

Introduction to Environmental Health and Safety – Summer `07

环境健康与安全导论

Lecture 8a

Topic: Siloxanes

* figures: ChemIDplus

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Slide no. 页码. 1



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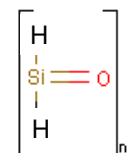
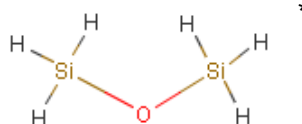
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According to IUPAC siloxanes are

- „[s]aturated silicon–oxygen hydrides with unbranched or branched chains of alternating silicon and oxygen atoms (each silicon atom is separated from its nearest silicon neighbours by single oxygen atoms). The general structure of unbranched siloxanes is $H_3Si[OSiH_2]_nOSiH_3$.“

this is for $n = 0$:

$H_3Si-O-SiH_3$ (disiloxane;
CASRN 13597-73-4)



„By extension hydrocarbyl derivatives are commonly included.“

(IUPAC Compendium of Chemical Terminology, „Gold Book“, 2nd Edition (1997),
URL: <http://www.iupac.org/goldbook/S05671.pdf>, accessed 10.04.2007)

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Slide no. 页码. 2

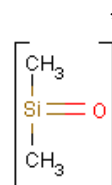


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Si compounds

Silicones: „Polymeric or oligomeric siloxanes, usually considered unbranched, of general formula $[-OSiR_2-]_n$ ($R \neq H$)“, e.g.

(IUPAC Compendium of Chemical Terminology, „Gold Book“, 2nd Edition (1997), URL: <http://www.iupac.org/goldbook/S05670.pdf>, accessed 10.04.2007)



Silane: SiH_4
(CASRN 7803-62-5)

Hydroxysilane (= silanol):
 SiH_3OH $\text{H}_3\text{Si}-\text{OH}$
(CASRN 14475-38-8)

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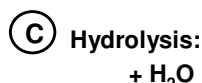
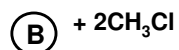
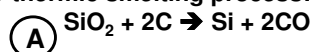


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Siloxane production by Dow Corning

URL: <http://www.dowcorning.com/content/sitecl>

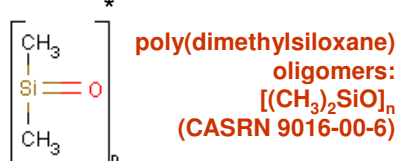
Carbo-thermic smelting process:



1 Silica: SiO_2
(CASRN 14808-60-7)

2 Elemental silicon:
Si (CASRN 7440-21-3)

3 Methylchlorosilanes, 70 – 90 %
dimethyldichlorosilane: $(\text{CH}_3)_2\text{SiCl}_2$
(CASRN 75-78-5)



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Other common but incorrect definition

Siloxanes are

- „a class of organosilicon compounds with the empirical formula R_2SiO , where R is an organic group.“

(URL: <http://en.wikipedia.org/wiki/Siloxane>, last modified 19:39, 21 March 2007, accessed 10.04.2007)

→ This is the definition of „polysilicones“!

Reminder:

- Organosilicon compounds: contain C-Si bonds
- Silicon (Si) \neq silicone

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Slide no. 页码, 5



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Organosilanes - use

- Adhesives and sealants
- Electronics
- Foundry resins
- Glass fibers/fabrics
- Mineral fillers
- Paints and coatings
- Pharmaceuticals
- Pigments
- Silicones
- Textiles
- Thermosets
- Wire and cable

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Siloxanes - systematics

- Short / medium / long chains
 - Linear / cyclic
 - High-molecular / low-molecular
- ↓
- Polydimethylsiloxane (PDMS)
 - Not volatile
 - 450 – 450,000 g/mol
- VOC
 - < 400 g/mol
 - „low molecular weight silicones“

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PDMS

- Mobile between water and organic phase (DOM, DOC...)
- Do not diffuse through cell membrane, no bioaccumulation
- Extremely slow biodegradation
- In soil degradation to low molecular weight-solanols (VOC), further degradation only by OH radicals

