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**NATIONAL INDUSTRIAL CHEMICALS NOTIFICATION AND ASSESSMENT SCHEME
(NICNAS)**

PUBLIC REPORT

Polymer in Hydropalat® WE 3500

This Assessment has been compiled in accordance with the provisions of the *Industrial Chemicals (Notification and Assessment) Act 1989* (the Act) and Regulations. This legislation is an Act of the Commonwealth of Australia. The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) is administered by the Department of Health, and conducts the risk assessment for public health and occupational health and safety. The assessment of environmental risk is conducted by the Department of the Environment and Energy.

This Public Report is available for viewing and downloading from the NICNAS website or available on request, free of charge, by contacting NICNAS. For requests and enquiries please contact the NICNAS Administration Coordinator at:

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**Director
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SUMMARY

The following details will be published in the NICNAS *Chemical Gazette*:

ASSESSMENT REFERENCE	APPLICANT(S)	CHEMICAL OR TRADE NAME	HAZARDOUS CHEMICAL	INTRODUCTION VOLUME	USE
LTD/2031	BASF Australia Ltd	Polymer in Hydropalat® WE 3500	ND*	≤ 40 tonnes per annum	Component of industrial and automotive coatings

*ND = not determined

CONCLUSIONS AND REGULATORY OBLIGATIONS

Hazard classification

As no toxicity data were provided, the notified polymer cannot be classified according to the *Globally Harmonised System of Classification and Labelling of Chemicals (GHS)*, as adopted for industrial chemicals in Australia.

Human health risk assessment

Provided that the recommended controls are being adhered to, under the conditions of the occupational settings described, the notified polymer is not considered to pose an unreasonable risk to the health of workers.

When used in the proposed manner, the notified polymer is not considered to pose an unreasonable risk to public health.

However, the notified polymer is anticipated to degrade in the environment to release fluorinated degradants similar to perfluorohexanoic acid (PFHxA) that is known to be persistent. Due to environmental distribution of the persistent chemicals, the use of the notified polymer may lead to secondary human exposure to the fluorinated degradants via the environment. The notified polymer is proposed to replace perfluoroalkyl polymers that may release longer chain perfluorocarboxylic acids (PFCAs) in the environment. Longer chain PFCAs are known to be more hazardous to human health with higher bioaccumulation potential compared to shorter chain PFCAs. The overall human health risk posed by the notified polymer is anticipated to be less than that of the perfluoroalkyl polymers it replaces.

Environmental risk assessment

On the basis of the assessed use pattern, the notified polymer itself is not considered to directly pose an unreasonable short-term risk to the environment. However, the notified polymer contains fluorinated carbon groups that have the potential to degrade to the exceptionally persistent short-chain perfluorinated carboxylic acid, PFHxA. The assessed use pattern of the notified polymer does not control the release of breakdown products into the environment during use and after disposal and the long-term environmental risk profile of PFHxA is currently unknown. Consequently, the long-term risk profile for the notified polymer and its degradation products is unknown.

The persistence of chemicals similar to PFHxA in the environment is of concern because they have potential to be globally distributed. Based on the currently available environmental hazard information, PFHxA is considered to have lower overall ecotoxicity concerns than homologous long-chain perfluorocarboxylic acids, which contain seven or more perfluorinated carbon atoms, such as perfluorooctanoic acid (PFOA).

The environmental degradation of the notified polymer is expected to contribute to the cumulative emissions of perfluorohexanoic acid to the environment. Based on the currently available evidence, the concentrations of PFHxA and other short chain perfluorinated carboxylic acids are not considered to pose a concern for the health of the environment. However, if additional hazard information becomes available to indicate that short-chain perfluorinated carboxylic acids have hazard characteristics of high concern for the environment (such as PBT properties), then the risks posed by industrial uses of precursors to these environmental degradants may need to be re-assessed.

Recommendations

CONTROL MEASURES

Occupational Health and Safety

- A person conducting a business or undertaking at a workplace should implement the following engineering controls to minimise occupational exposure to the notified polymer as introduced in Hydropalat® WE 3500 and in the end use products:
 - Local exhaust ventilation
 - Spray booth if spray application occurs
- A person conducting a business or undertaking at a workplace should implement the following safe work practices to minimise occupational exposure during handling of the notified polymer as introduced in Hydropalat® WE 3500 and in the end use products:
 - Avoid breathing in mists, vapours or aerosols
 - Avoid skin and eye contact
- A person conducting a business or undertaking at a workplace should ensure that the following personal protective equipment is used by workers to minimise occupational exposure to the notified polymer as introduced in Hydropalat® WE 3500 and in the end use products:
 - Respiratory protection if inhalation may occur
- A person conducting a business or undertaking at a workplace should ensure that the following personal protective equipment is used by workers to minimise occupational exposure to the notified polymer as introduced in Hydropalat® WE 3500:
 - Gloves, protective clothing and safety glasses

Guidance in selection of personal protective equipment can be obtained from Australian, Australian/New Zealand or other approved standards.

