Use of Triclosan and Polycyclic Musks as Indicator Chemicals for Domestic Wastewater

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Introduction

Triclosan (TCS)

- –Consumer product use as anti-microbial
- –Plastic and textile market use
- –Demand doubled during the 1990s

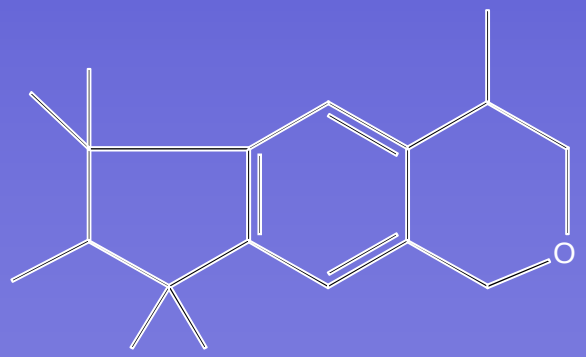
5-chloro-2- (2,4-dichlorophenoxy) phenol
CAS No. 3380-34-5

10 mg/L aqueous solubility
4 x 10^{-6} mmHg vapor pressure
K_d = 21,590 L/kg
pK_a = 8.1

Introduction

Polycyclic Musk Fragrances

- –Consumer product use
- –Laundry detergent fragrance compound
- –6000 tons annual production (1999)



1.8 mg/L aqueous solubility

5.5 x 10^{-4} mmHg vapor pressure

Log K_{ow} = 5.9

1,3,4,6,7,8-Hexahydro-4,6,6,7,8,8-hexamethyl -cyclopenta (γ-)-2-benzopyran (HHCB), CAS No. 122-05-5

Introduction

Properties of Ideal Chemical Markers

- –Unique to pollutant source
- –Persistent in the aquatic environment
- –Limited sorption to solids
- –Readily-available analytical methodology

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Methods

Characterization of untreated and treated domestic wastewater

- –Treatment facilities of varying size
- –Collected during dry weather
- –Daily composites for 3 or more weeks
- –Preserved at pH<2 and 4˚C

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Methods

Parameter	WWTP No. 1	WWTP No. 2	WWTP No. 3
Population Served	120,000	30,000	7,500
Wastewater Flow (MGD)	11.2	2.7	0.827
Water use rate (gal/capita/day)	93	92	109
CBOD5 – Influent (mg/L)	318	157	269
CBOD5 – Effluent (mg/L)	7	5	4
CBOD5 Removal %	98	97	98
TSS – Influent (mg/L)	325	183	321
TSS – Effluent (mg/L)	10	7	4.5
TSS Removal %	97	97	98
Solids Retention Time (days)	6	7	20 to 30
Hydraulic residence time (hours)	8.25	26	32

