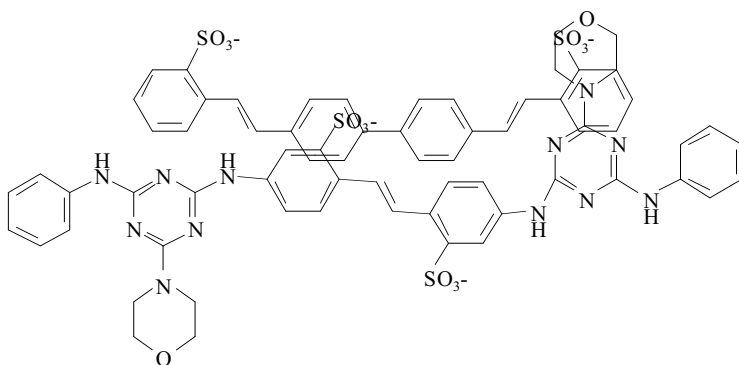


## Fluorescent whitening agents (Brighteners)

### I. Chemical Identity



Chemical Names, synonyms	There are mainly two fluorescent whitening agents (FWAs, the so-called brighteners) used in P&G Western European detergents: <ul style="list-style-type: none"> <li><b>FWA-1:</b> Benzenesulfonic acid, 2,2'-(1,2-ethenediyl)bis[5-[[4-(4-morpholinyl)-6-(phenylamino)-1,3,5-triazin-2-yl]amino]-, disodium salt.</li> <li><b>FWA-5:</b> Benzenesulfonic acid, 2,2'-([1,1'-biphenyl]-4,4'-diyldi-2,1-ethenediyl)bis-, disodium salt; also known as DSBP (Distyrylbiphenylsulfonate).</li> </ul>
Chemical Structures	FWA-1: FWA-5:
SMILES (SRC QSAR suite)	<ul style="list-style-type: none"> <li><b>FWA-1:</b>  <chem>OS(=O)(=O)c2c(ccc(c2)Nc3nc(nc(n3)Nc4ccccc4)N5CCOCC5)C=Cc6ccc(cc6S(=O)(=O)O)Nc7nc(nc(n7)Nc8ccccc8)N1CCOCC1</chem> </li> <li><b>FWA-5:</b>  <chem>[Na]OS(=O)(=O)c1ccccc1C=Cc2ccc(cc2)c4ccc(C=Cc3ccccc3S(O[Na])(=O)=O)cc4</chem> </li> </ul>
Function	Fluorescent whitening agents are used in laundry detergents to improve the whiteness of fabrics. Unbrightened fabrics have a yellowish colour due to blue light deficiency during light reflection. FWAs compensate the blue light deficiency by absorbing the UV-part of daylight and emitting in the blue part of the visible light.

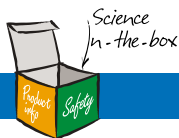
### II. Physical and chemical properties

Brightener 15 (FWA-1)	Value	Unit	Reference
Molecular Weight	924	g/mole	Calculated
Log Kow	-1.58		van de Plassche et al (1999)
Half-life photodegradation (at 25°C)	< 5	h	van de Plassche et al (1999)
Vapour Pressure (at 25°C)	10 <sup>-16</sup>	Pascal	van de Plassche et al (1999)
Brightener 49 (FWA-5)	Value	Unit	Reference
Molecular Weight	563	g/mole	HERA 2002
Density	1490	Kg/m <sup>3</sup>	HERA 2002
Solubility (at 20°C)	17.6	g/litre	HERA 2002
Fat Solubility (at 37°C)	<0.0005	g/kilogram	HERA 2002
Log K <sub>ow</sub> (pH 6.8, 25°C)	-2.32		HERA 2002
Melting Point	>300	°C	HERA 2002
Vapour Pressure (at 25°C)	<7x 10 <sup>-16</sup>	Pascal	HERA 2002
Half-life photodegradation (at 25°C)	< 100	min	van de Plassche et al (1999)

### III. Environmental effects

#### Aquatic toxicity to freshwater organisms

Fluorescent whitening agents were toxic to not harmful to aquatic organisms in standard ecotoxicity tests with LC50 values ranging from 7 to 1000 mg/L and NOEC values ranging from 1 to 100 mg/L for all the tested species.