- Spray applications should be carried out in accordance with the Safe Work Australia Code of Practice for *Spray Painting and Powder Coating* (SWA, 2015) or relevant State or Territory Code of Practice.
- A copy of the SDS should be easily accessible to employees.
- If products and mixtures containing the notified polymer are classified as hazardous to health in accordance with the *Globally Harmonised System of Classification and Labelling of Chemicals (GHS)* as adopted for industrial chemicals in Australia, workplace practices and control procedures consistent with provisions of State and Territory hazardous substances legislation should be in operation.

Environment

- The notified polymer should only be introduced as part of a strategy to phase out the use of long chain perfluorinated chemicals, or chemicals/polymers that degrade to long chain perfluorinated chemicals.
- The notifier should seek ways to minimise the level of residual polyfluoroalkyl monomers and impurities in the notified polymers. Such levels should be as low as practicable. Where possible, the total weight of these constituents should not exceed the levels attainable utilising international best practice.
- The following control measures should be implemented by users of the notified polymer, or products containing the notified polymer, to minimise exposure of the notified polymer to the environment:
 - Best practice on-site treatment of waste streams should be employed to maximise removal of the notified polymer from wastewaters.

Disposal

- If the notified polymers or products containing the notified polymers cannot feasibly be disposed of using a technique that will destroy or irreversibly transform the fluoroalkyl components of the notified polymers, disposal should be to landfill.

Emergency procedures

- Spills or accidental release of the notified polymer should be handled by containment, collection and subsequent safe disposal.

Regulatory Obligations

Secondary Notification

This risk assessment is based on the information available at the time of notification. The Director may call for the reassessment of the chemical under secondary notification provisions based on changes in certain circumstances. Under Section 64 of the *Industrial Chemicals (Notification and Assessment) Act (1989)* the notifier, as well as any other importer or manufacturer of the notified chemical, have post-assessment regulatory obligations to notify NICNAS when any of these circumstances change. These obligations apply even when the notified polymer is listed on the Australian Inventory of Chemical Substances (AICS).

Therefore, the Director of NICNAS must be notified in writing within 28 days by the notifier, other importer or manufacturer:

- (1) Under Section 64(1) of the Act; if
 - the polymer has a number-average molecular weight of less than 1,000 g/mol;
 - products containing the notified polymers are intended for use by the public;
 - information on the acute or repeated inhalation toxicity of the notified polymers becomes available;
 - additional information has become available as to an adverse effect of the per- or polyfluoroalkyl degradation products of the notified polymer.

or

- (2) Under Section 64(2) of the Act; if
 - the function or use of the polymer has changed from component of industrial and automotive coatings, or is likely to change significantly;
 - the amount of polymer being introduced has increased, or is likely to increase, significantly;
 - the polymer has begun to be manufactured in Australia;
 - additional information has become available to the person as to an adverse effect of the polymer on occupational health and safety, public health, or the environment.

The Director will then decide whether a reassessment (i.e. a secondary notification and assessment) is required.

AICS Annotation

- When the notified polymer is listed on the Australian Inventory of Chemical Substances (AICS) the entry is proposed to be annotated with the following statement(s):
 - This polymer has been assessed by NICNAS and there are specific secondary notification obligations that must be met. Potential introducers should contact NICNAS before introduction.

Safety Data Sheet

The SDS of product containing the notified polymer provided by the notifier was reviewed by NICNAS. The accuracy of the information on the SDS remains the responsibility of the applicant.

ASSESSMENT DETAILS

1. APPLICANT AND NOTIFICATION DETAILS

APPLICANT(S)

BASF Australia Ltd (ABN: 62 008 437 867)
Level 12, 28 Freshwater Place
Southbank VIC 3006

NOTIFICATION CATEGORY

Limited: Synthetic polymer with Mn > 1,000 Da.

EXEMPT INFORMATION (SECTION 75 OF THE ACT)

Data items and details claimed exempt from publication: chemical name, other names, CAS number, molecular and structural formulae, molecular weight, analytical data, degree of purity, polymer constituents, residual monomers, impurities, additives/adjuvants and import volume.

VARIATION OF DATA REQUIREMENTS (SECTION 24 OF THE ACT)

Variation to the schedule of data requirements is claimed as follows: all physico-chemical endpoints

PREVIOUS NOTIFICATION IN AUSTRALIA BY APPLICANT(S)

None

NOTIFICATION IN OTHER COUNTRIES

Canada (2014), China (2014), Korea (2014), USA (2014)

2. IDENTITY OF CHEMICAL

MARKETING NAME(S)

Hydropalat® WE 3500 (contains ~ 60% notified polymer)

MOLECULAR WEIGHT

> 1,000 g/mol

ANALYTICAL DATA

Reference IR and GPC spectra were provided.