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Methods

Sample filtration

<u>Filtrate</u>

C18 solid-phase extraction

<u>Solids</u>

16-hr Soxhlet extraction

Conventional GC/MS Analysis

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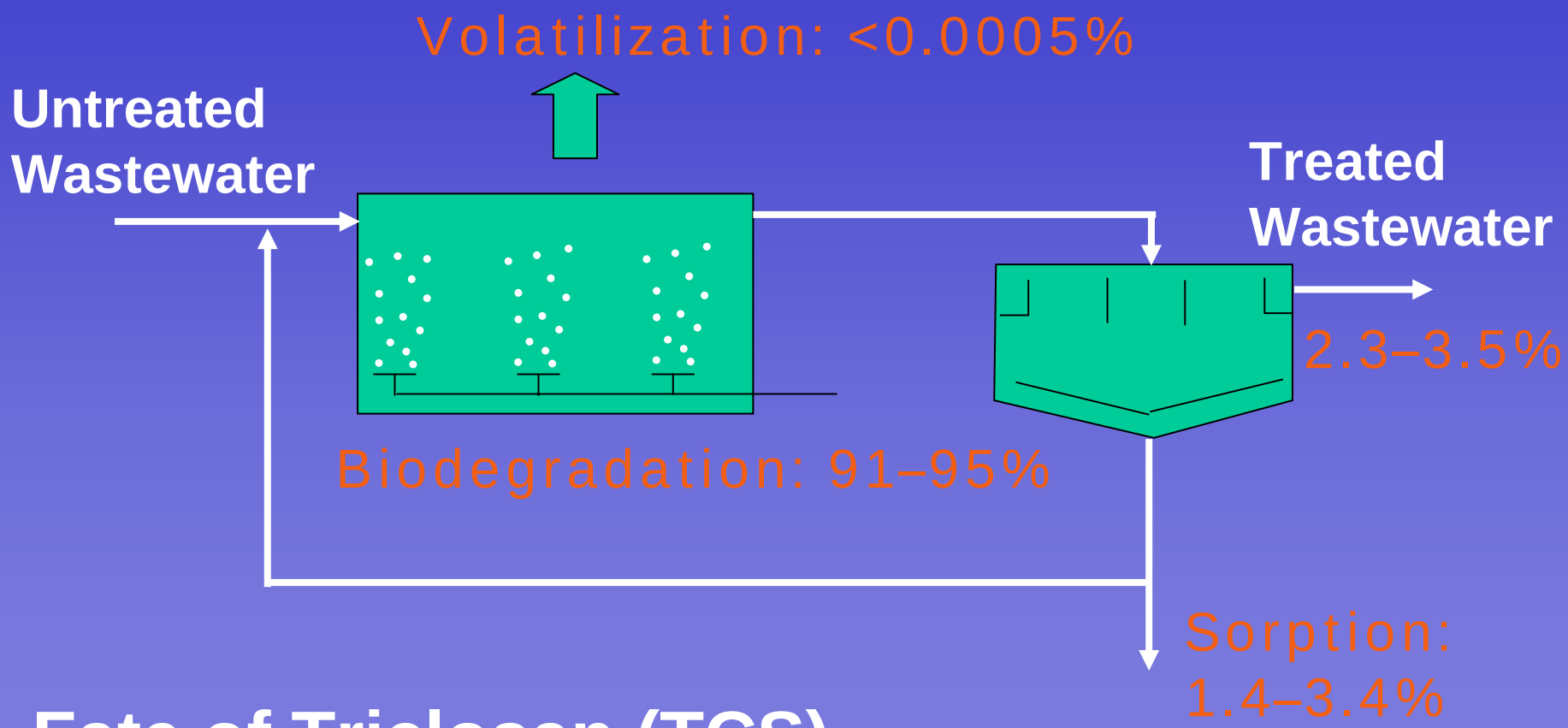
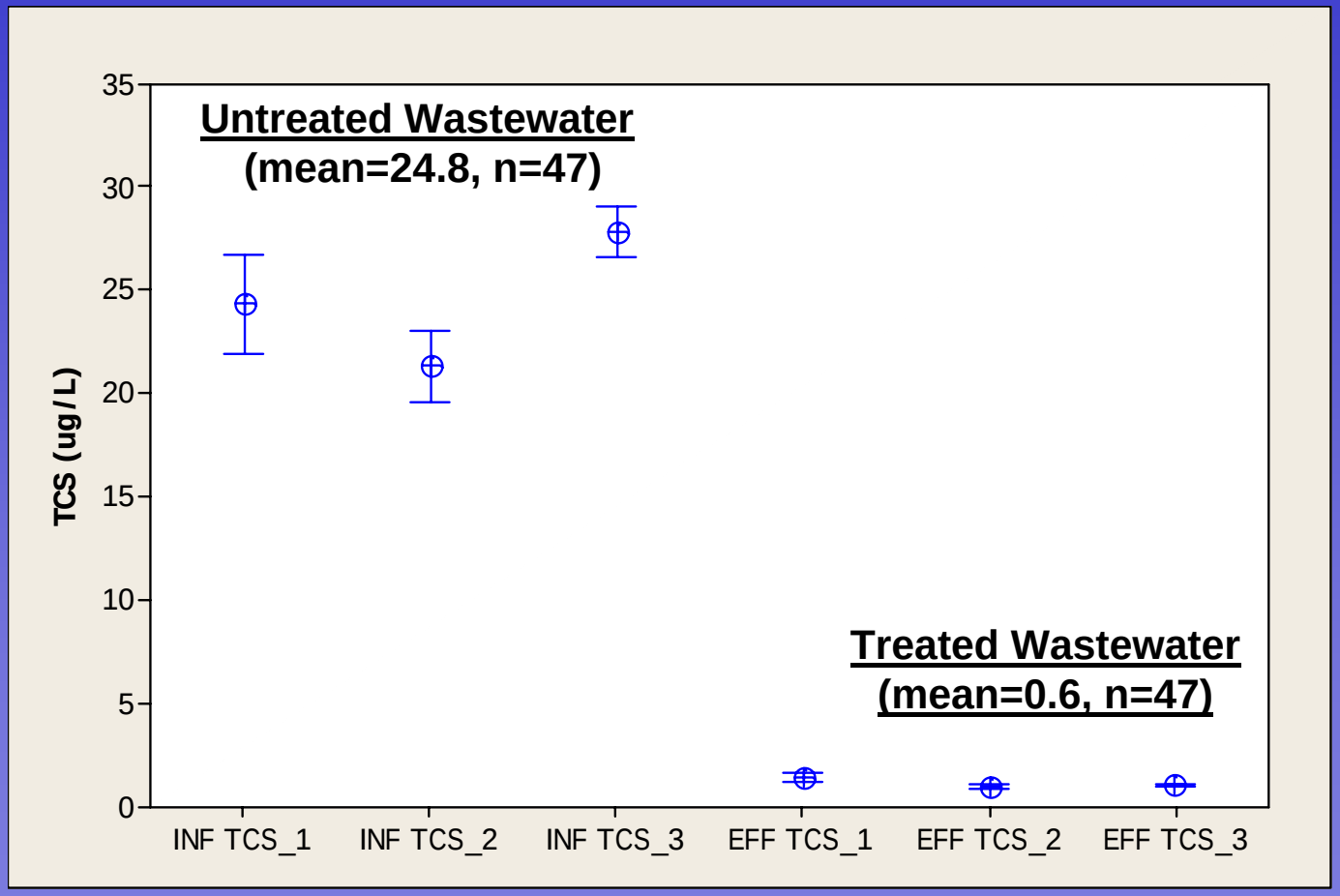
Results



