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PFOS in China:

Production, Application & Alternatives

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Production

- "East heats up as west cools down"
  - Main producer 3M (USA) stopped before 2002

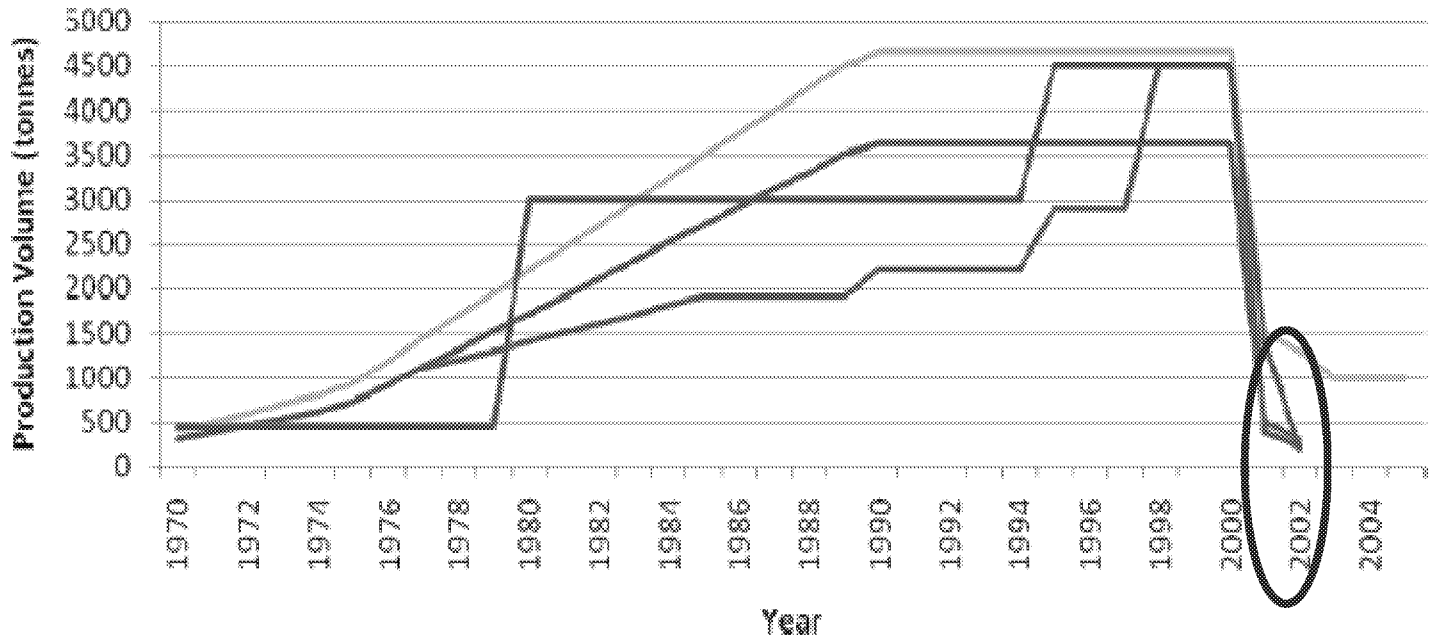

FIGURE 1. Estimated total global POSF production volumes (1970–2002). This work's estimates of total global (green line) and 3M's production (purple line) are compared to estimates from Smithwick et al. (*9*) (red line) and Prevedouros et al. (*13*) (blue line). (Note: Smithwick et al. (*9*) and Prevedouros et al. (*13*) assume POSF production stops with 3M).

POSF = PFOSF = perfluorooctanesulfonyl fluoride

Source: Paul et al., *Environ. Sci. Technol.* 2009

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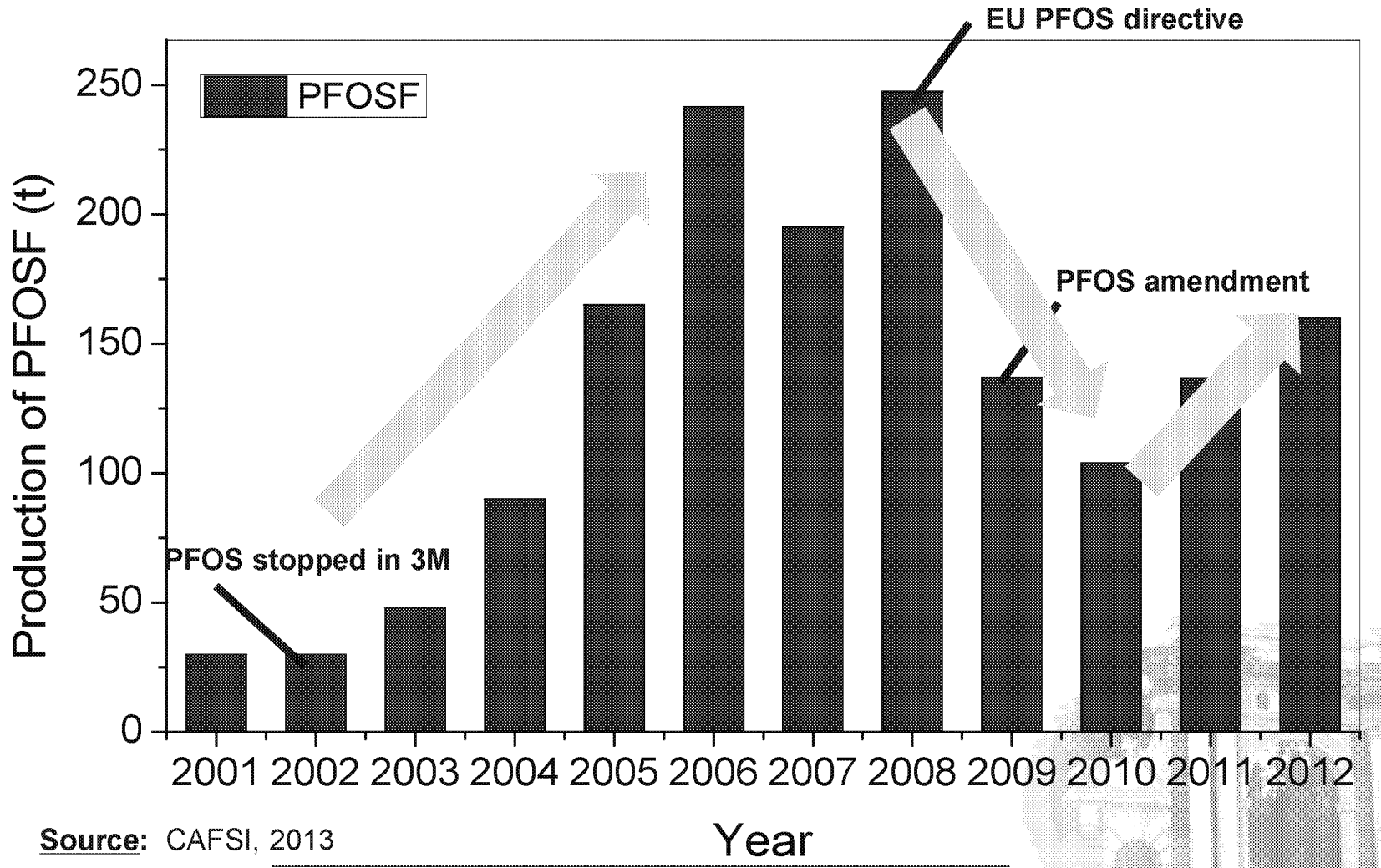
Production

- China: Latecomer & Survivor
  - Production in China increased since 2001



Source: CAFSI, 2013

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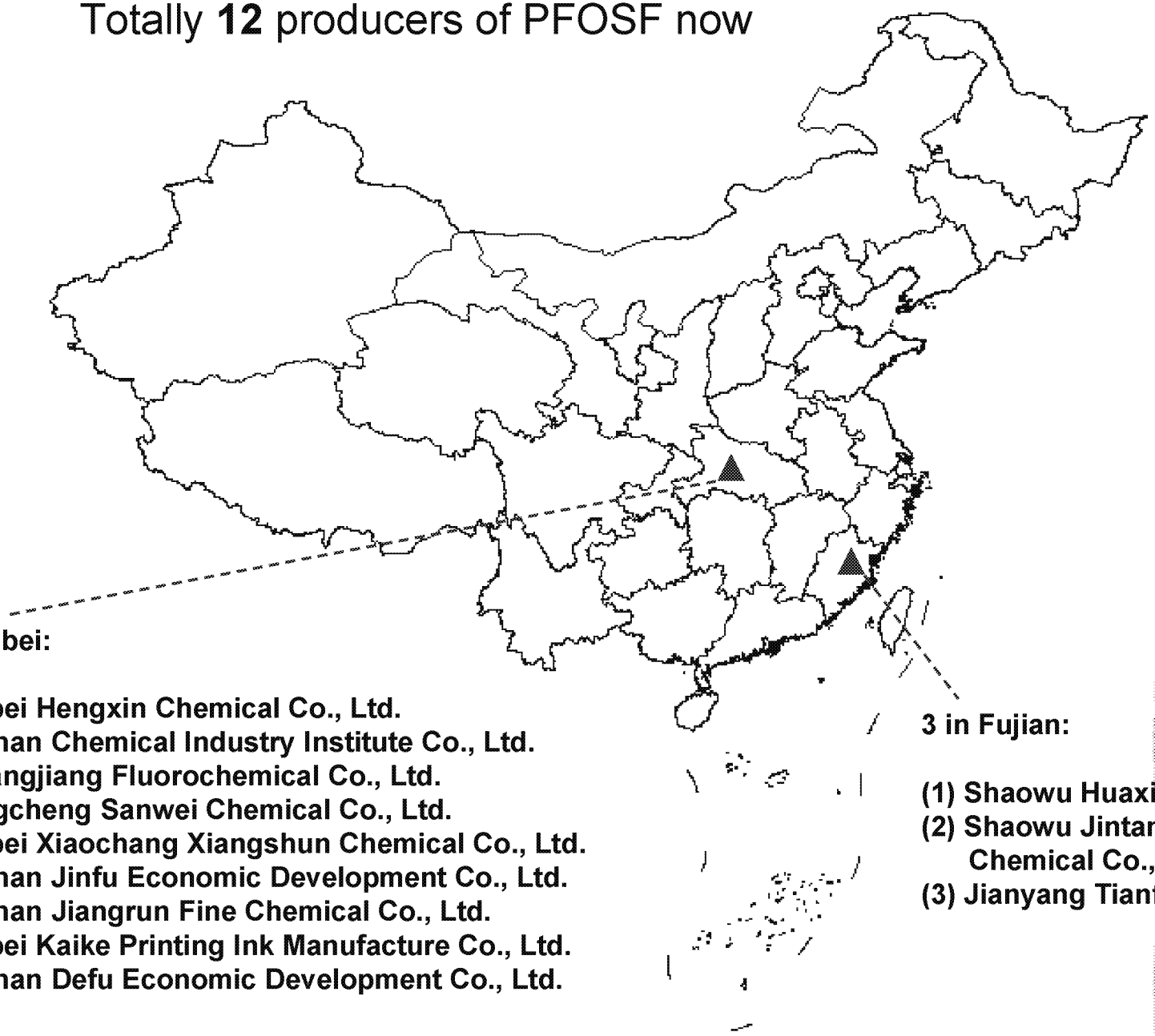
Production

- **Producers:**
  Totally **12** producers of PFOSF now



9 in Hubei:

(1) Hubei Hengxin Chemical Co., Ltd.
(2) Wuhan Chemical Industry Institute Co., Ltd.
(3) Changjiang Fluorochemical Co., Ltd.
(4) Yingcheng Sanwei Chemical Co., Ltd.
(5) Hubei Xiaochang Xiangshun Chemical Co., Ltd.
(6) Wuhan Jinfu Economic Development Co., Ltd.
(7) Wuhan Jiangrun Fine Chemical Co., Ltd.
(8) Hubei Kaike Printing Ink Manufacture Co., Ltd.
(9) Wuhan Defu Economic Development Co., Ltd.

3 in Fujian:

(1) Shaowu Huaxin Chemical Co., Ltd.
(2) Shaowu Jintang Anshengqi Chemical Co., Ltd.
(3) Jianyang Tianfu Chemical Co., Ltd.