3. COMPOSITION

DEGREE OF PURITY

> 95%

LOSS OF MONOMERS, OTHER REACTANTS, ADDITIVES, IMPURITIES

No losses are expected during use.

DEGRADATION PRODUCTS

The notified polymer is a potential precursor for PFHxA (perfluorohexanoic acid – CAS name: hexanoic acid, 2,2,3,3,4,4,5,5,6,6,6-undecafluoro-; CAS No. 307-24-4) in the environment.

4. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AT 20 °C AND 101.3 kPa: colourless to yellowish liquid with product specific odour*

Property	Value	Data Source/Justification
Melting Point/Freezing Point	Not determined	Imported in aqueous solution
Boiling Point	Not determined	Imported in aqueous solution
Density	1,080 kg/m ³ at 20 °C	SDS*
Vapour Pressure	< 1.3 × 10 ⁻⁹ kPa	Estimated based on the NAMW > 1,000 g/mol (US EPA, 2013)
Water Solubility	Not determined	Expected to have limited solubility based

Hydrolysis as a Function of pH	Not determined	on its predominantly hydrophobic structure and high molecular weight. Contains hydrolysable functionality and may slightly hydrolyse under environmental conditions.
Partition Coefficient (n-octanol/water)	Not determined	Expected to partition from water to n-octanol on the basis of its low predicted water solubility and predominantly hydrophobic structure.
Adsorption/Desorption	Not determined	May have low absorption based on the presence of perfluorinated functionalities which have both hydrophobic and lipophobic tendencies.
Dissociation Constant	Not determined	Contains dissociable functionalities and may dissociate under environmental conditions (pH 4-9).
Particle Size	Not determined	Imported in aqueous solution
Flash Point	> 100 °C	SDS*
Flammability	Not flammable	SDS*
Autoignition Temperature	Not self-igniting	SDS*
Explosive Properties	Not determined	Contains no functional groups that would imply explosive properties
Oxidising Properties	Not determined	Contains no functional groups that would imply oxidative properties

*For Hydropalat® WE 3500 (contains ~ 60% notified polymer)

Reactivity

The notified polymer is expected to be stable under normal conditions of use.

Physical hazard classification

Based on the available physico-chemical information depicted in the above table, the notified polymer is not recommended for physical hazard classification according to the *Globally Harmonised System of Classification and Labelling of Chemicals (GHS)*, as adopted for industrial chemicals in Australia.

5. INTRODUCTION AND USE INFORMATION

MODE OF INTRODUCTION OF NOTIFIED CHEMICAL (100%) OVER NEXT 5 YEARS

The notified polymer will not be manufactured in Australia. It will be imported as a component of formulations at ~ 60% concentration for local reformulation into industrial and automotive coatings.

MAXIMUM INTRODUCTION VOLUME OF NOTIFIED CHEMICAL (100%) OVER NEXT 5 YEARS

Year	1	2	3	4	5
Tonnes	20-40	20-40	20-40	20-40	20-40

PORT OF ENTRY

Melbourne

TRANSPORTATION AND PACKAGING

Hydropalat® WE 3500 containing ~ 60% notified polymer will be imported by sea in 20 kg plastic jerricans or 190 kg steel drums. The products will be then transported within Australia by road.

USE

The notified polymer will be used as a component of industrial and automotive coatings (at < 1% concentration). The notified polymer will be introduced to replace products containing longer polyfluoroalkyl carbon chains.

OPERATION DESCRIPTION

The notified polymer will not be manufactured in Australia. The notified polymer will be imported at ~ 60% concentration.

Reformulation

At the reformulation site, the imported products containing the notified polymer at ~ 60% concentration will be transferred to the mixing tank by gravity feed or by low pressure pumps. Hydrocarbon solvent will then be added to the mixing tank. The mixing process is expected to be enclosed and automated, with local exhaust ventilation in place. Once mixing is complete, sampling for quality assurance purposes will take place and the finished industrial and automotive coatings containing the notified polymer at $\leq 1\%$ will be pumped to filling machines where they will be transferred to a variety of containers (1 L, 4 L and 10 L cans and 210 L steel drums) through gravity feed or low pressure pumps.

End-use

Industrial and automotive coatings containing the notified polymer at $\leq 1\%$ concentration will be used by professional workers in industrial settings and are expected to be applied by spray, roller or brush.

6. HUMAN HEALTH IMPLICATIONS**6.1. Exposure Assessment**

The notified polymer may undergo slow degradation in the environment. As such, most potential exposure to workers and the public is expected to be to the notified polymer itself, rather than to its degradation products. Exposure to the residual polyfluoroalkyl starting constituents of the notified polymer is also possible.