## Ingredient Safety Information - Phys-chem, Environmental Hazard and Fate data

This document presents data that P&G scientists are using to perform environmental risk assessment. This is not a compilation of all the data that may be available.

FWA-1 (P&G Internal Data, 1973, 1987; Kramer, 1992; van de Plassche et al, 1999):

Test  
Endpoint  
Acute  
(LC50, EC50)  
Chronic  
(NOEC, EC10)

Algae  
[41 – 81] mg/L  
25 mg/L

Crustacean  
1000 mg/L  
1 mg/L

Fishes  
[7 – 1000] mg/L  
100 mg/L

FWA-5 (P&G Internal Data, 1971, 1987; van de Plassche et al, 1999; HERA, 2002):

Test  
Endpoint  
Acute  
(LC50, EC50)  
Chronic  
(NOEC, EC10)

Algae  
8 - 10 mg/L  
3.1 mg/L

Crustacean  
>1000 mg/L  
7.5 mg/L

Fish  
[76 – 550] mg/L  
1 mg/L

Terrestrial toxicity

The terrestrial toxicity for FWA-5 is low as shown experimentally with the earthworm *Eisenia foetida*: LC50>1000 mg/Kg and NOEC=1.37 mg/Kg soil (HERA, 2002).

Bioaccumulation potential

Fluorescent whitening agents present a low bioaccumulation potential as shown by:

- Fish (Bluegill) exposed to various FWAs for 70 days had only traces of FWAs in their tissues. A bioconcentration factor <1 was calculated. Depuration rates were rapid (Kramer, 1992).
- P&G internal data (1971) confirmed that the uptake of FWAs by fish is low and reversible.
- In bean plants, 2% of radio-labelled FWA-5 was adsorbed after 40 days and over 90% of the uptake was found in the root. Accumulation by roots due to adsorption does occur, but concentrations due to translocation appear to be insignificant (Kramer, 1992).

### IV. Environmental Fate

Biodegradability

FWAs are not readily biodegradable. However, biodegradation can be initiated after relatively long microbial acclimation (Kramer, 1992). Relevant biodegradation data are listed below:

- 0% BOD/COD removal in aerobic screening (acclimated 25 days) was observed for both FWA-1 and FWA-5 (P&G Internal Data, 1974).
- 0-5% ThCO<sub>2</sub> production in activated sludge after 25 days for FWA-1 and FWA-



## Ingredient Safety Information - Phys-chem, Environmental Hazard and Fate data

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	5 (P&G Internal Data, 1972). FWAs are likely not biodegradable in anaerobic conditions.
Abiotic degradation	FWAs undergo photodegradation (photolysis) at a relatively fast rate. For example, for FWA-5, >70% was degraded within 28 days. According to van de Plassche et al (1999), a photodegradation rate of 0.69 day <sup>-1</sup> can be conservatively assumed for FAWs. The FWA-5 photodegradation products (o-sulfobenzoic acid and biphenyl-4,4'-dicarboxylic acid) are readily biodegradable (OECD 301F; Kramer, 1992; HERA, 2002).
Removal in wastewater treatment plant	The removal efficiency was determined by field monitoring (P&G Internal Data, 1970, 1974; Kramer, 1992): <ul style="list-style-type: none"><li>• 30-55% removal for primary treatment</li><li>• 68-95% removal for primary and secondary treatments</li><li>• 98% removal for primary, secondary and tertiary treatments</li></ul> Because of the relatively slow biodegradation rate, removal is mainly due to sorption to sludge (van de Plassche et al 1999).
Partition coefficients to solids	FWAs are strongly sorptive and not mobile in soil. This indicates that pollution of groundwater by FWAs is unlikely (Kramer, 1992).

### V. Literature references

- HERA (2002). Report on Fluorescent Brightener FWA-5 (CAS 27344-41-8) <http://www.heraproject.com/files/ACF1E2E.pdf>
- Kramer JB (1992). Fluorescent whitening agents. In de Oude NT (ed.) The handbook of environmental chemistry. Volume 3 part F, Anthropogenic compounds. Detergents. Springer-Verlag, Berlin. pp.351-366.
- van de Plassche EJ et al (1999) Exploratory report Fluorescent Whitening Agents (FWAs). RIVM (ed), Bilthoven. 70 pp.