

Acute & Chronic Aquatic Toxicity of Ammonium Perfluorooctanoate (APFO)

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for:

APME (Association of Plastics Manufacturers in Europe)
Ad-Hoc APFO Environmental Working Group

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Acute & Chronic Aquatic Toxicity of APFO Content

- **Background**
- **Physico-chemical properties of APFO**
- **Acute toxicity**
- **Chronic toxicity**
- **Risk assessment**
- **Potential role of ammonium ion in APFO toxicity**
- **Conclusions**
- **Acknowledgements**

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Acute & Chronic Aquatic Toxicity of APFO

Ammonium perfluorooctanoate - Background

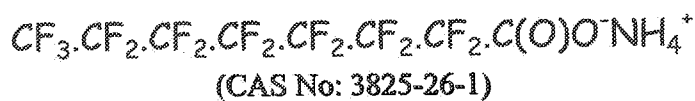
- Most commonly used salt of perfluorooctanoic acid (PFOA)
- Essential processing aid in fluoropolymer and fluoroelastomer production (e.g. PTFE) and application (e.g. non-stick cookware)
- Existing data on aquatic toxicity, but with various test substance formulations, purity etc. and of variable quality
 - Variability in toxicity values
- Need for complete and uniform set of data to current regulatory guidelines and to Good Laboratory Practice
- For this work:

99.7% Purity; 78% normal-chain : 12% branched

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Ammonium Perfluorooctanoate (APFO)

Properties



- H₂O Solubility: 3400 mg/l^[1]
(Fully ionised in water at environmental pH)
- Log Kow: Uncertain (surfactant)
- Log Koc: 1.7 – 2.4^[2]
- Bioconcn. factor (BCF): 4 (Rainbow trout)^[3]
1.8 (Fathead minnow)^[1]

[1] USEPA (2002) [2] Dekleva *et al* (2003) [3] Martin *et al* (2003)

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Ammonium Perfluorooctanoate (APFO) Acute Toxicity

- **Fish** (*Oncorhynchus mykiss*) (OECD 203)
 - 96 hr LC50: **710 mg/l** (nominal)
(No effect at 500 mg/l; 100% mortality at 1000 mg/l)
- **Crustacea** (*Daphnia magna*) (OECD 202)
 - 48 hr EC50: **480 mg/l** (nominal)
(24 hr EC50 600 mg/l; No effect at 320 mg/l; 100% effect at 1000 mg/l)
- **Algae** (*Pseudokirchneriella subcapitata*) (OECD 201)
 - 72 & 96 hr E_rC50: **> 400 mg/l** (measured)
(72 & 96 hr E_bC (biomass) also > 400 mg/l)

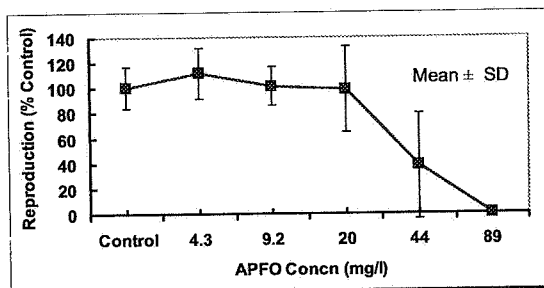
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Ammonium Perfluorooctanoate (APFO) Chronic Toxicity – *Daphnia magna*



21-day Growth & Reproduction (OECD 211 – semi-static)

- No effect on mortality at highest concn: 89 mg/l
- Length of parents at 21 days, NOEC = 44 mg/l
- Reproduction: NOEC = 20 mg/l (mean measured)

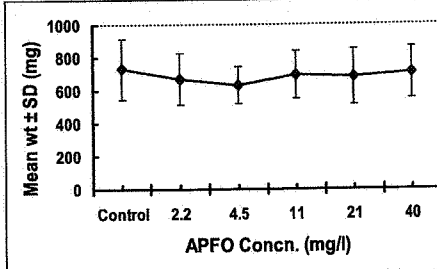
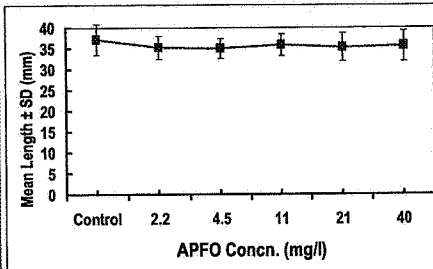