The notified polymer is a potential precursor for PFHxA in the environment. This may lead to secondary human exposure to PFHxA. This exposure is unquantifiable.

6.1.1. Occupational Exposure

CATEGORY OF WORKERS

<i>Category of Worker</i>	<i>Exposure Duration (hours/day)</i>	<i>Exposure Frequency (days/year)</i>
Transportation and storage	1	4-5
Process operator	2-3	40-50
Quality control	0.5	40-50
Professional painters	1	50-70

EXPOSURE DETAILS

Transport and storage

Transport and storage workers are expected to only come into contact with the notified polymer (at ~ 60% concentration) in the unlikely event of an accident.

Reformulation process

Dermal and ocular exposure may occur when workers manually weigh and pour imported products containing the notified polymer (at ~ 60% concentration) into mixing equipment, or when connecting and disconnecting transfer hoses, and during cleaning and maintenance operations. Inhalation exposure is not expected based on the measured low vapour pressure of the notified polymer and because aerosols are not expected during reformulation processes. The remainder of the reformulation process, including packaging, is expected to be mostly automated and exposure is expected to be low. Exhaust ventilation is likely to be used during reformulation.

End-use

Repeated incidental dermal and ocular exposure of workers to the notified polymer (at $\leq 1\%$ concentration) may occur when workers apply industrial and automotive coatings. There is also some potential for repeated inhalation exposure when applying coatings by low pressure spraying methods. Personal protective equipment (PPE) is expected to be worn, including gloves, protective clothing, safety glasses and respiratory protection when aerosols may be present.

6.1.2. Public Exposure

Products containing the notified polymer will be used in industrial settings only and will not be made available to the public. The public may come into contact with surfaces that have been coated with products containing the notified polymer. However, once dried and cured, the notified polymer is bound within a solid matrix and is not expected to be available for exposure.

6.2. Human Health Effects Assessment

No toxicity data were submitted for the notified polymer.

The notified polymer is a polyacrylate with a $M_n > 1,000$ g/mol and low percentage (< 5%) of low molecular weight species ($M_n < 500$ g/mol). This type of polymers may generally be considered to be of low hazard. However, the notified polymer contains polyfluorinated carbon chains and fluorinated polymers have been known to cause lung injury, which is characterised by respiratory problems ranging from mild to severe effects associated with acute or repeated exposures. Uncertainties remain surrounding possible acute or chronic respiratory tract effects following acute or repeated exposures to the notified polymer.

Although not considered in this risk assessment, NICNAS notes that the notified polymer contains residual monomers that are classified as hazardous according to the *Globally Harmonised System of Classification and Labelling of Chemicals (GHS)*, as adopted for industrial chemicals in Australia. These are not present in the notified polymer as introduced above the cut off concentrations for classification.

Health hazard classification

As no toxicity data were provided, the notified polymer cannot be classified according to the *Globally Harmonised System of Classification and Labelling of Chemicals (GHS)*, as adopted for industrial chemicals in Australia.

Hazard implication of breakdown products

The notified polymer contains polyfluoroalkyl side-chains that are potential precursors of PFHxA in the environment. PFHxA is a perfluorocarboxylic acid consisting of 5 perfluorinated carbons (a short chain perfluorinated chemical). The notified polymer is proposed to replace products containing polymers with longer polyfluoroalkyl carbon chains. It has been known that the toxicokinetic and toxicological properties of fluorinated substances are generally becoming less favourable with increase of polyfluoroalkyl carbon chain length. It has also been reported that the bioaccumulation potential of perfluorocarboxylic acids increases with polyfluoroalkyl carbon chain length increase (Conder, 2008; Giesy 2010).

A review of the literature indicates that PFHxA has a less hazardous human health profile, compared to PFOA (NICNAS, a). It is therefore inferred that the human health hazards associated with the expected breakdown products of the notified polymer (PFHxA) are likely to be similar or less than those associated with PFOA or longer chain perfluorocarboxylic acids, which are known degradants of many polyfluoroalkyl polymers currently on the market and that are intended to be replaced by the notified polymer.

6.3. Human Health Risk Characterisation

6.3.1. Occupational Health and Safety

There are uncertainties surrounding possible acute or chronic respiratory tract effects from the notified polymer when inhaled, because of the presence of perfluorinated alkyl chains in the notified polymer. However, during the reformulation and end use, inhalation exposure of workers to the notified polymer is expected to be minimised by use of enclosed and automated systems and the use of engineering controls such as spray booths and local exhaust ventilation, and use of PPE including safety glasses, impervious gloves, protective clothing, and respirators where required.

Once the final coatings are cured after end use, the notified polymer will be trapped in an inert polymer matrix and will not be available for further exposure.

Therefore, under the conditions of the occupational settings described, in the presence of engineering controls and PPE specified, the notified polymer is not considered to pose an unreasonable risk to occupational health.