Fate of Triclosan (TCS)
In Wastewater Treatment Plants

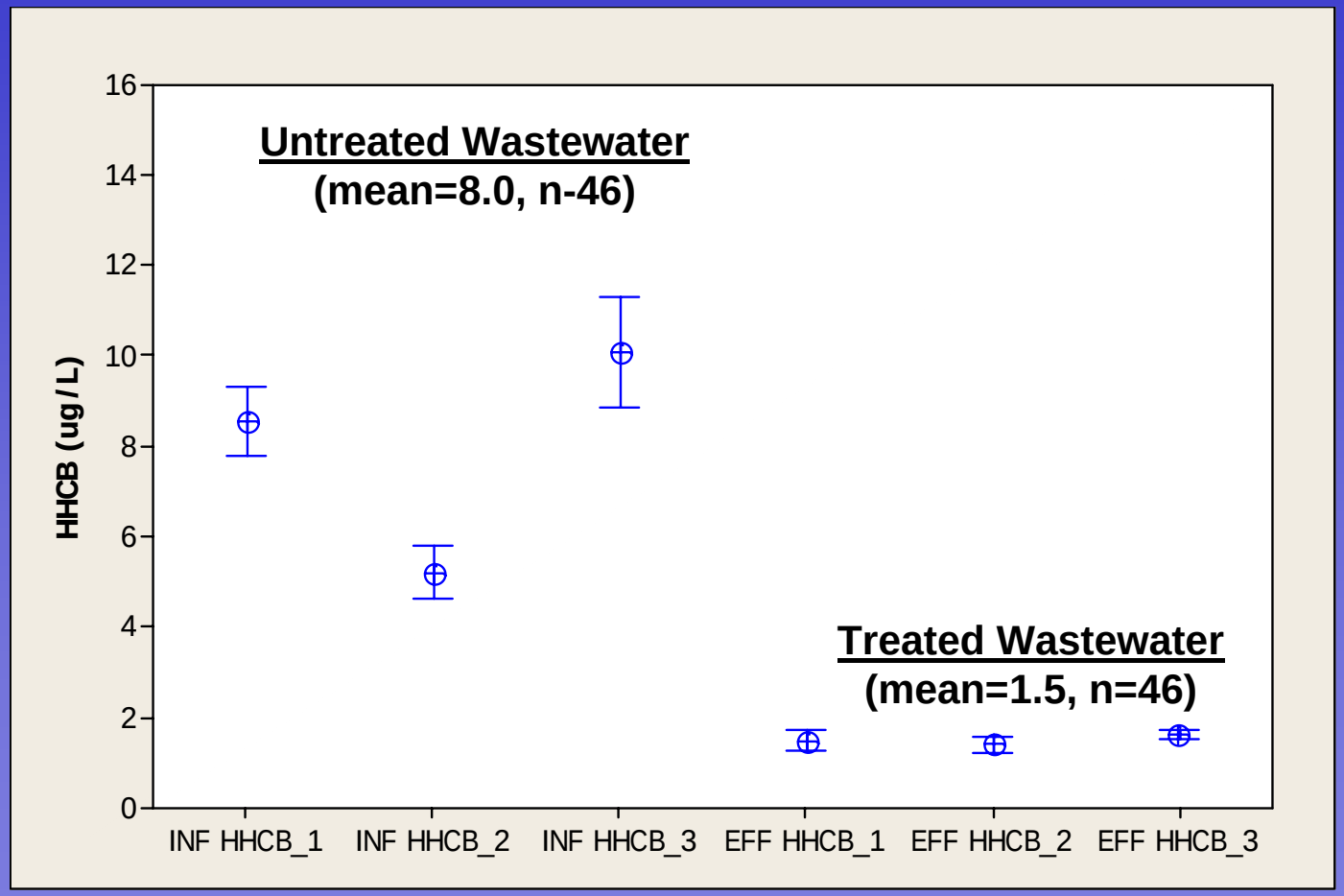
Results



Triclosan (TCS)