Production

- **Process:**
  All producers use **E**lectro**C**hemical **F**luorination (ECF) process

Sulfonation: $C_8H_{17}Br + Na_2SO_3 \rightarrow C_8H_{17}SO_3Na + NaBr$

Acyl chlorination: $C_8H_{17}SO_3Na + POCl_3 \rightarrow C_8H_{17}SO_2Cl + NaH_2PO_2 + H_2O$

Fluorination: $C_8H_{17}SO_2Cl + KF \rightarrow C_8F_{17}SO_2F + KCl$

Electrofluorination: $C_8H_{17}SO_2H + HF \rightarrow C_8F_{17}SO_2F + H_2\uparrow$

Photo: ECF facilities in a PFOSF producer in Hubei

Production

- **Products:**
  - ✓ PFOSF

Photo: PFOSF used as raw material in a FC surfactant producer in Shanghai

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Production

- **Products:**
  - ✓ PFOS surfactants

$C_8F_{17}SO_2F$

- $C_8F_{17}SO_3H$
- $C_8F_{17}SO_3M$
- $C_8F_{17}SO_2NHR$
  - $C_8F_{17}SO_2NRCH_2COOH$
  - $C_8F_{17}SO_2NRC_2H_4OH$
    - $C_8F_{17}SO_2NR(C_2H_4O)_nH$
    - $C_8F_{17}SO_2NRC_2H_4OP(O)(OH)_2$
    - $C_8F_{17}SO_2NRC_2H_4OSO_3H$
- $C_8F_{17}SO_2NHC_3H_6N(CH_3)_2$
  - $C_8F_{17}SO_2NHC_3H_6N(C_2H_5)_2RX^-$
  - $C_8F_{17}SO_2NHC_3H_6N^+(C_2H_5)_2C_2H_4COO^-$
  - $C_8F_{17}SO_2NHC_3H_6N^+(CH_3)_2 \cdot HX$

* R = CH_3, C_2H_5, C_3H_7, C_4H_9; X = Cl, Br, I; M = K, Na, ...

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Production

- Annual production of main products

Product	Typical name	Production (t)	Domestic use (t)	Export (t)
PFOSF	FX-8	139	89.5	49.5
Potassium perfluorooctanesulfonate	FC-95	8.9		
Tetranethylammonium perfluorooctanesulphonate	FC-248	5.4		
N-Ethyl perfluorooctylsulfonamide ethanol	FC-10	1.1		
Perfluorooctanesulfonate amine	FC-120	1.7		
N-Ethyl perfluorooctylsulfonamide	FC-09	3.1		
Perfluoroalkylsulfonyl quaternary ammonium iodides (for AFFF)	FC-134	10.4		
Other Surfactants for AFFF	JF111	11		
Others		3		

Source: CAFSI, 2013

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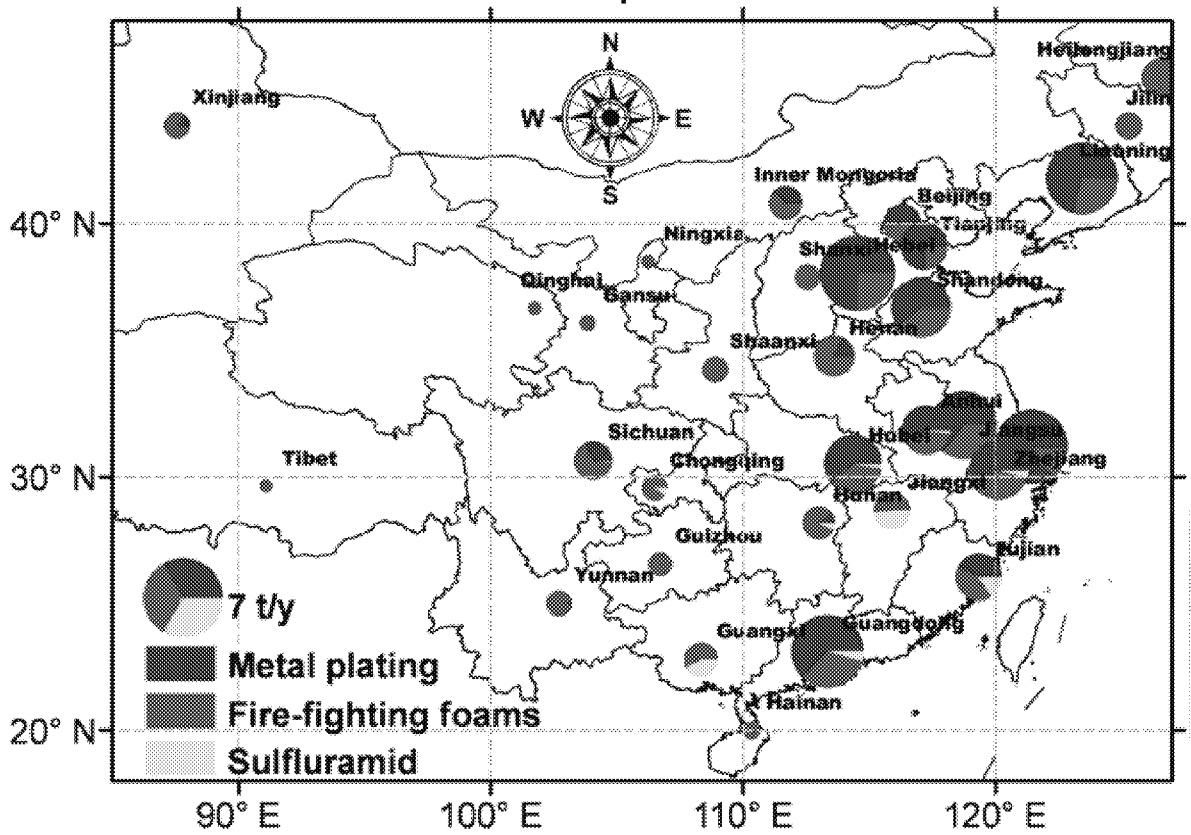
Application

- Where does the produced PFOSF go?
  - Average production in 2009-212: **100-160 t/a** (PFOSF)
  - About 1/4 - 1/3 was exported (esp. to Brazil)
  - Previously identified domestic applications
    - ✓ Mist suppressant in metal plating (esp. hard Cr(VI) plating)
    - ✓ Fluorocarbon surfactant in fire-fighting foam
    - ✓ Sulfluramid as A. I. in pesticides



Source: Zhang *et al.*, **Environmental Pollution**. 2012, 165: 193-198

Application

- Results from latest surveys
  - CAFSI Survey 2013

Sector	Application	Consumption (Converted into PFOSF)
Electroplating	Chrome mist suppressant	20~25
Pest control	Bait for cockroach and termite control	~5
Fire-fighting	Surfactants for AFFF	~50
Oil production	1. Surfactant for Chemical EOR; 2. Cleanup agent in oil production; 3. Viscosity reducer in oil transportation	~40
Others	Textile finishing, paper, leather, rubber, coating, etc.	4~8

Source: CAFSI, 2013

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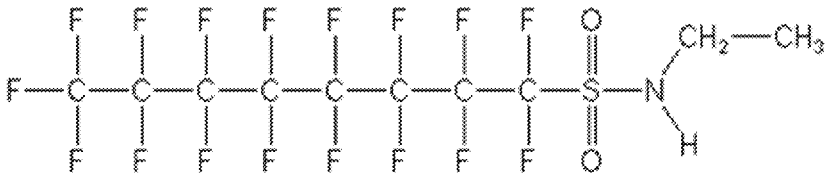
Application

Confirmed applications of PFOS in China

1. **Sulfluramid as A.I. in**
   - ✓ Bait for termite control
   - ✓ Bait for cockroach control



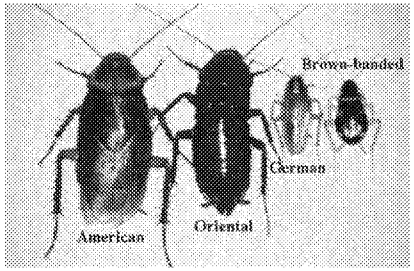
CAS No.: 4151-50-2
$CF_3(CF_2)_7SO_2NHCH_2CH_3$

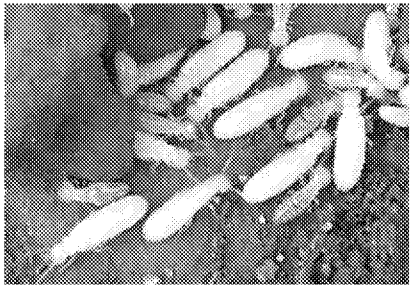
Producer	Name	A.I.	Content	Registration Status	Registered No.	Period of validity	Toxicity
Currently in valid							
Jiangshu Changzhou Yekang Chemical Product Co., Ltd	Raw pesticide	Sulfluramid	95%	Full Registration	WP20040004	2009-11-02 ~ **2014-11-02**	Slightly toxic
	Bait for cockroach	Sulfluramid	1%	Full Registration	WP20040005	2009-11-02 ~ **2014-11-02**	Low toxic
	Bait for termite	Sulfluramid	0.08%	Full Registration	WP20120180	2012-09-13 ~ **2017-09-13**	Low toxic

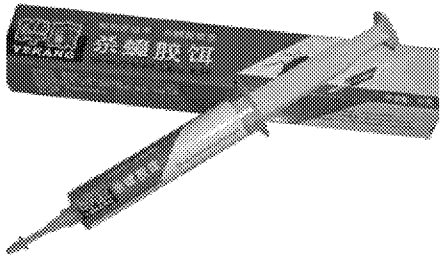
Source: http://www.chinapesticide.gov.cn/

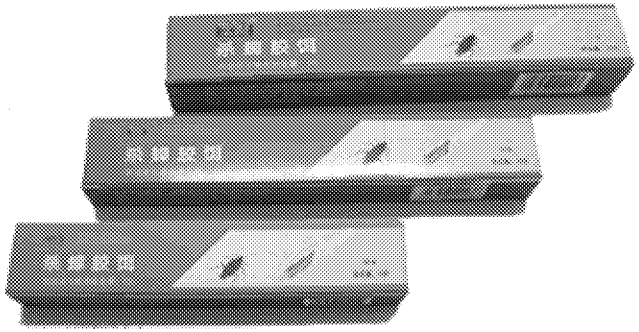
Application

* Examples of sulfluramid baits in China









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Application

- Sulfluramid based bait for cockroach control is quite welcome in current market, and has been adopted by both **Olympic 2008** and **Expo 2010**.
- The sale of the producer has amounted up to 30 million RMB (about 5 million USD).

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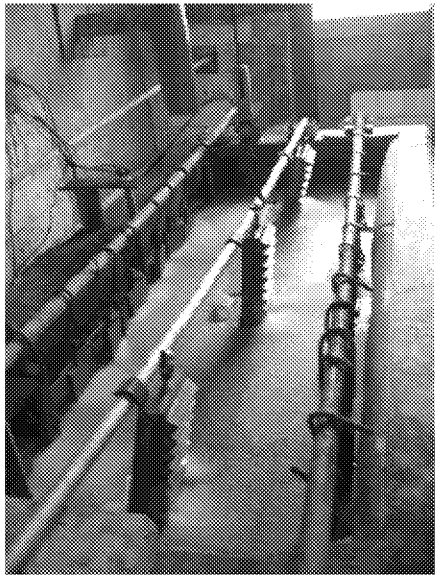
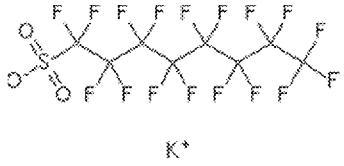
Application