Workers may also be exposed to per- and polyfluoroalkyl impurities of the notified polymer at low concentrations (< 0.1%), during use. It is expected that the PPE utilised during these operations (as outlined above) will mitigate any risk associated with such exposure.

6.3.2. Public Health

The notified polymer is intended for industrial use only and therefore direct exposure of members of the public to the notified polymer in imported and formulated products is not expected. Once the final coatings containing

the notified polymer are cured, the polymer is expected to be bound within an inert matrix and will not be available for exposure. Therefore, the notified polymer is not considered to pose an unreasonable risk to public health.

The public may be exposed indirectly to the ultimate break down product of the notified polymer, PFHxA, via the environment. Such exposure may increase over time due to the persistence of PFHxA in the environment. However, the available data indicates that PFHxA has lower bioaccumulation potential than the long chain perfluoroalkyl substances (such as PFOA) that are the ultimate break down products of long chain perfluoroalkyl polymers currently in Australian commerce. In particular, it is noted that the polymer being replaced contains perfluoroalkyl carbon chain lengths > 6. It is concluded that the risks to human health from indirect exposure to breakdown products of perfluoroalkyl substances will decrease following introduction of the notified polymer, on the basis that the notified polymer is intended to replace products containing polymers with longer perfluoroalkyl carbon chains.

7. ENVIRONMENTAL IMPLICATIONS

7.1. Environmental Exposure & Fate Assessment

7.1.1. Environmental Exposure

RELEASE OF CHEMICAL AT SITE

The notified polymer will be imported into Australia and therefore, release from manufacturing is not expected. Accidental spillage may occur during importation, transport and distribution. Any notified polymer that is spilled is expected to be absorbed onto a suitable material and collected for disposal in accordance with local regulations.

The notified polymer will be reformulated to final products locally. Reformulation is expected to be conducted following the standard operation procedure in a closed system. Therefore, release of the notified polymer from reformulation is not expected to be significant. Solvents used for equipment cleaning are expected to be recycled for reuse on site or disposed of via accredited waste disposal contractors. Wastes containing residues of the notified polymer (up to 1% of annual import volume as estimated by the notifier) are expected to be contained on-site and disposed of in accordance with local regulations. Empty import containers with residues of the notified polymer are expected to be disposed of to landfill.

RELEASE OF CHEMICAL FROM USE

The coating formulation containing the notified polymer will be applied to the substrate by spray, roller or brush by professional workers in industrial facilities. The use of roller and brush is expected to be efficient and no significant loss of the products is expected. Any losses from overspray (estimated at 30% of annual import volume) during industrial use are expected to be collected using standard engineering controls such as spray booths. All wastes generated during use, including residues in application equipment washings and empty coating containers are expected to be disposed of in accordance with local regulations.

RELEASE OF CHEMICAL FROM DISPOSAL

The notified polymer in coatings is expected to share the fate of the industrial coatings and automotive parts to which it has been applied. Hence, the notified polymer is likely to be either thermally decomposed during metal reclamation processes or be disposed of to landfill at the end of the useful life of the article to which it has been applied.

7.1.2. Environmental Fate

No environmental fate data were submitted.

The notified polymer is methacrylate-based where one of the ester side chains is polyfluorinated. This polyfluorinated side-chain incorporates a chain segment of six perfluorinated carbon atoms. Under the NICNAS action plan for assessing and managing chemicals that could degrade to perfluorinated carboxylic acids, the notified polymer would be considered to be an indirect precursor to the exceptionally persistent perfluorinated carboxylic acid, perfluorohexanoic acid (PFHxA) and shorter-chain perfluorinated carboxylic acid (NICNAS, b).

The biodegradation potential of fluoroacrylate polymers in soils has been investigated and the studies show that analogous polymers have the potential to degrade to release fluorotelomer alcohols (Washington *et al.*, 2009, 2015). The notified polymer is derived from 6:2 fluorotelomer methacrylate and can therefore, potentially,

release the 6:2 fluorotelomer alcohol, 6:2 FTOH. This polyfluorinated alcohol is known to undergo environmental biodegradation to form short-chain perfluorocarboxylic acids, including perfluorohexanoic acid (PFHxA) (NICNAS, b).

When associated with the articles, the notified polymer is not likely to be mobile or bioavailable. Based on its high molecular weight, the notified polymer is not likely to cross biological membranes or to bioaccumulate.

The majority of the notified polymer is expected to adhere to the surface of articles to which it is applied. Treated articles and other dried residues containing the notified polymer are expected to ultimately be disposed of to landfill or subjected to metals reclamation.

The notified polymer will eventually degrade in landfill and has the potential to release per- and polyfluoroalkyl degradation products, including short-chain perfluorinated carboxylic acids, such as PFHxA.

