂)	D.O. Depletion (A ₁ - A ₂)	Average D.O. Depletion (A ₁ - A ₂)
75	8.95	8.65	0.30	0.23
16	8.90	8.70	0.20	
128	8.90	8.70	0.20	

Seeded Dilution - Water Blank (optional)

Bottle No.	Initial D.O. (C ₁)	Present D.O. (C ₂)	D.O. Depletion (C ₁ - C ₂)	Average D.O. Depletion (C ₁ - C ₂)
13	8.95	8.45	0.50	0.45
22	8.95	8.55	0.40	
1	8.90	8.45	0.45	

Seed Controls

Bottle No.	Sample Size	Initial D.O. (B ₁)	Present D.O. (B ₂)	D.O. Depletion (B ₁ - B ₂)
118	20	8.60	6.05	2.55
55	40	8.40	2.65	5.75
68	80	7.75	< 0.05	-

Glucose - Glutamic Acid Standard

Bottle No.	Sample Size	Initial D.O. (D ₁)	Present D.O. (D ₂)	Total D.O. Depletion (D ₁ - D ₂)	Depletion Due To Standard	12 - Day BOD mg/l	Average 12 - Day BOD mg/l
115	3	8.95	6.50	2.45	1.97	197	210
3	5	8.90	4.85	4.05	3.58	215	
90	7	8.95	3.40	5.55	5.08	218	

Potassium Hydrogen Phthalate Standard (optional)

Bottle No.	Sample Size	Initial D.O. (D ₁)	Present D.O. (D ₂)	Total D.O. Depletion (D ₁ - D ₂)	Depletion Due To Standard	12 - Day BOD	Average 12 - Day BOD

Request No. 53605		BOD Run No. 80-5	
Analyst M. Roberts, W.A. Schil		Date Started 1-30-80	20 - Day BOD Readings
Seed Type & Source Charlotte sewage	Seed Concentration 6ml/l	Analyst W.A. Schil	Date 2-19-80

SAVE

Nonseeded Dilution - Water Blank

Bottle No.	Initial D.O. (A ₁)	Present D.O. (A ₂)	D.O. Depletion (A ₁ - A ₂)	Average D.O. Depletion ($\bar{A}_1 - \bar{A}_2$)
75	8.95	8.60	0.35	0.35
16	8.90	8.55	0.35	
128	8.90	8.55	0.35	

Seeded Dilution - Water Blank (optional)

SAVE

Bottle No.	Initial D.O. (C ₁)	Present D.O. (C ₂)	D.O. Depletion (C ₁ - C ₂)	Average D.O. Depletion ($\bar{C}_1 - \bar{C}_2$)
13	8.95	7.85	1.10	0.983
22	8.95	8.05	0.90	
1	8.90	7.95	0.95	

Seed Controls

SAVE

Bottle No.	Sample Size	Initial D.O. (B ₁)	Present D.O. (B ₂)	D.O. Depletion (B ₁ - B ₂)
118	20	8.60	3.60	5.00 ✓
55	40	8.40	< 0.5	
68	80	7.75	—	

Glucose - Glutamic Acid Standard

Bottle No.	Sample Size	Initial D.O. (D ₁)	Present D.O. (D ₂)	Total D.O. Depletion (D ₁ - D ₂)	Depletion Due To Standard	$\frac{20}{BOD}$ - Day	Average $\frac{20}{BOD}$ - Day
115	3	8.95	4.55	4.40	3.64	364	340
3	5	8.90	2.55	6.35	5.59	336	
90	7	8.95	0.95	8.00	7.25	311	

Potassium Hydrogen Phthalate Standard (optional)

Bottle No.	Sample Size	Initial D.O. (D ₁)	Present D.O. (D ₂)	Total D.O. Depletion (D ₁ - D ₂)	Depletion Due To Standard	$\frac{20}{BOD}$ - Day	Average $\frac{20}{BOD}$ - Day