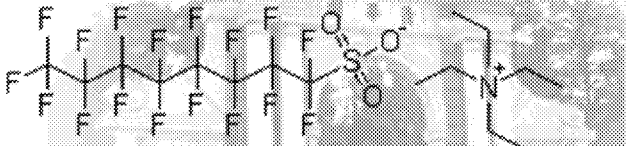
Confirmed applications of PFOS in China

2. Mist suppressant in hard chrome plating industry



- FC-80: $CF_3(CF_2)_7SO_3^-\ K^+$ CAS: 2795-39-3
- FC-248: $CF_3(CF_2)_7SO_3^-\ (C_2H_5)_4N^+$ CAS: 56773-42-3





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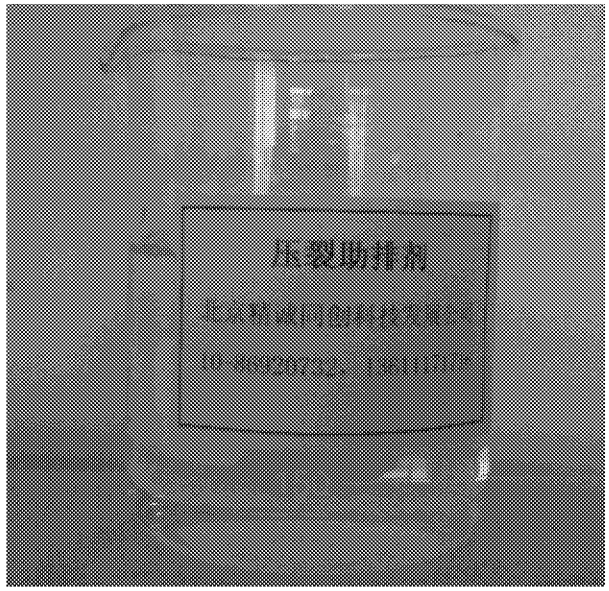
Application

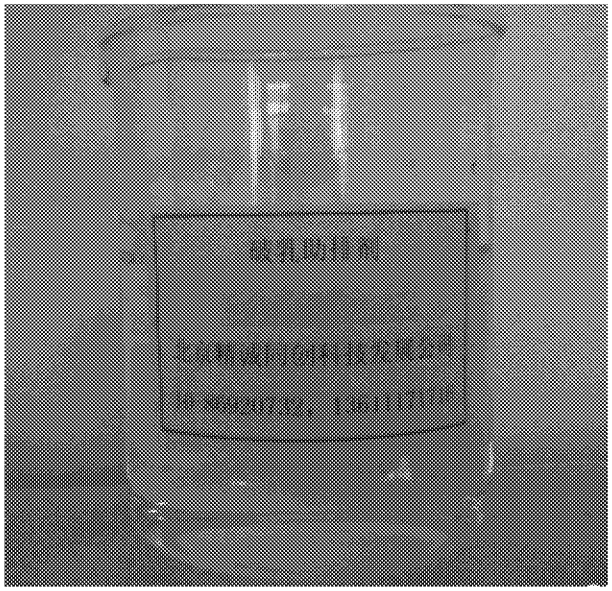
- Confirmed applications of PFOS in China
  3. **Fluorocarbon surfactant in fire-fighting foam**
     - ✓ e.g. SC-2170 for AFFF; VF-570 for AFFF; FC-134 for AFFF
     - ✓ Total consumption in 2001-2008 is **131 t**, with the amount of related foam products **24,224 t**

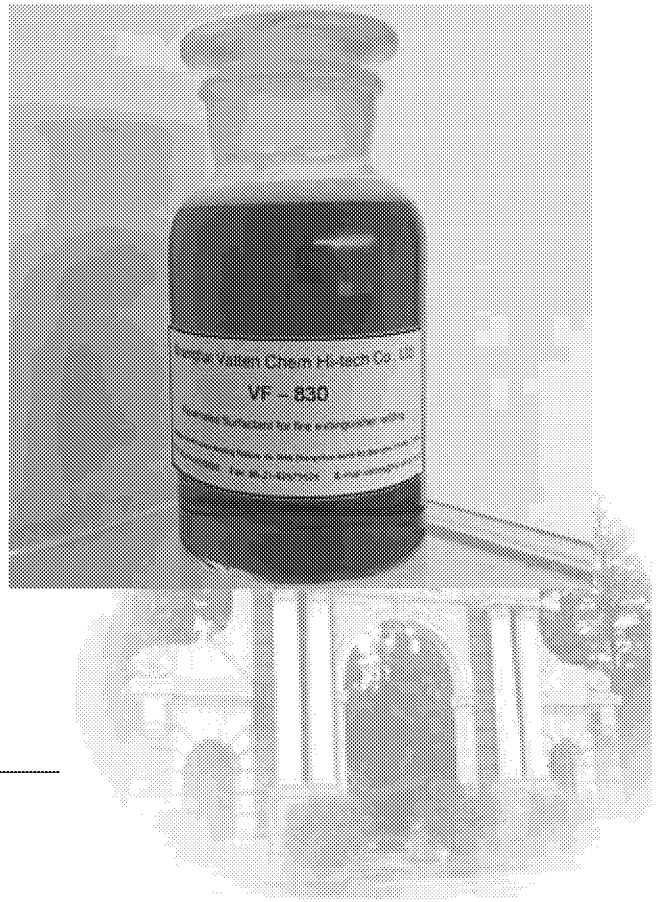
       Source: Yu et al., 2010 (in Chinese)

Application

- Confirmed applications of PFOS in China
  4. **Surfactants for oil production (a new key use)**
     - ✓ Main functions: Surfactant for Chemical EOR; Cleanup agent in oil production; Viscosity reducer in oil transportation
     - ✓ e.g. JF-03T; VF-830







Source: http://www.bjjctc.com/pro.asp?class_id=6
http://vatten.com.cn/productinfor/p7_20.html?&pageid=7&_id=20&r=0

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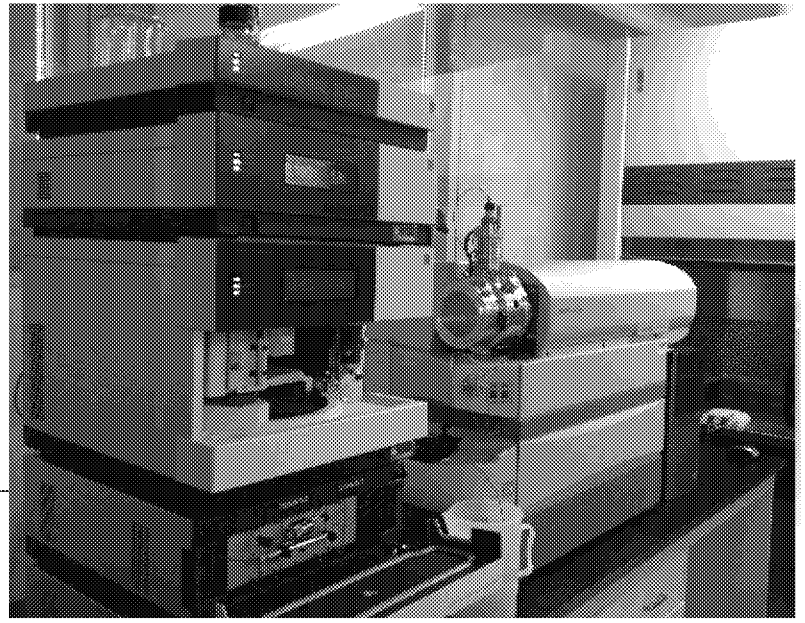
PFOS in products

- Real testing of some Chinese PFOS products

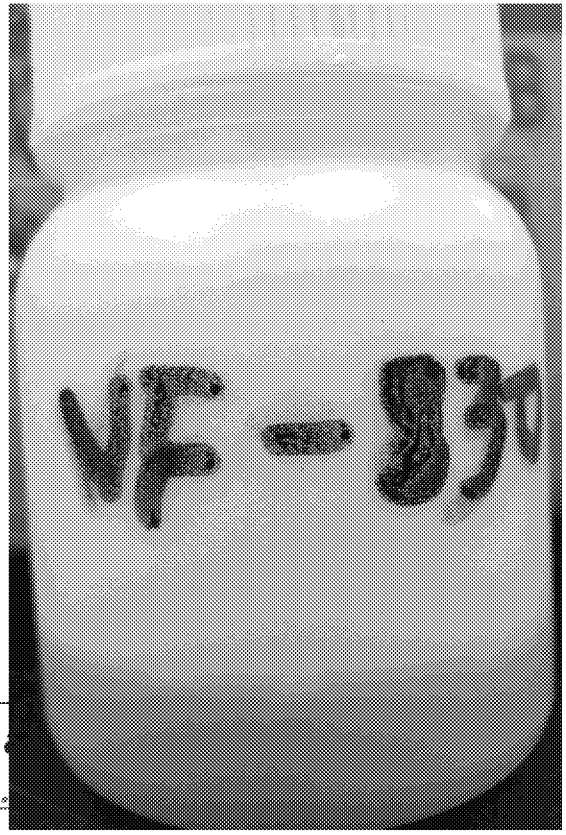
[Method] GB/T 24169-2009 Determination of perfluorooctane sulfonates (PFOS) in the fluorine-containing products and consumer products - High performance liquid chromatography-tandem mass spectrometry

1. **Chrome mist suppressant (2 samples)**
   - ✓ FC-80
     Producer: Wuhan Heide Chemical Development Co., Ltd.
   - ✓ FC-248
     Producer: Wuhan Bright Chemical Co., Ltd



PFOS in products

2. **Fluorocarbon surfactants for fire-fighting foam (1 sample)**
   - ✓ VF-570
     Producer: Shanghai Vatten Chem Hi-tech Co., Ltd.
3. **Fluorocarbon surfactants for oilfield cleanup agent (1 sample)**
   - ✓ VF-830
     Producer: Shanghai Vatten Chem Hi-tech Co., Ltd.



PFOS in products

- Some testing results
  - Purity of Chinese PFOS salts

  * Mist suppressant in Chrome plating industry

    ✓ **FC-80**

    – 67.7% （n=3, SD=0.25%）

    ✓ **FC-248**

    – 96.3% （n=3, SD=0.34%）

  - PFOS and related chemicals in PFOS formulations (unit: mg/L)

	PFBA	PFBS	PFHxA	PFHxS	PFOA	PFOS
VF-570 (for AFFF)	293	10.8	55.8	36.9	25.5	11,500
VF-830 (for oil production)	122	0.131	23.4	0.384	9.94	11,300

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Alternatives

Key Facts

- Some alternatives are always there, despite of the coming and going of PFOS. e.g.
  - ✓ cockroach/termite control bait
  - ✓ chrome mist suppressant
  - ✓ oil production surfactant
- Replacement of PFOS actually has been completely in some applications, where the market was controlled by imported products. e.g.
  - ✓ textile finishing agent

- **PBT profiles of alternatives are not well understood**
  - ✓ **Local products**: e.g. F-53B (synica)
  - ✓ **Imported products**: e.g. C6-telomer based products (DuPont, Dakin, etc.); C4-PFBS based products (3M), etc.

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Alternatives

- Commercial alternatives in Chinese market
  1. **Registered non-PFOS baits**
     - ✓ for termite control:
       - 3 products, using 2 chemicals as A.I.