PFHxA is a globally distributed pollutant and is expected to be recalcitrant in the environment, potentially undergo long range transport while mainly staying in the water column. In water, it is expected to be very persistent and will not hydrolyse, photolyse or biodegrade under environmental conditions (NICNAS, c).

PFHxA is expected to be less bioaccumulative than perfluorooctanoic acid (PFOA) and other long-chain perfluoroalkyl acids, supported by the available laboratory evidence (Higgins *et al.*, 2007; Martin *et al.*, 2003a, b; Woodcroft *et al.*, 2010) and field (Falandysz *et al.*, 2006; Falandysz *et al.*, 2007, Furdui *et al.*, 2007) evidence. In general, bioaccumulation potential decreases when the length of the perfluorinated carbon chain is decreased (Ng and Hungerbühler, 2014, Giesy *et al.*, 2010). The short-chain perfluorocarboxylic acids, including PFHxA, have been assessed to have low bioaccumulation potential based on the currently available information (NICNAS, c, d).

7.1.3. Predicted Environmental Concentration (PEC)

A PEC has not been calculated for the notified polymer because, based on its reported use pattern (including during reformulation), significant quantities are not expected to be released to the aquatic environment.

PEC for PFHxA and other perfluorocarboxylic acids

The notified polymer has the potential to degrade and ultimately form the persistent degradant, PFHxA. However, the yield and rate of conversion of the notified polymer to PFHxA and shorter-chain carboxylic acids has not been established and depends on environmental conditions (microbial communities, Eh, pH, soil characteristics and climate conditions)

Environmental monitoring data shows that PFHxA and PFOA are widely found in the environment, particularly in fresh water close to industrial sources, but also in some biota. Water appears to be the main compartment where PFHxA is found. High measured concentrations of both PFHxA and PFOA in surface waters in Germany have been associated with the legal application of waste materials to agricultural soils (Skutlarek *et al.*, 2006), indicating that these chemicals have the potential to enter the aquatic compartment following initial release into the soil compartment.

Some larger available data sets from the literature (McLachlan *et al.*, 2007; Skutlarek *et al.*, 2006; Nakayama *et al.*, 2007; So *et al.*, 2007; Ahrens *et al.*, 2009) include monitoring from a range of rivers in Europe, the USA and China, along with data from the Atlantic Ocean. Using these data ($n \geq 60$), the 10th, 50th and 90th percentile concentrations for PFHxA are 1.0, 6.15 and 22.5 ng/L respectively, while those for PFOA are 2.94, 11.85 and 231.9 ng/L respectively. As use of chemicals that degrade to form PFHxA increases, levels of PFHxA may build up further in the environment.

Analyses of drinking water samples from Europe, Canada, the USA, Japan, India and China have also detected PFHxA and other short chain perfluoroalkyl compounds. PFHxA was recently detected in all samples taken from the Parramatta River (main tributary of Sydney Harbour), with a mean concentration of 2.9 ng/L. Sampling of the Brisbane River catchment following a major flooding event in 2011 also found PFHxA present in water at Somerset Dam, Wivenhoe Dam, Jindalee, Oxley Creek, West End, Bulimba and Moreton Bay. The chemical was detected in all samples obtained at these sites in concentrations ranging between 0.06 and 6.2 ng/L (NICNAS, c).

PFHxA and other poly- and perfluoroalkyl compounds have also been found in landfill leachate, with concentrations of PFHxA ranging from 270 – 790 ng/L (Huset *et al.*, 2011). As landfills are reservoirs of solid

waste, and receive waste water treatment plant sludge, which may contain poly- and perfluoroalkyl compounds, landfills have the potential to continue to release PFHxA and homologous perfluorinated carboxylic acids well into the future.

The lifetime of PFHxA in the aquatic environment is unknown, but is expected to be comparable to the very long lifetimes established for homologous perfluorinated acids such as PFOA and PFOS (NICNAS, d, e).

7.2. Environmental Effects Assessment

Effects of the notified polymer

No ecotoxicity data were submitted. Non-ionic polymers are generally of low toxicity to aquatic life and the notified polymer is expected to have very limited aquatic exposure based on its use pattern.

Effects of PFHxA and other perfluorocarboxylic acids

The currently available data, summarised in the NICNAS IMAP Environment Tier II Assessment for Short-Chain Perfluorocarboxylic Acids and their Direct Precursors, indicate that PFHxA and other short-chain perfluorinated acids (i.e. those with five or fewer perfluorinated carbon atoms) have low toxicity to aquatic life (NICNAS, c,f) compared to PFOA and perfluorooctanesulfonic acid (PFOS) (NICNAS, d, f). However, no long-term intergenerational studies were identified for PFHxA and other short chain short-chain PFCAs. Emerging evidence suggest that the most significant aquatic toxicity effects of PFOA and PFOS may manifest in offspring when the parent generation is exposed to PFOA or PFOS (NICNAS, d, f).