6-11-72

See

Meeting

Description	Strong CAD. PPM	BOD - PPM					Bioassay Static 96 hr. %
FC-200 2515	800,000	5-Days 45,000	14-Days 495,000	20-Days 540,000	24-Days 540,000		0.005
FC-200-2036, 2037, 2516	800,000	5-Days 45,000	14-Days 495,000	20-Days 540,000	24-Days 540,000		0.0125
FC-200 2517	800,000	5-Days 45,000	14-Days 495,000	20-Days 540,000	24-Days 540,000		0.0106
FC-200 Comp 3311:47	800,000	5-Days 45,000	14-Days 495,000	20-Days 540,000	24-Days 540,000		0.0031
FC-200 Premix 6% 30849-19A	48,000	5-Days 18,000	12-Days 33,000	18-Days 33,000		Before Fire	0.0625
FC-200-6% 30849-19B	60,000	5-Days 24,000	12-Days 37,500	18-Days 36,000		After Fire	0.0257
FC-201 Lot 1	960,000	5-Days 240,000	12-Days 600,000	18-Days 600,000			0.0406
FC-203 Lot 4 3%	1,000,000	5-Days 240,000	12-Days 660,000	18-Days 660,000			0.0438
AF-3 Lot-11129	480,000	5-Days 180,000	12-Days 300,000	18-Days 300,000			0.0281
AF-5 Lot 10663	340,000	5-Days 150,000	12-Days 225,000	18-Days 225,000			0.0188
Sipex ols Lot A 40382	560,000	5-Days 420,000	12-Days 450,000	18-Days 450,000			0.0125
FC 203 (6%) 1112	779,000	5-Days 0	10 Days 243,000				
FC 200 (Trout)							0.0125

cc: LAB REQUEST BOOK - 42-5W

CC FC-203
206File: Compounds FC-203Water and Wastewater

REQUEST FOR LABORATORY WORK

Lab Request No. 1940

TO: ENVIRONMENTAL ENGINEERING LABORATORY - BUILDING 53-6N

Requestor

Lab Personnel

Name: BACON Request Date: 12/5
 Project No. 717028 Prob. No. 07 Code # 3400
 Description: Samples
 Sample Date: _____ Date Needed: _____
 Hold Sample For _____ Days Est. Time: _____ Hrs.

Date Rec'd. Sample: 11-30-73
 Analyst: Joc Ruiz
 Y 73 B 14 P 166
 Date Completed: 12/2/73
 Hrs. Spent: _____

Sample Description

FC 203FC 203 6Butyl
CarbitalEthylene
Glycol

Total Hardness, mg/l as CaCO ₃			Lot 4		
Calcium Hardness, mg/l as CaCO ₃			check		
"P" Alkalinity, mg/l as CaCO ₃			Grp		
"M" Alkalinity, mg/l as CaCO ₃			Date		
pH					
Sulfate, mg/l as SO ₄					
Nitrate, mg/l as NO ₃					
Chloride, mg/l as Cl					
Silica, mg/l as SiO ₂					
Fluoride, mg/l as F					
Ortho Phosphate, mg/l as P					
Total Phosphate, mg/l as P					
Total Chromium, mg/l as Cr					
Hex. Chromium, mg/l as Cr					
Total Cyanide, mg/l as CN					
Ferrocyanide, mg/l as CN					
Iron, mg/l as Fe					
Manganese, mg/l as Mn	30-DAY	557,813	426,562	1,575,000	1,078,125
Surfactant, mg/l as LAS	15-DAY	604,687	426,341	1,612,800	1,143,750
Phenol, mg/l	10-DAY	646,875	459,000	1,453,125	1,190,625
BOD, mg/l *	5-DAY	300,000	206,250	686,000	515,625
COD, mg/l (Short, Long, Dilute)		878,000	420,000	1,826,666	1,280,000
Total Suspended Solids, mg/l					
Volatile Suspended Solids, mg/l					
Turbidity, mg/l Silica					
Total Solids, mg/l					
Total Volatile Solids, mg/l					
Conductivity, mhos					
Total Bacteria, No./100 ml					
Total Coliform, No./100 ml					
Fecal Coliform, No./100 ml					
Fecal Streptococcus, No./100 ml					
Ammonia Nitrogen, mg/l as N					
Kjeldahl Nitrogen, mg/l as N					
Oil and Grease, mg/l					

Comments:

Tox
BOD₅, BOD₁₀, BOD₂₀

5. DAY 12/12

1740 12/12
BR 14

ENVIRONMENTAL ENGINEERING LAB

BOD WORK SHEET

Date: 12/7/73
Dilution Water: 15
Seed: 90 mlBlanks: 7 7.6 , 8 8.4 , 9 8.0 , 10 8.5 Bk Ave. 8.7

Bottle No.	Sample Size	Description	D.O.	Depletion	5 Day BOD	Av
142	.4 (10013)	BACON	8.3	1.1	75,000	
143	.8	FC 203	7.5	.9	337,500	
144	1.6	872,000	6.8	1.6	300,000	46
145	3.2	51000	7.2	7.0	675,000	
138	.4	FC 203 6%	8.7	-		
137	.8	L-3243	8.5	-		
139	1.6	420,000	7.9	.5	93,750	46
140	3.2	51000	6.4	2.2	206,250	
156	.2	Butyl Carbide	8.7	-		
157	.4	1,826,666	7.9	.5	375,000	64
158	.8	51000	7.0	1.4	735,000	
159	1.6		5.0	3.4	637,500	
119	.4	Ethylene	8.0	.4	300,000	
141	.8	Glycol	7.0	1.4	525,000	
165	1.6	1,280,000	5.7	2.7	506,250	44
166	3.2	51000	3.8	4.6	431,250	