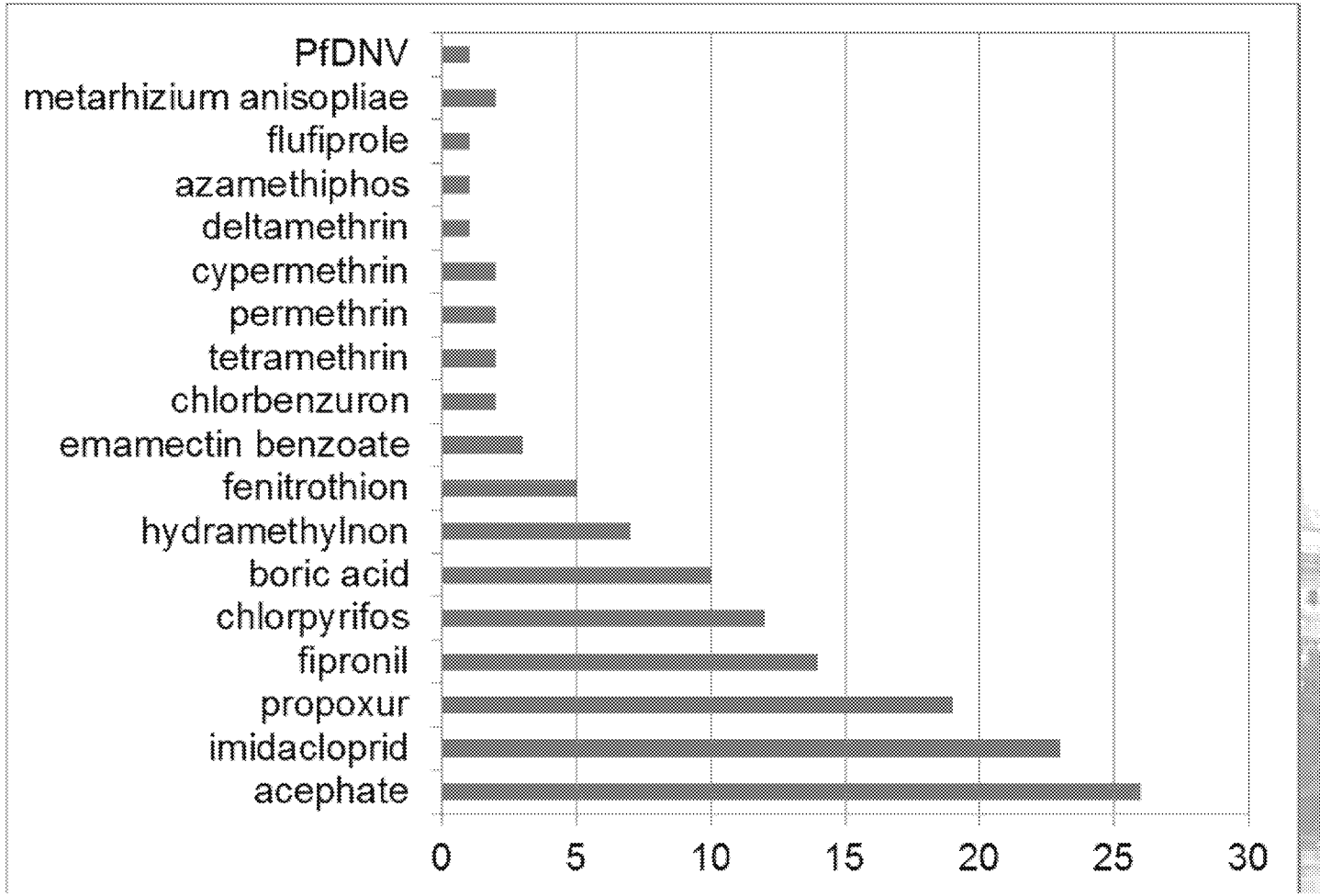
Producer	Name	A.I.	Target Pest	Registration No.	Period of validity	Toxicity
Dow AgroSciences USA	Termite bait	0.5% hexaflumuron	Termite	WP20070015	2012-07-18 ~ 2017-07-18	Low toxic
Ensystex USA	Chlorfluazuron	0.1% Chlorfluazuron	Termite	WP20100125	2010-10-27 ~ 2015-10-27	Low toxic
Suzhou Jiangfeng Termite Control Co., Ltd.	Termite bait	0.5% hexaflumuron	Termite	WP20090384	2009-12-24 ~ 2014-12-14	Slightly toxic

Source: http://www.chinapesticide.gov.cn/service/aspx/B3.aspx

Alternatives

1. **Registered non-PFOS baits**
   - ✓ for cockroach control:
     - 127 products (Low toxic: 78; Slightly toxic: 49)
     - involving15 chemicals and 3 bio-substances as A.I.

Source: http://www.chinapesticide.gov.cn/service/aspx/B3.aspx; (2013/09/16)



Alternatives

◆ PBT evaluation of chemicals involved in baits

- Using **PBT profiler** developed by USEPA (http://www.pbtprofiler.net/)

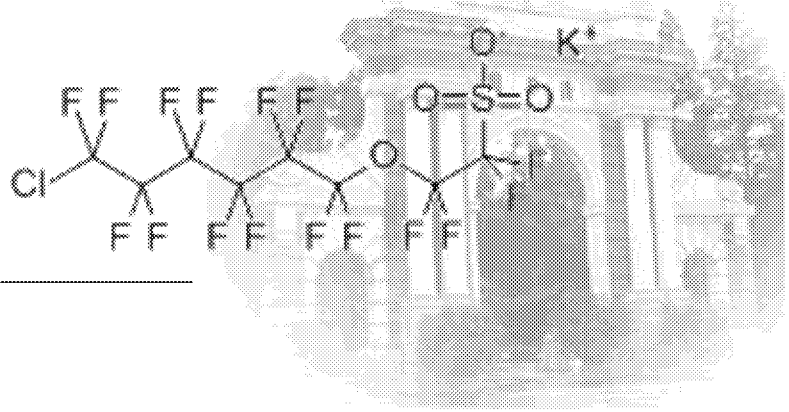
No.	Name	CAS No.	$t_{1/2}$ (d)				Percentage (%)				BCF	ChV (Fish) mg/L
			Wat.	Soi.	Sed.	Air	Wat.	Soi.	Sed.	Air		
1	Acephate	30560-19-1	38	75	340	1.4	46	54	0	0	3.2	5,800
2	Imidacloprid	138261-41-3	60	120	540	0.1	47	53	0	0	3.2	440
3	Propoxur	114-26-1	38	75	340	0.5	33	67	0	0	3	15
4	Fipronil	120068-37-3	180	360	1,600	0.17	5	93	2	0	240	0.00094
5	Chlorpyrifos	2921-88-2	180	360	1,600	0.18	4	76	20	0	1,300	NA
6	Hydramethylnon	67485-29-4	180	360	1,600	0.096	1	49	50	0	550	NA
7	Fenitrothion	122-14-5	38	75	340	0.27	18	81	1	0	69	NA
8	Chlorbenzuron	35409-97-3	60	120	540	1.1	8	85	7	0	560	NA
9	Tetramethrin	7696-12-0	38	75	340	0.019	14	69	17	0	20	0.023
10	Permethrin	52645-53-1	60	120	540	0.71	2	40	58	0	450	0.00073
11	Cypermethrin	52315-07-8	180	360	1,600	0.75	3	74	23	0	970	0.000057
12	Deltamethrin	52918-63-5	60	120	540	0.67	2	40	57	0	270	0.01
13	Azamethiphos	35575-96-3	60	120	540	0.11	43	57	0	0	1.3	130
14	Flufiprole	704886-18-0	180	360	1,600	0.092	4	95	1	0	2,200	NA
15	Hexaflumuron	86479-06-3	180	360	1,600	0.75	2	66	32	0	470	NA
16	Chlorfluazuron	71422-67-8	180	360	1,600	0.83	2	58	40	0	5,800	NA

Alternatives

2. **Mist suppressant in hard chrome plating industry**
   - ✓ **F-53B** (widely accepted in China)

   ** A short chain (C6) revision 4:2 F-53B has been recently synthesized in lab and under testing.*

•F-53B： $C_8ClF_{16}O_4SK$
CAS: 73606-19-6



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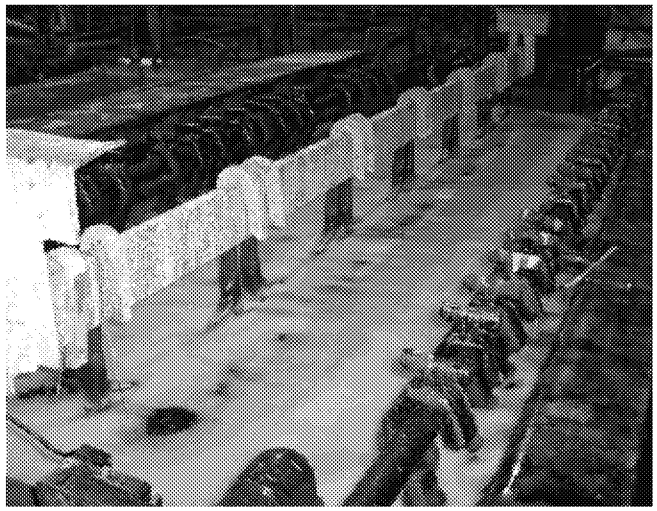
Alternatives

2. Mist suppressant in hard chrome plating industry

✓ **Other imported product** (not well known in China)

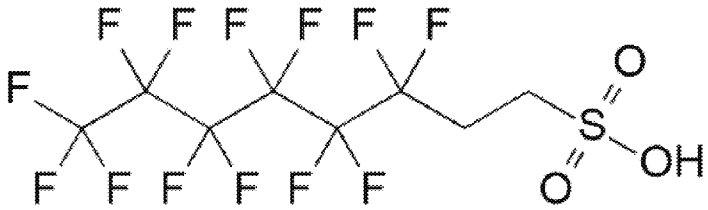
Hard Chrome Bath with Fumetrol® 21 LF (non-PFOS low foaming mist suppressant)



Hard Chrome Bath with Fumetrol® 21 (non-PFOS mild foaming mist suppressant)

•Fumetrol 21：6:2 FTS

CAS: 27619-97-2



http://www.atotech.com/nl/products/general-metal-finishing/news-single-view/article/fumetrolreg.html

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Alternatives

3. **Surfactants for AFFF**

✓ **Imported** C6-telomer based surfactants, e.g.

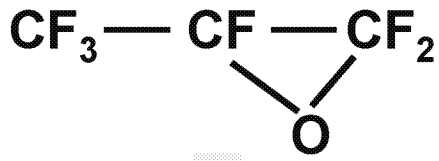
Chemguard	DuPont
FS-157	Capstone® 1157
FS-257	Forafac® 1157N
FS-183	Forafac® 1183
FP-5103	Forafac® 1268
FS-203	Forafac® 1203

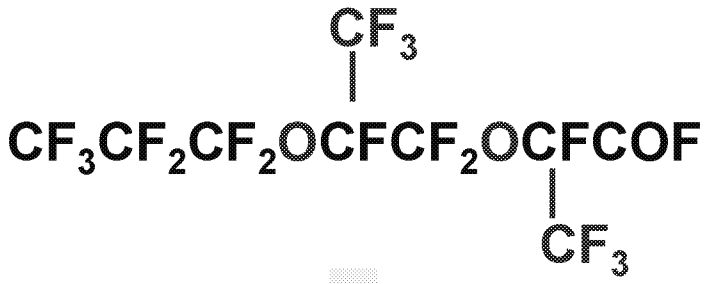
✓ **Local** products, e.g.

- VF-230 (Vattern): C6-telomer based
- VF-9126 (Vattern): PFHxS based
- **FC-3B (Synica)**: branch chain oligomer

Alternatives

* FC-3B





perfluoro surfactant
Oligomer

Fire Fighting Foam Liquid

Alternatives

4. Fluorocarbon surfactants for other applications

✓ **C6 (PFHxS) , C4 (PFBS)**

PFBS & PFBSF

PFHxS PFHxSF

Source: http://www.fluoride-cn.com/pages/pro.htm

氟表面活性剂产品目录

序号	商品牌号	化学名称	类型	规格	添加询单
1	HX-8	全氟辛基磺酰氟		≥90%	立即订购
2	HX-95	全氟辛基磺酸钾	阴离子	≥98%	立即订购
3	HX-10	N-乙基全氟辛基磺酰胺乙醇	非离子	≥80%	立即订购
4	HX-120	全氟辛基磺酸铵	阴离子	≥95%	立即订购
5	HX-12	N-乙基全氟辛基磺酰胺	阴离子	≥95%	立即订购
6	HX-134	全氟辛基季胺碘化物(固体)	阳离子	≥98%	立即订购
7	HX-134	全氟辛基季胺碘化物(液体)	阳离子	50%	立即订购
8	HX-921	全氟烷基甜菜碱	两性	≥90%	立即订购
9	HX-248	全氟辛基磺酸四乙基胺(固体)	阴离子	≥98%	立即订购
10	HX-248	全氟辛基磺酸四乙基胺(液体)	阴离子	50%	立即订购
11	HX-403	全氟丁酸		≥98%	立即订购
12	HX-401	全氟丁基磺酰氟		≥98%	立即订购
13	HX-98	全氟丁基磺酸钾	阴离子	≥95%	立即订购
14	HX-1890	长效铬雾抑制剂	阴离子	≥98%	立即订购
15	HX-807	全氟烷基磷酸酯	阴离子	≥80%	立即订购
16	HX-99	全氟辛基磺酰胺	阴离子	≥25%	立即订购
17	HX—PAG—4S	全氟丁基磺酸锍盐光产酸剂		≥98%	立即订购
18	HX--601	全氟己基磺酰氟		≥90%	立即订购
19		全氟己基磺酸钾		≥95%	立即订购
20	HX-131	全氟三乙胺		≥95%	立即订购
21	HX-3283	全氟三丙胺		≥98%	立即订购
22	HX-43	全氟三丁胺		≥84%	立即订购