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Ammonium Perfluorooctanoate (APFO) Chronic Toxicity – *Oncorhynchus mykiss*

Early Life Stage test (85 days) (OECD 210 – Continuous flow)

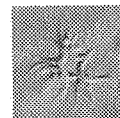
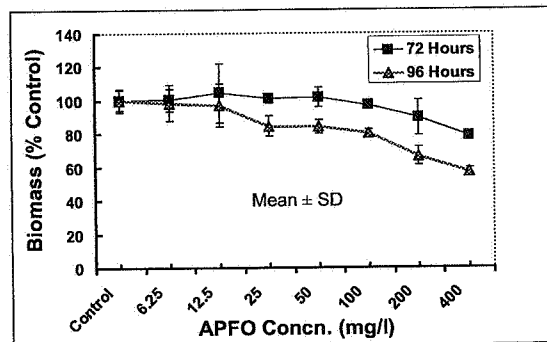
- No significant effect on survival, length or weight of the fish at highest concentration tested
- NOEC = 40 mg/l (mean measured)



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Ammonium Perfluorooctanoate (APFO) Chronic Toxicity – *Pseudokirchneriella subcapitata*

- 72 hr NOEC (biomass & growth rate): 200 mg/l
- 96 hr NOEC (biomass & growth rate): 12.5 mg/l



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Acute & Chronic Aquatic Toxicity of APFO Risk Assessment

- Chronic NOECs for 3 trophic levels

Fish	50 mg/l
Crustacea	20 mg/l
Algae	12.5 mg/l

- Assessment (safety) factor : 10 (EU Technical Guidance Doc)
- Therefore: PNEC = 1.25 mg/l

Predicted No Effect Concentration

- Few data on environmental concns (EC) : Generally < LOD

Lake Ontario: ca. 10^{-6} mg/l (PFOA) (Scott et al, 2003)

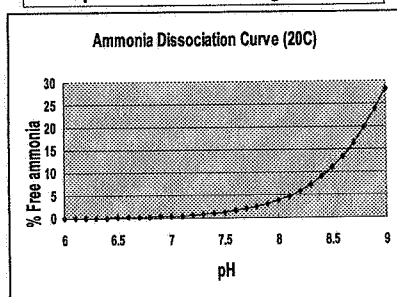
Local to manufacture: < 10^{-3} mg/l (PFOA) (USEPA, 2002)

(P)EC/PNECs < 10^{-3} = Very Low Risk to Aquatic Organisms

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Ammonium Perfluorooctanoate (APFO) Potential Role of Ammonium Ion

- APFO dissociates in water yielding NH_4^+
- pH-dependent dissociation yielding NH_3 (Free Ammonia)



Free ammonia ca. 100 times more toxic than ionised

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Ammonium Perfluorooctanoate (APFO)

Potential Role of Ammonium Ion

- Calculate free ammonia concn from EC/LC50 and test pH

Species	LC50 (mg APFO/l)	mg NH ₃ -N/l	Ref
<i>Oncorhynchus mykiss</i>	710	0.38	This study
<i>Pimephales promelas</i>	300	0.3	US EPA (2002)
<i>Daphnia magna</i>	480	0.47	This study
<i>Daphnia magna</i>	240	0.61	US EPA (2002)

- Free ammonia EC/LC50:

Oncorynchus mykiss 0.16 - 1.1

Daphnia magna 0.53 - 4.9 mg NH₃-N/l

(US EPA, 1984)

A P M E

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Acute & Chronic Aquatic Toxicity of APFO

Conclusions

- APFO shows relatively low acute & chronic aquatic toxicity
(Lowest NOEC = 12.5 mg/l)
- Based on available data, concentrations (PFOA) occurring in the aquatic environment are orders of magnitude below the PNEC, indicating negligible risk
- The ammonium content of APFO may contribute to the acute (and possibly chronic) aquatic toxicity, and may explain some of the apparent variability in the historical data.

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