7.2.1. Predicted No-Effect Concentration

A predicted no-effect concentration (PNEC) has not been calculated for the notified polymer as, based on its reported use pattern, significant quantities are not expected to be released to the aquatic environment.

7.3. Environmental Risk Assessment

The risk quotient ($Q = PEC/PNEC$) for the notified polymer has not been calculated because release to the aquatic environment in significant quantities is not expected based on its use pattern in industrial and automotive coatings.

However, the notified polymer has the potential to eventually degrade to form very persistent PFHxA. PFHxA is currently understood to have low potential for bioaccumulation (NICNAS, b). The currently available data also indicate that PFHxA and other short-chain perfluorocarboxylic acids and their direct precursors have low toxicity to aquatic life (NICNAS, b, c).

The main environmental risks associated with polyfluoroalkyl polymers relate to the release of perfluorinated degradation products such as PFHxA. It is not possible to quantify the release of PFHxA to the environment from the use of the notified polymer at present. However, as use of chemicals/polymers that degrade to form PFHxA increases, levels of PFHxA may build up in the environment. Hence, there is potential for environmentally significant concentrations to eventually be reached following its accumulation in the environment. In this eventuality, precursors of PFHxA such as the notified polymer cannot be recalled after release and are potential sources of PFHxA releases into the environment even long after their use ceases. Thus, use and disposal of the notified polymer will likely lead to increases in the levels of PFHxA in the environment.

Conclusions

On the basis of the assessed use pattern, the notified polymer itself is not considered to directly pose an unreasonable short-term risk to the environment. However, the notified polymer contains fluorinated carbon groups that have the potential to degrade to the exceptionally persistent short-chain perfluorinated carboxylic acid, PFHxA.

The environmental degradation of the notified polymer is expected to contribute to the cumulative emissions of perfluorohexanoic acid to the environment. Based on the currently available evidence, the concentrations of PFHxA and other short-chain perfluorinated carboxylic acids are not considered to pose a concern for the health of the environment. However, if additional hazard information becomes available to indicate that short-chain perfluorinated carboxylic acids have hazard characteristics of high concern for the environment (such as PBT properties), then the risks posed by industrial uses of precursors to these environmental degradants may need to be re-assessed.

During metal recycling incomplete combustion of perfluoroalkyl functionality may produce an array of partially oxidised fluoro-compounds and hydrofluoric acid. The emissions of hydrofluoric acid should be controlled to

not exceed current Federal and State legislated limits. This is expected to be carried out through monitoring at metal reclamation sites.

BIBLIOGRAPHY

- Ahrens L, Felizeter S, Sturm R, Xie Z and Ebinghaus R (2009). Polyfluorinated compounds in wastewater treatment plant effluents and surface waters along the River Elbe, Germany. *Mar Pollut Bull*, 58(9):1326-1333.
- Conder JM, Hoke RA, de Wolf W, Russell MH, Buck RC (2008). Are PFCAs bioaccumulative? A critical review and comparison with regulatory criteria and persistent lipophilic compounds. *Environ Sci Technol*;42:995–1003.
- Falandysz J, Taniyasu S, Gulkowska A, Yamashita N and Schulte-Oehlmann U (2006) Is Fish A Major Source of Fluorinated Surfactants and Repellents in Humans Living on the Baltic Coast. *Environ Sci Technol*, 40(3):748-751.
- Falandysz J, Taniyasu S, Yamashita N, Rostkowski P, Zalewski K and Kannan K (2007) Perfluorinated compounds in some terrestrial and aquatic wildlife species from Poland. *J Environ Sci Health, Part A: Environ Sci Eng*. 42(6):715-719.
- Furdui V, Stock N, Ellis D, Butt C, Whittle D, Crozier P, Reiner E, Muir D and Mabury S (2007) Spatial Distribution of Perfluoroalkyl Contaminants in Lake Trout from the Great Lakes. *Environ Sci Technol*, 41(5):1554-1559.
- Giesy JP, Nail JE, Khim JS, Jones PD & Newsted JL (2010) Aquatic Toxicology of Perfluorinated Chemicals. *Rev Environ Contam Toxicol*, 202: 1-52.
- Higgins C, McLeod P, Macmanus-Spencer L and Luthy R (2007) Bioaccumulation of Perfluorochemicals in Sediments by the Aquatic Oligochaete *Lumbriculus variegatus*. *Environ Sci Technol*, 41(13):4600-4606.
- Huset C A, Barlaz M A, Barofsky D F and Field J A (2011). Quantitative determination of fluorochemicals in municipal landfill leachates, *Chemosphere*, Volume 82, Issue 10, 1380-1386.
- Martin J, Mabury S, Solomon K and Muir D (2003a) Bioconcentration and Tissue Distribution of Perfluorinated Acids in Rainbow Trout (*Oncorhynchus mykiss*). *Environ Sci Technol*, 22(1):196:204.
- Martin J, Mabury S, Solomon K and Muir D (2003b) Dietary Accumulation of Perfluorinated Acids in Juvenile Rainbow Trout (*Oncorhynchus mykiss*). *Environ Toxicol Chem*, 22(1):189-195.
- McLachlan M, Holmstrom K, Reth M and Berger U (2007) Riverine Discharge of Perfluorinated Carboxylates from the European Continent. *Environ Sci Technol*, 41(21):7260-7265.
- Nakayama S, Strynar M, Helfant L, Egeghy P, Ye X and Lindstrom A (2007) Perfluorinated Compounds in the Cape Fear Drainage Basin in North Carolina. *Environ Sci Technol*, 41(15):5271-5276.
- Ng CA and Hungerbühler K (2014). Bioaccumulation of Perfluorinated Alkyl Acids: Observations and Models. *Environmental Science and Technology*, 48(9), pp 4637-4648.
- NICNAS (a) *IMAP Environment Tier II Assessment for Perfluoroheptanoic Acid (PFHpA) and its Direct Precursors*, National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia, <https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-ii-environment-assessments/perfluoroheptanoic-acid-pfhpa-and-its-direct-precursors>. Accessed on 24 September 2018.
- NICNAS (b) *IMAP Environment Tier II Assessment for Indirect Precursors to Short-Chain Perfluorocarboxylic Acids*, National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia, <https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-ii-environment-assessments/indirect-precursors-to-short-chain-perfluorocarboxylic-acids>, Accessed on 24 September 2018.
- NICNAS (c) *IMAP Environment Tier II Assessment for Short-Chain Perfluorocarboxylic Acids and their Direct Precursors*, National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia, <https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-ii-environment-assessments/short-chain-perfluorocarboxylic-acids-and-their-direct-precursors>. Accessed on 24 September 2018.
- NICNAS (d) *IMAP Environment Tier II Assessment for Perfluorooctanoic acid (PFOA) and its direct precursor*, National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia, <https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-ii-environment-assessments/perfluorooctanoic-acid-and-its-direct-precursors>. Accessed on 24 September 2018.