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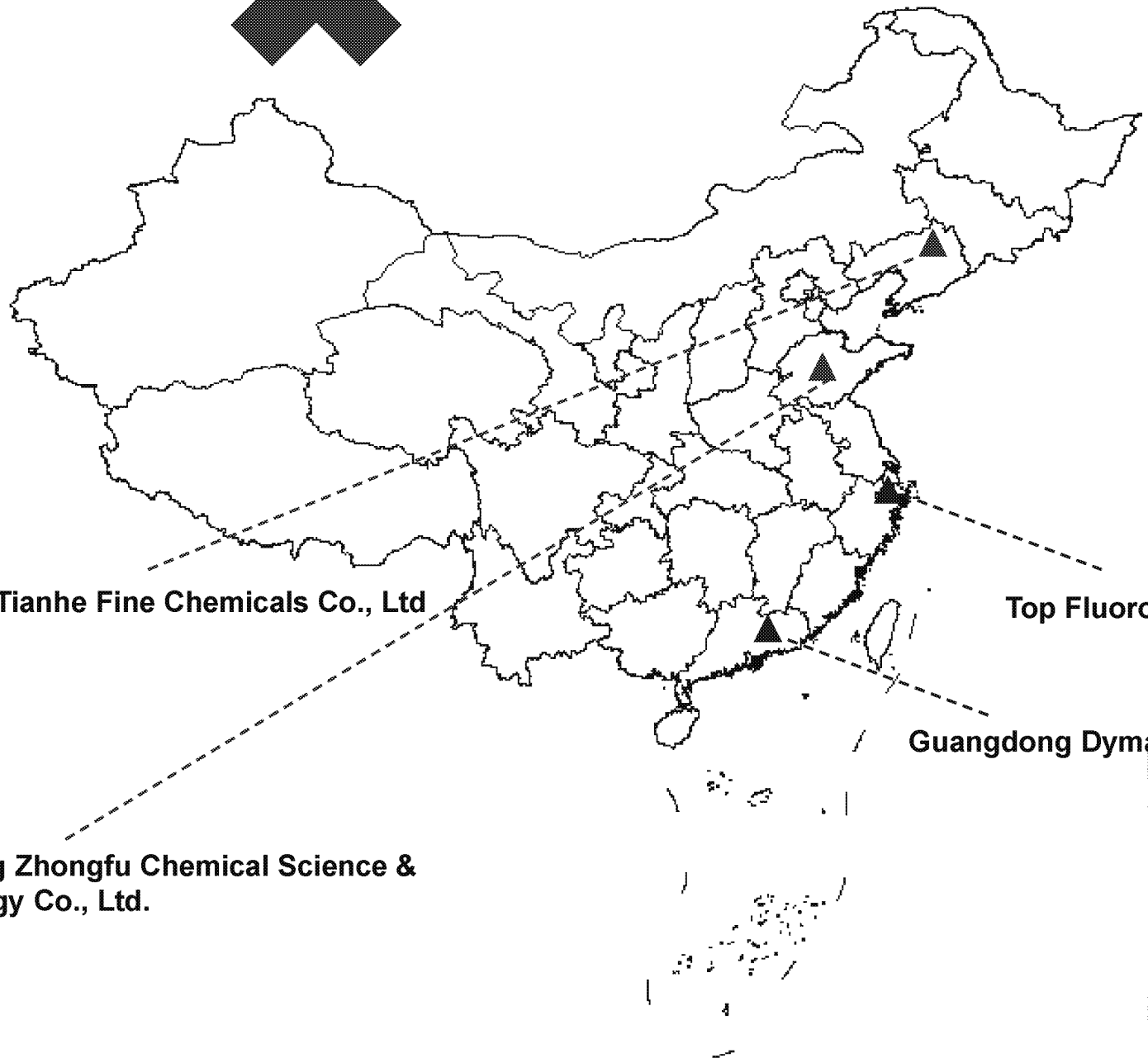
Alternatives

- ✓ **C8-telomer based, C6-telomer based**



Alternatives

✓ **Branch chain perfluorinated ether surfactants**

** Interchem as an example*

"Our products must be environment friendly, because of the branch chain and ether bond in structure…"

- **Branch chain**
- **Ether bond (-O-)**

http://www.intechem.com

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PFCs in alternatives

- Real testing of some Chinese alternatives to PFOS
  - **Short-chain PFASF (2 samples)**
    - ✓ PFBSF(C4)、PFHxSF(C6)
  - **Water proofing agent (2 samples)**
    - ✓ PFBS(C4)-based、PFHxS(C6)-based

  Producer: Hubei Hengxin Chemical Co., Ltd.

PFCs in alternatives

- **PFHxS derivatives (3 samples)**
  - ✓ 2-[methyl[(tridecafluorobutyl)sulphonyl]amino]ethyl acrylate (CAS No.: 49859-70-3)
  - ✓ 2-[methyl[(tridecafluorohexyl)sulphonyl]amino]ethyl acrylate (CAS No.: 67584-57-0)
  - ✓ N-methyl-perfluorohexane-1-sulfonamide (CAS No.: 68259-15-4)

  Producer: Hubei Hengxin Chemical Co., Ltd.

PFCs in alternatives

- **Textile finishing agents (3 samples)**
  - ✓ PFHxS (C6) based
  - ✓ Telomer (C6) based
  - ✓ PFBS (C4) based

  Producer: Wuhan Fengfan Surface Engineering Co., Ltd.

PFCs in alternatives

- **Fluorocarbon surfactants in fire-fighting foam (4 samples)**
  - ✓ VF-230
  - ✓ VF-6119
  - ✓ VF-9128
  - ✓ VF-9126

  Producer: Sh[illegible], Ltd.

PFCs in alternatives

- Testing results:
  - **Short-chain PFASFs** (unit: mg/L)

	PFBA	PFBS	PFHxA	PFHxS	PFOA	PFOS
PFHxSF	3.57	0.312	7.48		0.0779	
PFBSF	6.78	506				

  - **Fluorocarbon surfactant for fire-fighting foam** (unit: mg/L)

	PFBA	PFBS	PFHxA	PFHxS	PFOA	PFOS
VF-9128 (for AFFF)	19.4	0.833	3.82	13.1		
VF-9126 (for AFFF)	27		2.54	**1,050**		
VF-6119 (for AFFF)	6.83			9.39		5.28
VF-230 (for AFFF)	95.4					

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PFCs in alternatives

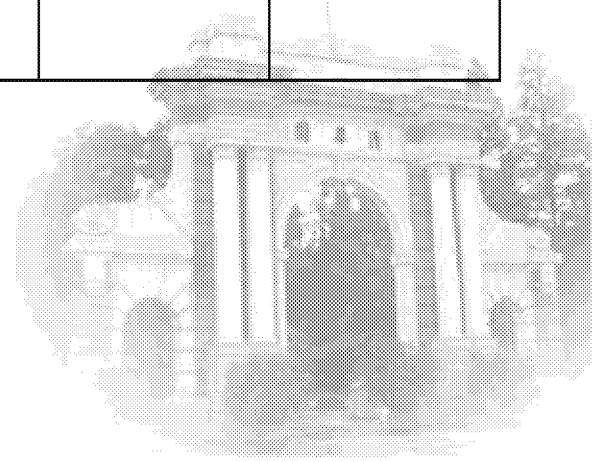
- **Water proofing agent** (unit: mg/L)

	PFBA	PFBS	PFHxA	PFHxS	PFOA	PFOS
PFHxS(C6)-based	0.92	1.32		2.6		
PFBS(C4)-based	1.97	1.49				

- **Textile finishing agent** (unit: mg/L)

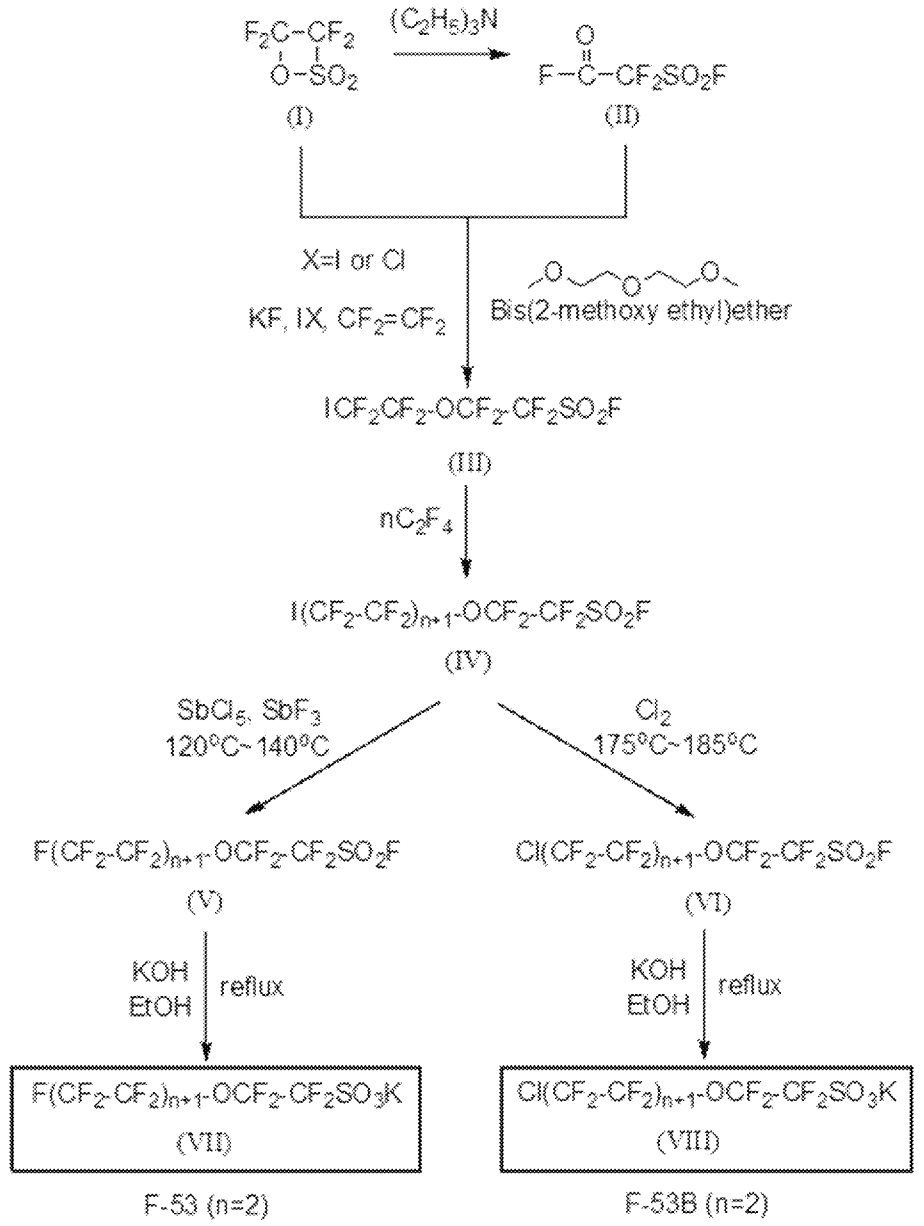
	PFBA	PFBS	PFHxA	PFHxS	PFOA	PFOS
PFBS based	1.26	4.15				
C6 telomer based	2.76	1.74	5.77			

- **No target PFCs found in other samples**



F-53B: An Example

- Synthesis process of F-53B
  - **1971**: R&D team in SIOC was established as required by the central government
  - **1975**: F-53 was successfully developed in SIOC
  - **1979**: F-53B was invented as a revision of F-53 to reduce the production cost
  - **1982**: F-53B was commercialized and disseminated
  - **2012**: The CAS No. of F-53B was assigned in June.