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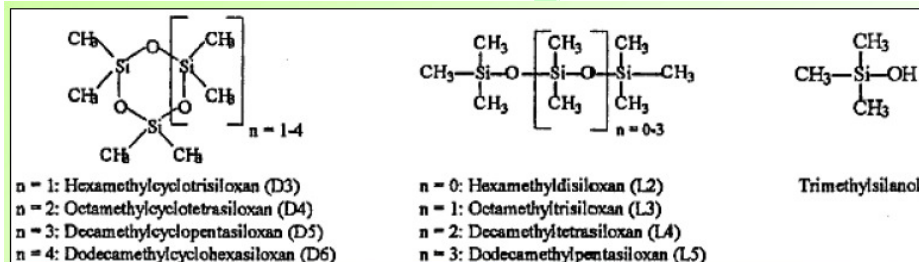
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Siloxanes in biogas / landfill gas



Source: Schweigkofler (2000)



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Siloxanes in wastes – potential problems

- Waste → landfill gas → atmosphere
 combustion
- Landfill gas → → formation & disposal of SiO₂ → corrosion
- ???



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Lecture 8b

Topic: Pesticides, DDT, Atrazine

<http://en.wikipedia.org/wiki/Pesticide>

<http://en.wikipedia.org/wiki/Atrazine>

<http://en.wikipedia.org/wiki/Ddt>

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Pesticides

- USEPA: A **pesticide** is „any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.“
- USEPA: A **pest** is „living organisms that occur where they are not wanted or that cause damage to crops or humans or other animals.“
- USEPA: „Examples include: insects, mice and other animals, unwanted plants (weeds), fungi, microorganisms such as bacteria and viruses, and prions.“

<http://www.epa.gov/pesticides/about/index.htm>, accessed 12.04.2007

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Use in household

Many household products are or contain pesticides, e.g.:

- * Cockroach sprays and baits
- * Insect repellents for personal use.
- * Rat and other rodent poisons.
- * Flea and tick sprays, powders, and pet collars.
- * Kitchen, laundry, and bath disinfectants and sanitizers.
- * Products that kill mold and mildew.
- * Some lawn and garden products, such as weed killers.
- * Some swimming pool chemicals.

<http://www.epa.gov/pesticides/about/index.htm>, accessed 12.04.2007

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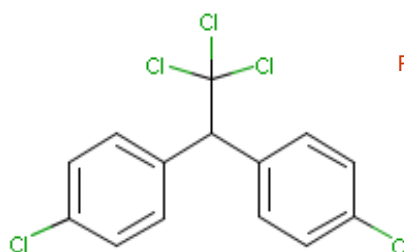
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DDT

- Dichloro-Diphenyl-Trichloroethane (CASRN 50-29-3)
- 4,4'-(2,2,2-trichloroethane-1,1-diyl)bis(chlorobenzene)



Picture: ChemIDplus

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DDT

- Insecticide
- Use in agriculture, against insects that malaria, typhus...
- DDT „kills by opening sodium ion channels in insect neurons, causing the neuron to fire spontaneously. This leads to spasms and eventual death.“
- „In the 1970s and 1980s, agricultural use of DDT was banned in most developed countries.“

<http://en.wikipedia.org/wiki/Ddt>, accessed 12.04.2007

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DDT

- Degradation products in part more toxic than DDT
 - 50 % degradation/ elimination in environment may take 30 years („half-life“)
 - Half of all animals in USA are contaminated with DDT
- National Report on Exposure to Environmental Chemicals. Centers for Disease Control and Prevention 2005. (<http://www.cdc.gov/exposurereport>)
- Insects may become resistant to DDT
 - Better health care etc. may reduce malaria by 97 % without use of DDT

Inter Press Service News Agency, <http://www.ipsnews.net/print.asp?idnews=34928>, issued 28.09.2006, accessed 30.09.2006

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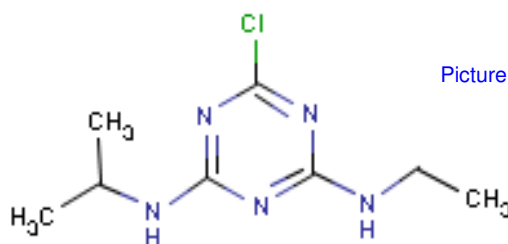
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Atrazine

- 1-chloro-3-ethylamino-5-isopropylamino-2,4,6-triazine (CASRN 1912-24-9)



Picture: ChemIDplus

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Atrazine

- Against „pre- and post-emergence broadleaf and grassy weeds in major crops.“
- „binds to the plastoquinone-binding protein in photosystem II, inhibiting electron transport.“
- One of the most widely used herbicides in USA
- Forbidden in Germany since 1992 but not in all EU countries
- In 1999/2000 still noticeable concentrations in German surface waters (Oehlmann & Markert, 1999)

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