Ecotox Findings for Ammonium Perfluorohexanoate

Hiroyuki Iwai[1]. and. Nobuhiko Tsuda[1]

[1] Daikin Industries, Ltd. 1-1 Nishi Hitotsuya, Settsu-Shi, Osaka, 566-8585, Japan

INTRODUCTION: Ammonium perfluorooctanoate (APFO) has long been used for polymerization of fluororesins and rubber. There are many reports on the hazards of perfluorooctanoate (PFO). Accordingly, its replacement substances have been examined. Ohmori et al. made a comparison of perfluorinated carboxylates (PFCAs) with different carbon number and reported that perfluoroheptanoate (PFHp) disappears rapidly from the rat's body. Perfluorooctanoate (PFHx) disappears from a rodent's body and perfluorobutyrate (PFB) disappears rapidly from rodent's and primate's bodies (Iwai, Chang et al.) . The toxicities of both substances are low. (Chengelis et al., Das et al.) It is considered because they do not accumulate in the body. The accumulation property in the body is considered to have a correlation with the partition coefficients. Accordingly, we examined the correlation between the partition coefficients and effects on Daphnia magna. Also, we studied the effects of PFHx, which is available for industrial use, on development of fertilized eggs of rainbow trout.

MATERIALS AND METHODS

The PFCAs studied were PFB, perfluoropentanoate (PFPn), PFHx, PFHp and PFO.

Partition Coefficient (n-octanol/water), High performance liquid chematography

The partition coefficients were calculated by a HPLC method according to the OECD Test Guideline 117.

Immobility in Daphnia magna at 24 and 48-h in a static, acute test

The immobilisation test of Daphnia magna was conducted according to the OECD Test Guideline 202. Based on the preparatory test for PFO, the concentrations were set at 150 and 320 mg/L.

Fish early –life stage toxicity test of PFHx

The rainbow trout, O. mykiss, early-life-stage (ELS) test was performed under flow-through conditions and in compliance with the OPPTS Biological Effect Test Guideline No. 850.1400. The test was conducted with a flow through test design.

Concentrated stock solutions and test media were analyzed during the ELS test. Measured concentrations of PFHx active moiety in the concentrated stock solutions ranged between 98and 100% of the nominal concentrations, test media concentrations ranged between 94 and 108% of nominal corresponding to geometric mean measured concentrations of 0.1, 0.3, 1, 3 and 10 mg/L.

RESULTS & DISCUSSION

Table 1: Structures of PFCAs, partition coefficients, and immobility of Daphnia magna.

Name	Formula	LogPow	Immobility rate (%)			
			150 mg/L		320 mg/L	
			24 h	48 h	24 h	48 h
PFB	C3F7COO-	1.43	100	100	100	100
PFPn	C4F9COO-	1.98	100	100	100	100
PFHx	C5F11COO-	2.51	15	65	30	45
PFHp	C6F13COO-	3.05	30	50	25	30
PFO	C7F15COO-	3.6	38	100	53	100

Table 2: Hatching success and fish larval survival during the fish early-life stage test.

concentration (mg/L)	hatched larvae (%)	Larvae surviving at 28days (%)
0	74	93
0.1	81	96
0.3	68	100
1	63	96
3	66	100
10	65	99

Table 3: Total Length of and Dry Weight of Fish - 28 Days Post-Hatch.

concentration (mg/L)	Total Length of Fish (cm)	Dry Weight of Fish (g)
0	3.4 ± 0.23	0.0564 ± 0.0126
0.1	3.5 ± 0.17	0.0583 ± 0.0129
0.3	3.4 ± 0.20	0.0558 ± 0.0110
1	3.4 ± 0.19	0.0571 ± 0.0097
3	3.5 ± 0.15	0.0578 ± 0.0087
10	3.4 ± 0.19	0.0588 ± 0.0102

Hatching Success

Hatching success in the control group was 74%. As this exceeded 66%, the validity criterion for hatching success was satisfied.

First egg hatch in treatment and control vessels occurred in the 24-hour period between the Day 25 and Day 26 pre-hatch observation timepoints. This indicated no difference in time to first hatch across all treatments when compared to the control group.

NOEC and LOEC were determined as nominal concentrations of 10 and >10 mg/L as PFHx.

Survival

Larval survival until Day 28 post-hatch in the control group exceeded 70% (93%) thereby satisfying the validity criterion for hatching success.

Post-hatch larval survival across all remaining treatments ranged between 96 and 100%.

In terms of measured concentrations, the NOEC and LOEC for post-hatch larval survival until Day 28 were both considered to be equal to or greater than 10 mg/L (highest mean measured concentration).

Fish Total Lengths and Wet Weights

The NOEC and LOEC for both total fish length and fish weight were determined on Day 28 post-hatch and were considered to be 10 and >10 mg/L respectively.

Abnormalities

There were no dose related abnormalities recorded during the test.

Water Quality and Environmental Conditions

All water quality parameters were within the specified ranges stated in the Guidelines.

CONCLUSIONS: APFHx is expected to have a small effect judging from the immobilisation test of Daphnia magna and fish early-life stage toxicity test. It can also be used for polymerization, therefore, it is considered to be a good replacement substance.

REFERENCES

- Ohmori K. et.al, 2003 Comparison of the toxicokinetics between perfluorocarboxylic acids with different carbon chain length. Toxicology 184, 135-40
- Iwai, H. 2011. Toxicokinetics of ammonium perfluorohexanoate. Drug Chem Toxicol. 34, 341-6
- Chang SC. et.al. 2008. Comparative pharmacokinetics of perfluorobutyrate in rats, mice, monkeys, and humans and relevance to human exposure via drinking water. Toxicol Sci. 104, 40-53
- Chengelis CP. et.al. 2009 A 90-day repeated dose oral (gavage) toxicity study of perfluorohexanoic acid (PFHxA) in rats (with functional observational battery and motor activity determinations) Reprod Toxicol. 27, 342-51
- Das KP. et.al. 2008 Effects of perfluorobutyrate exposure during pregnancy in the mouse Toxicol Sci. 105, 173-81