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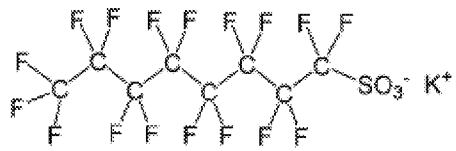
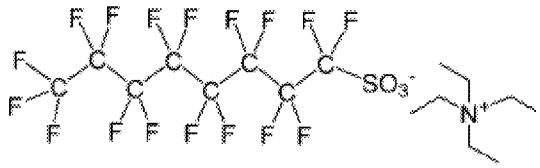
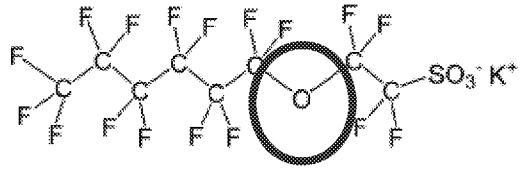
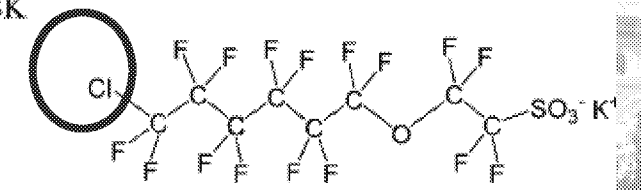
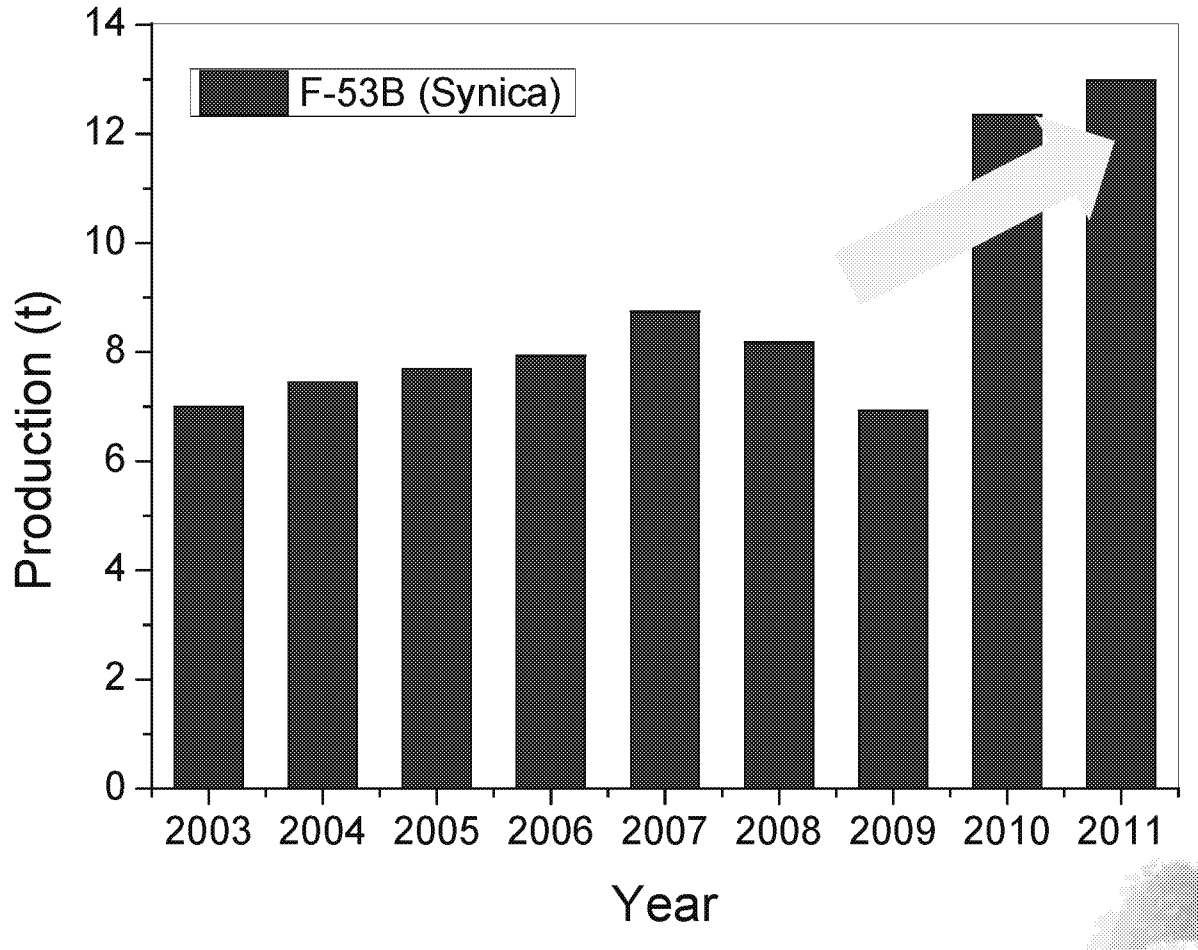
F-53B: An Example

Structure comparison

Product Name	Chemical	CAS Number	Chemical Formula	Structure
FC-80	Potassium perfluorooctane sulfonate	2795-39-3	$C_8F_{17}O_3SK$	
FC-248	Tetraethylammonium perfluorooctane sulfonate	56773-42-3	$C_{16}H_{20}F_{17}O_3NS$	
F-53	2-[(1,1,2,2,3,3,4,4,5,5,6,6,6-tridecafluorohexyl)oxy]-1,1,2,2-tetrafluoroethanesulfonic acid potassium salt	Not available	$C_8F_{17}O_4SK$	
F-53B	2-[(6-Chloro-1,1,2,2,3,3,4,4,5,5,6,6-dodecafluorohexyl)oxy]-1,1,2,2-tetrafluoroethanesulfonic acid potassium salt	73606-19-6	$C_8ClF_{16}O_4SK$	

F-53B: An Example

- Production of F-53B in Synica



Source: Annual Reports of Synica (2003-2011) , Conversion factor = 1300 RMB/kg
http://www.windin.com/Tools/BulletinDetail.aspx?windcode=600490.SH

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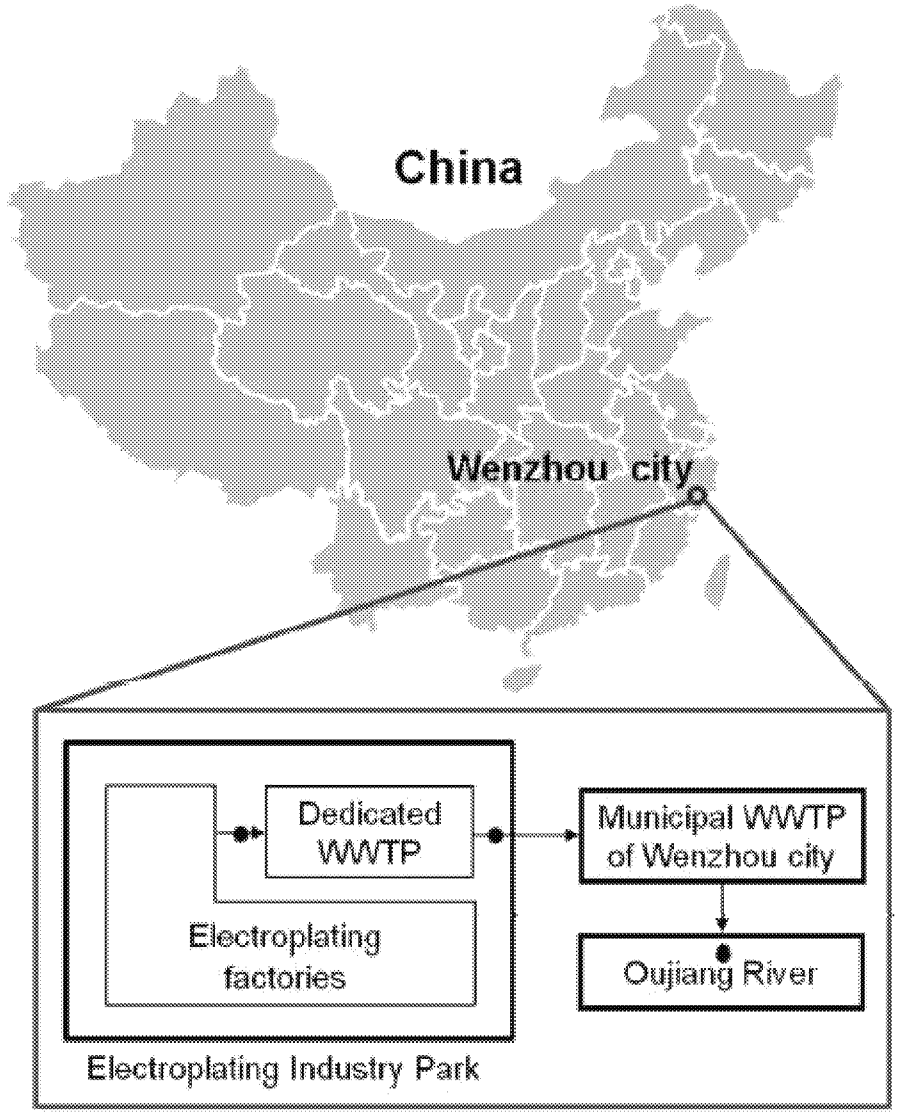
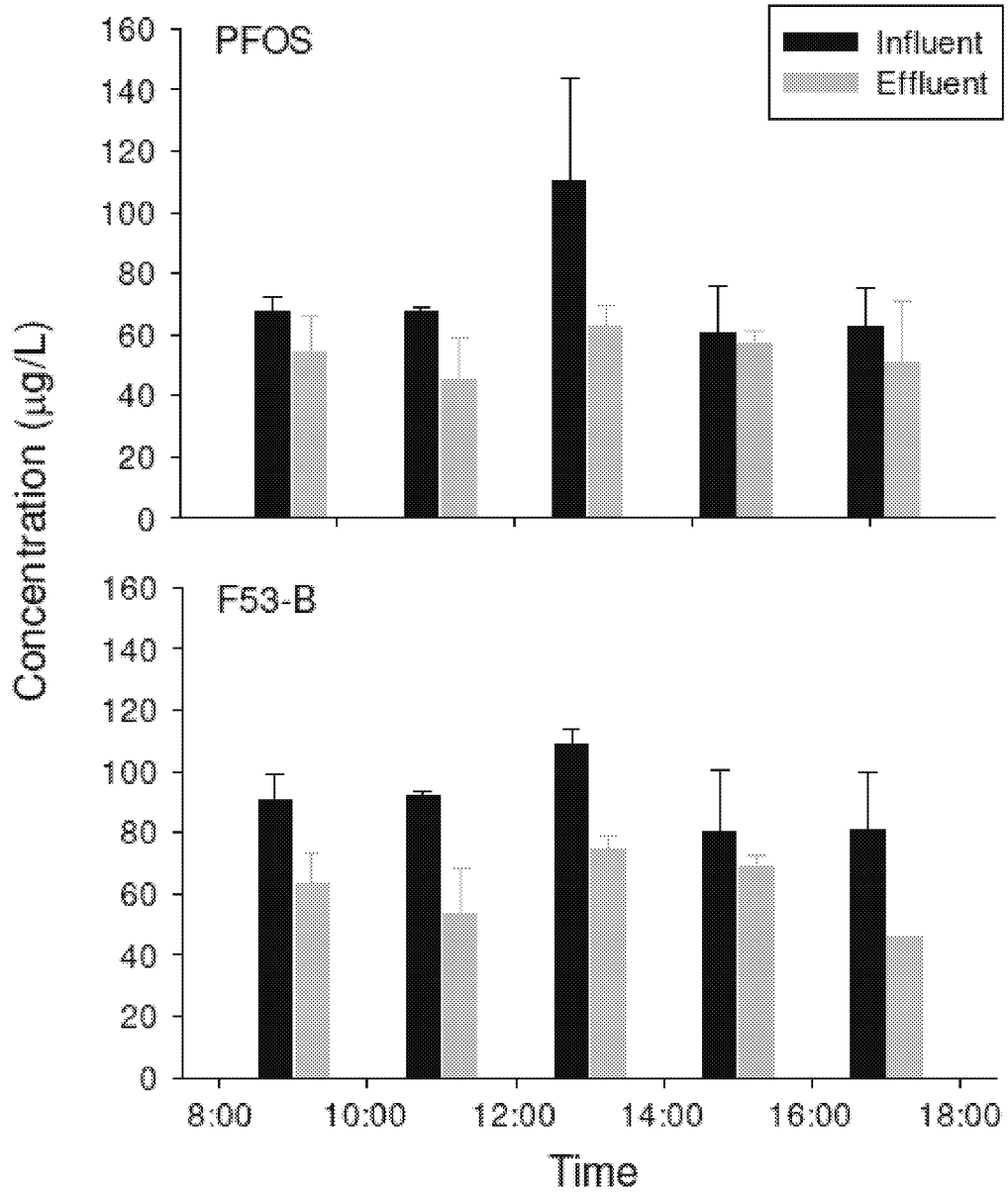
F-53B: An Example

- Case study
  - Sampling sites in Wenzhou city, Zhejiang Province, China. (●shows the location of sampling sites)