10-Day

ENVIRONMENTAL ENGINEERING LAB

BOD WORK SHEET

Date: 12/17/73Dilution Water: 5.0Seed: 90 mlBlanks: 7 6.0, 8 7.3, 9 6.5, 10 7.2 Bk Ave. 7.2

Bottle No.	Sample Size	Description	D.O.	Depletion	5 Day BOD	Ave.
142	.4	BACON	5.5	1.7	1,275,000	
143	.8	FC 103	4.5	2.7	1,012,500	
144	1.6	872,000	3.8	3.4	637,500	
145	3.2	91000	1.2	7.0	656,250	
138	.4	FC 803 6%	6.3	0.9	675,000	
137	.8	L-3243	5.2	2.0	750,000	
139	1.6	420,000	4.8	2.4	450,000	
140	3.2	91000	2.4	4.8	450,000	
156	.2	Butyl Carbitol	5.9	1.3	1,950,000	
157	.4	1,826,666	4.8	2.4	1,800,000	
158	.8	91000	3.0	4.2	1,575,000	
159	1.6		1.1	7.1	1,331,250	
119	.4	ETHYLENE GLYCOL	5.5	1.7	1,275,000	
141	.8	1,280,000	3.8	3.4	1,275,000	
165	1.6	91000	1.3	5.9	1,106,250	
166	3.2		1.1	7.1	665,625	

15-DAY

12/22/73 P 166
B 14

ENVIRONMENTAL ENGINEERING LAB

BOD WORK SHEET

Date: 12/22/73

Dilution Water: 15%

Seed: 90ml

Blanks: 7 5.3, 8 6.8, 9 6.0, 10 6.7 Bk Ave. 6.7

Bottle No.	Sample Size	Description	D.O.	Depletion	5 Day BOD	Av
142	.4	BACON	5.7	(1.5)	1125000	
143	.8	FC 203	4.2	2.5	937500	
144	1.6	870,000	3.5	3.2	600,000	
145	3.2	51000	(.7)	6.5	609,375	
138	.4	FC 203 690	5.9	.8	600,000	
137	.8	L-3243	5.0	1.7	637,000	
139	1.6	420,000	4.5	2.7	412,000	
140	3.2	51000	2.0	4.7	440,625	
156	.2	Burlyl Carbital	5.5	1.2	1800000	
157	.4	1,826,666	4.5	2.2	1,656,000	
158	.8	51000	2.5	4.2	1,575,000	
159	1.6		(.7)	6.6	1,237,500	
119	.4	Ethylene	5.2	1.5	1,125,000	
141	.8	Glycol	3.5	3.2	1,200,000	
165	1.6	1,280,000	(.7)	5.8	1,087,500	
166	3.2	51000	(.7)	6.6	618,750	

20-DAY

max temp. 14.0

Pg. 166
T₂ < 14

ENVIRONMENTAL ENGINEERING LAB

Date: 10/27/73

BOD WORK SHEET

Dilution Water: 150

Seed: 90 ml

Blanks: 7 4.5, 8 6.1, 9 5.2, 10 6.2 Bk Ave. 6.1 1.2

Bottle No.	Sample Size	Description	D.O.	Depletion	5 Day BOD	Av
142	.4	Brown	4.7	1.4	1050,000	
143	.8	FC 203	3.8	2.3	862,500	
144	1.6	870,000	3.4	3.0	562,500	
145	3.2	1000	2.2	5.9	553,250	
138	.4	FC 20369	5.7	7	625,000	
137	.8	L-3243	4.7	1.4	525,000	
139	1.6	420,000	4.6	2.1	393,750	
140	3.2	1000	1.2	4.9	459,375	
156	.2	Butyl Carbide	5.0	1.1	1650,000	
157	.4	1,826,666	4.0	2.1	1575,000	
158	.8	1000	1.9	4.2	1575,000	
159	1.6		2.2	5.9	1,106,250	
119	.4	Ethylene	4.8	1.3	975,000	
141	.8	Glycol	3.2	2.9	1087,500	
165	1.6	1,280,000	4.4	5.7	1,068,750	
166	3.2	1000	4.4	5.9	553,250	