Mean and 95% Confidence Interval

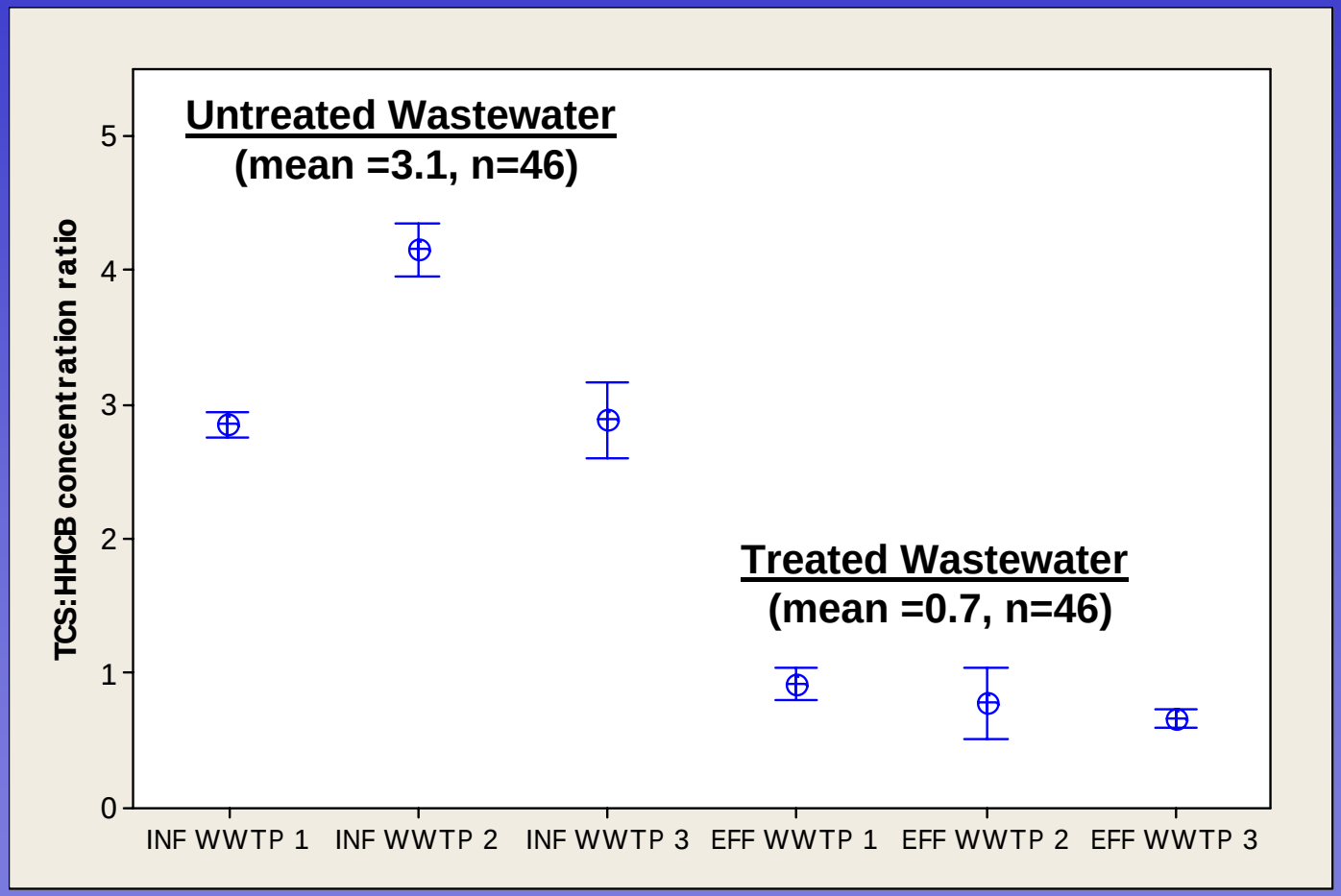
Results



HHCB (Galaxolide)

Mean and 95% Confidence Interval

Results



TCS:HHCB ratio

Mean and 95% Confidence Interval

Results

Stable source concentration and mass loading during dry weather conditions (<35% RSD).

Statistically significant TCS:HHCB ratios for treated versus untreated wastes ($p<0.0001$).

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Discussion

- **Instream TCS and HHCB presence indicates human impact**

- **Instream TCS:HHCB ratio indicates raw vs. treated wastewater presence**

- **Percent contribution of domestic waste in streams can be estimated**

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Discussion

- **Advantages**
  - **Unique marker of domestic wastewater**
  - **Can discern treated vs. untreated wastes**
  - **Conventional GC/MS analysis**
- **Disadvantages**
  - **Background surface water concentration**
  - **Some sorption to solids**
  - **TCS photodegradation possible**

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Conclusions

- **Promising application as chemical marker following additional study of fate**
- **Requires low background concentrations**
- **Future tool to estimate domestic wastewater contribution in streams**

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Acknowledgements

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