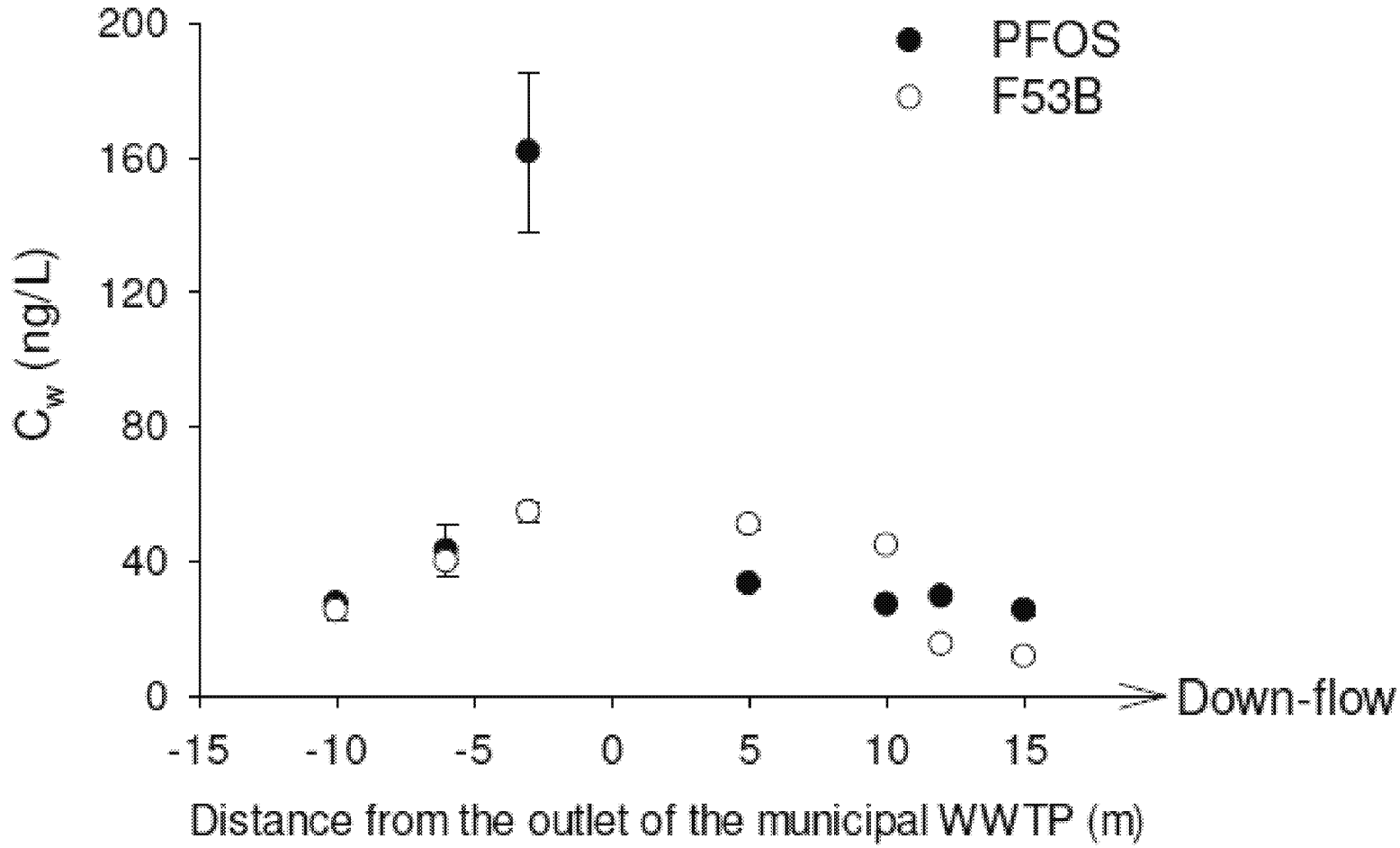
F-53B: An Example

- Concentrations of F-53B and PFOS at the dedicated WWTP at different times during a single day (n=3)



F-53B: An Example

- Water concentrations (C_w) of PFOS and F-53B in the vicinity of a WWTP discharge, Oujiang River, Wenzhou City (n = 3)



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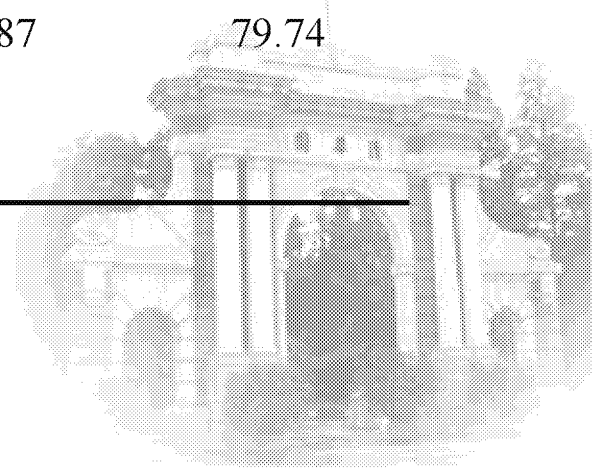
F-53B: An Example

- Fish acute toxicity
  - OECD 203 test

Sample	LC_{50}* (mg/L)		LC_0 (mg/L)	LC_{100} (mg/L)
	72 h	96 h		
F-53B	18.4	15.5	5.0	26.9
95% Confidence limits	16.7~20.5	14.8~16.3		

* p =0.0312 for 72 h and p =0.0005 for 96 h

Sample	LC_{50}* (mg/L)		LC_0 (mg/L)	LC_{100} (mg/L)
	72 h	96 h		
PFOS	56.16	17.00	2.87	79.74
95% Confidence limits	43.55~69.06	11.40~28.06		



F-53B: An Example

Ready biodegradability

- Percentage biodegradation of samples in the OECD 301D test

Sample	Average of percentage biodegradation[b] (% ThOD, n=2) at			
	7 d	14 d	21 d	28 d
Reference substance [a]	82.3	86. 2	87.6	88.2
F-53B	18.0	18.0	23.8	43.5

[a] Sodium benzoate

[b] The average percentage biodegradation is calculated by dividing the average DO consumption per unit mass of the test substance after each time period, corrected by the average DO consumption in blanks after the corresponding time period, by the calculated ThOD.

F-53B: An Example

Bioaccumulation

- **Software:** EPI Suite (USEPA), ACD Labs

Property	[a] F-53B (anion)	PFOS (anion)	Software programs
log *K*ow	5.24	4.49	KOWWIN v1.68 (EPI Suite 4.11)
pKa	-5.01	-5.08	ACD Labs 6.00/pKa DB
[b] log BAF	3.81	3.28	BCFBAF v3.01 (EPI Suite 4.11)
[b] log BCF	3.53	3.23	BCFBAF v3.01 (EPI Suite 4.11)

[a] The water solubility of F-53B (potassium salt) was higher than 200 mg/L in pure water at a room temperature of 25 °C. The water solubility of potassium salt of PFOS was measured at 570~910 mg/L.
[b] Both the BAF and BCF values were estimated for the fish in the upper trophic level based on Arnos-Gobas (2003) model.

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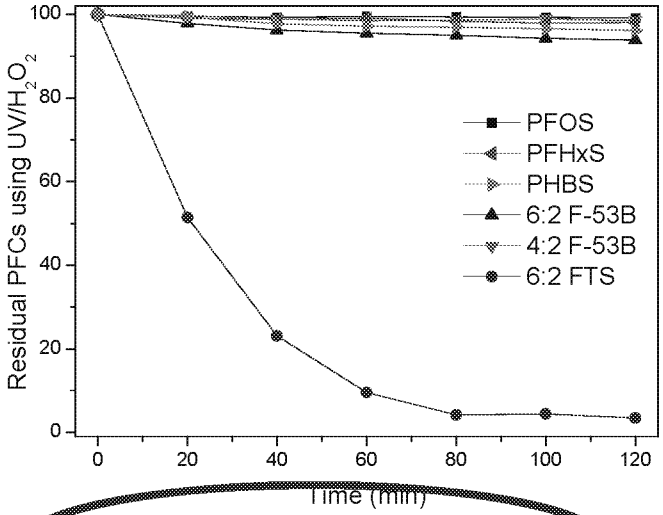
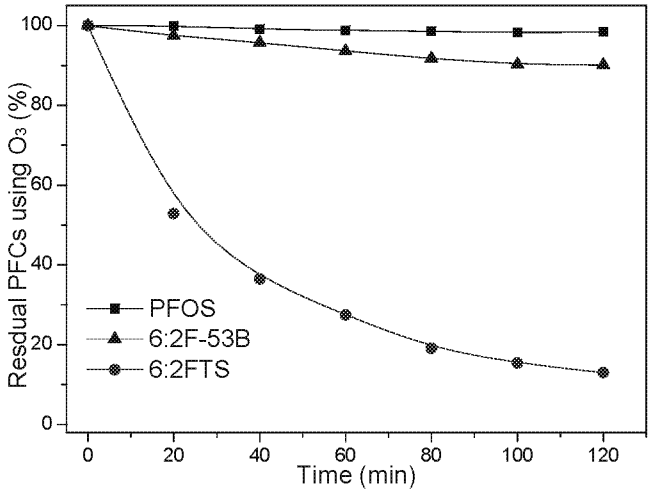
Stability under AOP

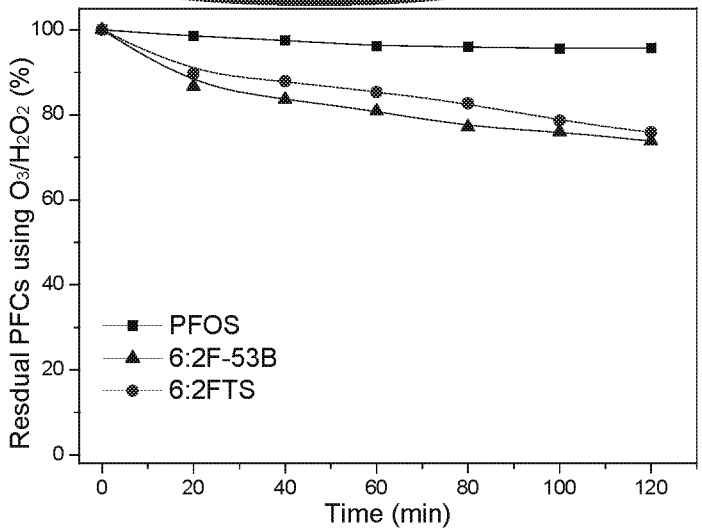
- Stability of some alternatives under AOP conditions



UV/H_2O_2 (4mL H_2O_2/250mL)



O_3 (3.0g O_3/h, pH=11)



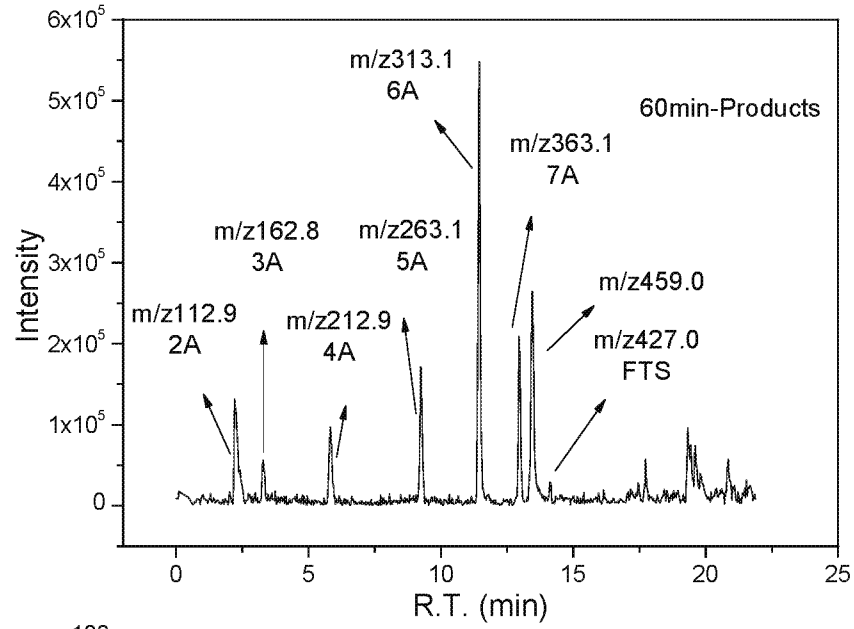
O_3/H_2O_2 (3.0g O3/h, 4mL H_2O_2/250mL)