- NICNAS (e) *IMAP Environment Tier II Assessment for Direct Precursors to Perfluorooctanesulfonate (PFOS)*, National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia, <https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-ii-environment-assessments/direct-precursors-to-perfluorooctanesulfonate-pfos>. Accessed on 24 September 2018.
- NICNAS (f) *IMAP Environment Tier II Assessment for Indirect Precursors to Short-Chain Perfluorocarboxylic Acids*, National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia, <https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-ii-environment-assessments/indirect-precursors-to-short-chain-perfluorocarboxylic-acids>, Accessed on 24 September 2018.
- Skutlarek D, Exner M & Färber H (2006) Perfluorinated Surfactants in Surface and Drinking Waters. *Environ Sci Pollut Res*, 13(5):299-307.
- So M, Miyake Y, Yeung W, Ho Y, Taniyasu S, Rostkowski P, Yamashita N, Zhou B, Shi X, Wang J, Giesy J, Yu H and Lam P (2007) Perfluorinated compounds in the Pearl River and Yangtze River of China. *Chemosphere*, 68(11):2085-2095.
- SWA (2015) Code of Practice: Spray Painting and Powder Coating, Safe Work Australia, <https://www.safeworkaustralia.gov.au/doc/model-code-practice-spray-painting-and-powder-coating>.
- United Nations (2009) Globally Harmonised System of Classification and Labelling of Chemicals (GHS), 3rd revised edition. United Nations Economic Commission for Europe (UN/ECE), <http://www.unece.org/trans/danger/publi/ghs/ghs_rev03/03files_e.html >
- US EPA (United States Environmental Protection Agency) (2013) Interpretive Assistance Document for Assessment of Polymers. Sustainable Futures Summary Assessment. Updated June 2013: https://www.epa.gov/sites/production/files/2015-05/documents/06-iad_polymers_june2013.pdf accessed (8 August 2018).
- Washington J, Ellington J, Jenkins T, Evans J, Yoo H and Hafner S (2009) Degradability of an acrylate-linked, fluorotelomer polymer in soil. *Environmental Science and Technology*, 43(17):6617-6623.
- Washington J, Jenkins T, Rankin K, Naile J (2015) Decades-scale degradation of commercial, side-chain, fluorotelomer-based polymers in soils and water. *Environmental Science and Technology*, 49(2):915-923
- Woodcroft M, Ellis D, Rafferty S, Burns D, March R, Stock N, Trumpour K, Yee J and Munro K (2010) Experimental Characterization of the Mechanism of Perfluorocarboxylic Acids' Liver Protein Bioaccumulation: The Key Role of the Neutral Species. *Environ Toxicol Chem*, Early View. DOI: 10.1002/etc.199.