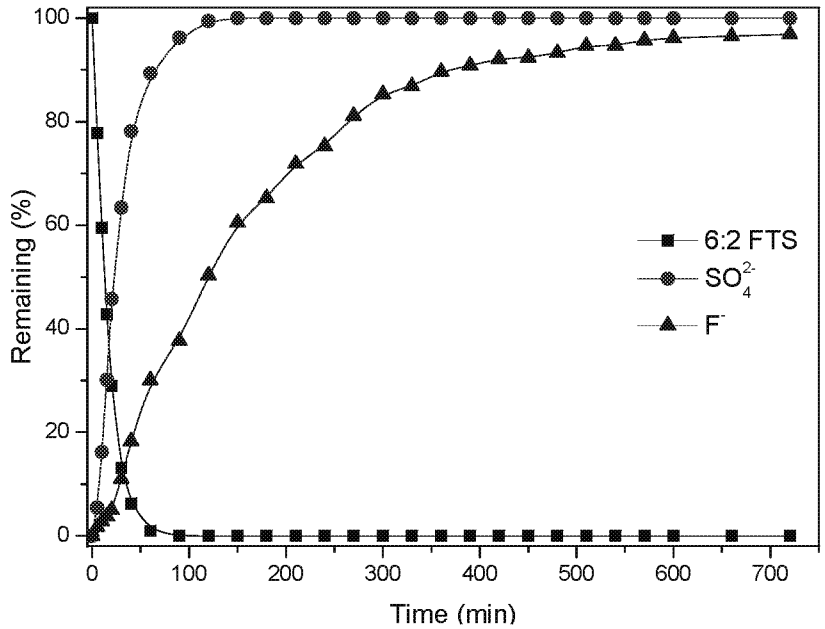
6:2 FTS

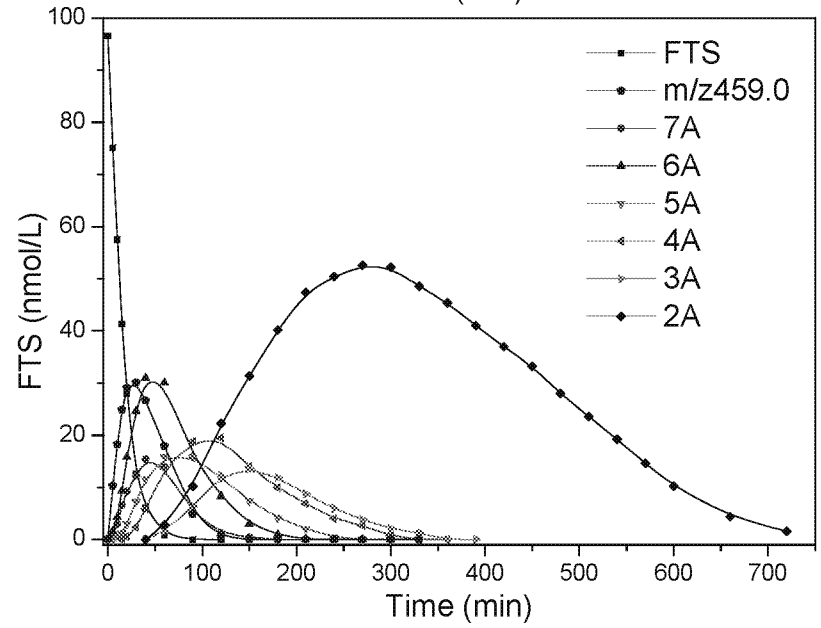
Stability under AOP

- Stability of 6:2 FTS under UV/H_2O_2

6:2 FTS

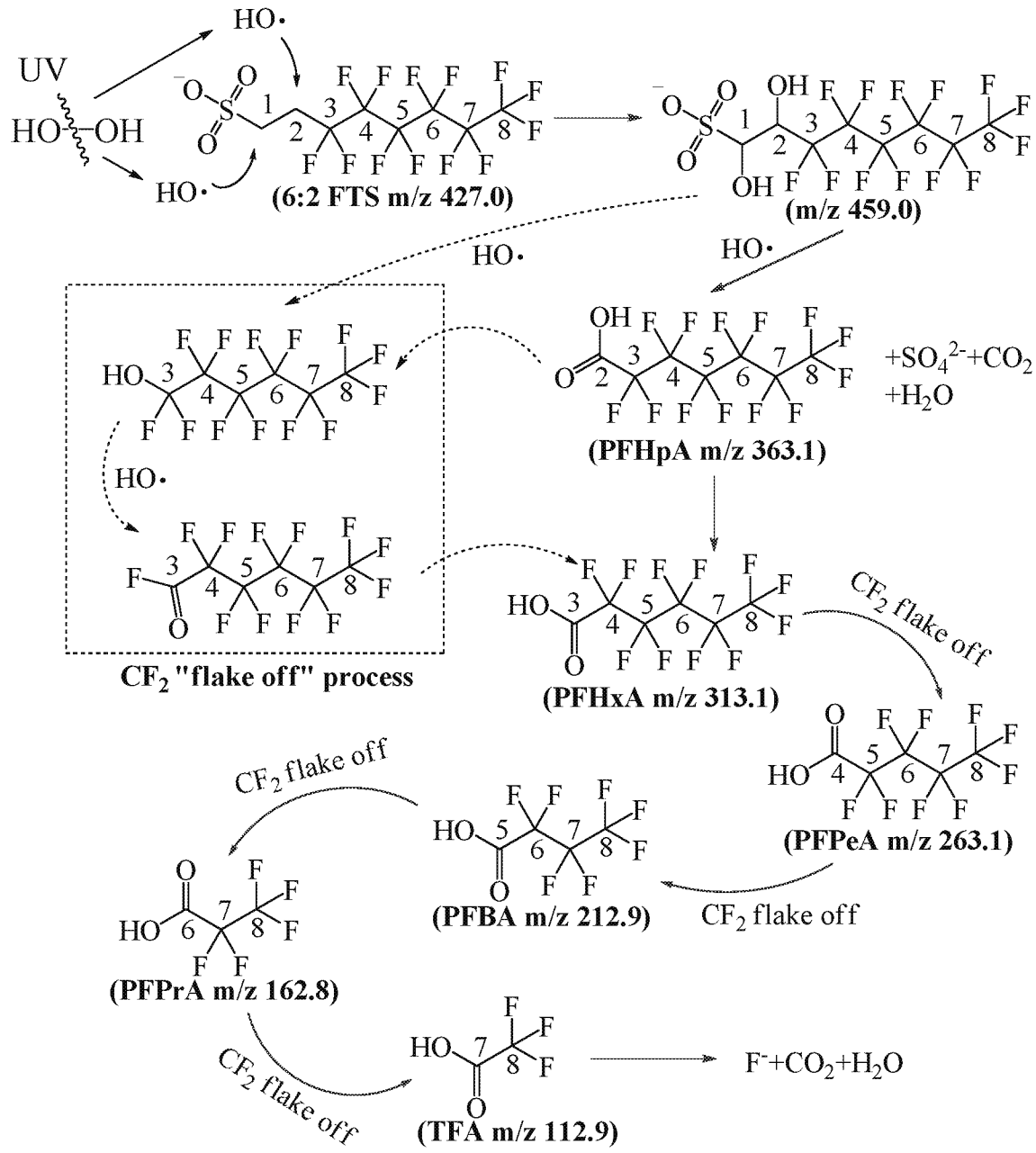






Stability under AOP

- Stability of **6:2 FTS** under UV/H_2O_2



Conclusion

- Production
  - **China is latecomer with very small scale of PFOS production**
  - Information about the primary producers (PFOSF) is clear
  - Producers using PFOSF as feedstock have not well identified
- Application
  - PFOS uses are concentrated in several key sectors
  - List of users have not been well established
  - No clue on the label to show whether PFOS is contained
- Risk
  - Emissions from producers and users have not well investigated
  - Monitoring data are limited, and related HRA and ERA are absent
- Alternatives
  - Replacement in some sectors have been completed passively
  - Competitive products exist in pest control and electroplating industry
  - The safety of main alternatives need further evaluation

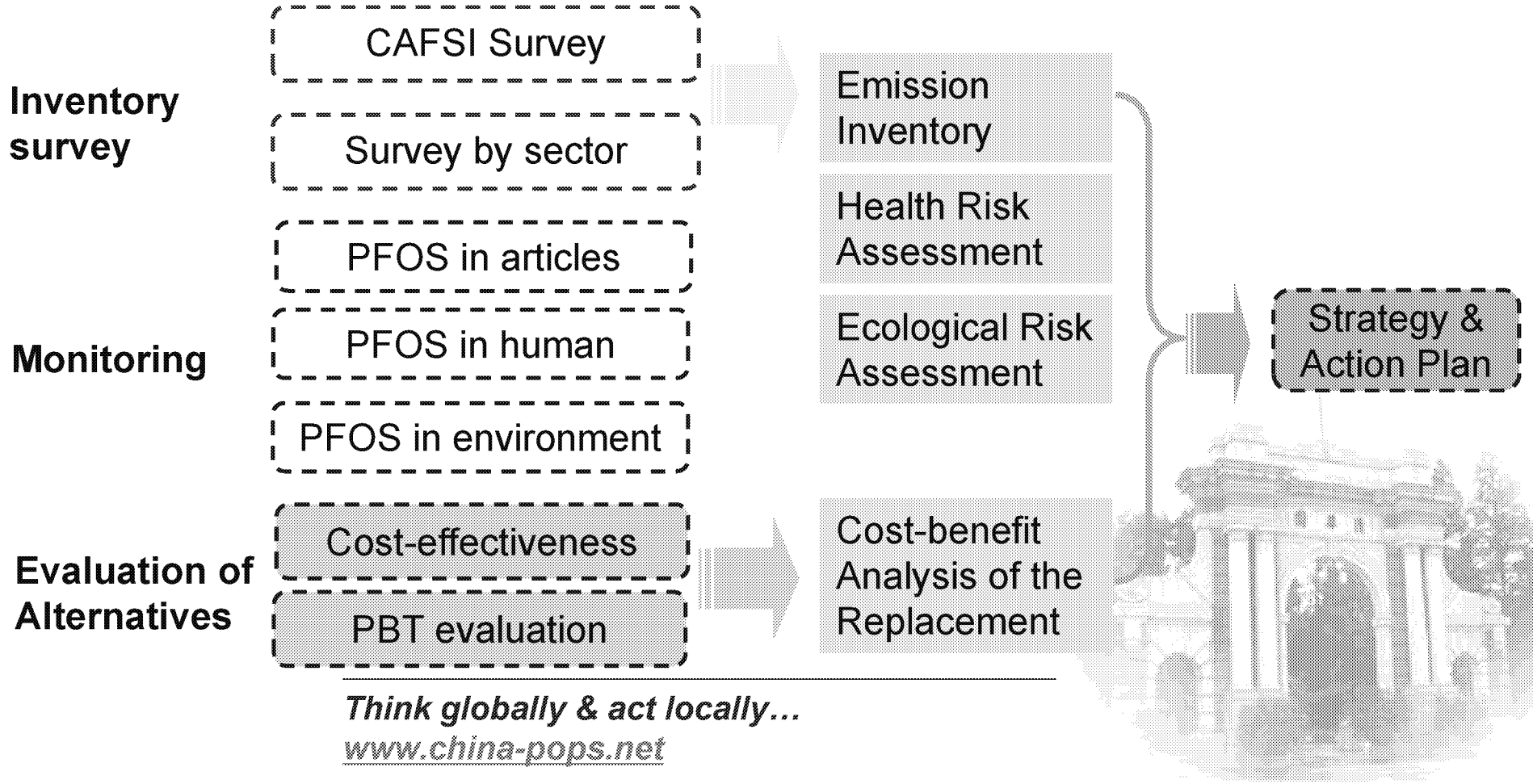
Thanks for your attention

- This research was supported by
  - Chinese National Environmental Protection Public Welfare Industry Targeted Research Fund (No. 201009026; 201309001)
  - SiNoPOP2 project supported by Norwegian Ministry for Foreign Affairs and the Norwegian Institute for Water Research (NIVA)

Perspectives

China's PFOS strategy

- China approved the PFOS amendment on Aug.30, 2013
- A project proposal for NIP update has been submitted to GEF
- Development of "Strategy and action plan for phasing out PFOS in China" will be initiated soon to support the NIP update



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