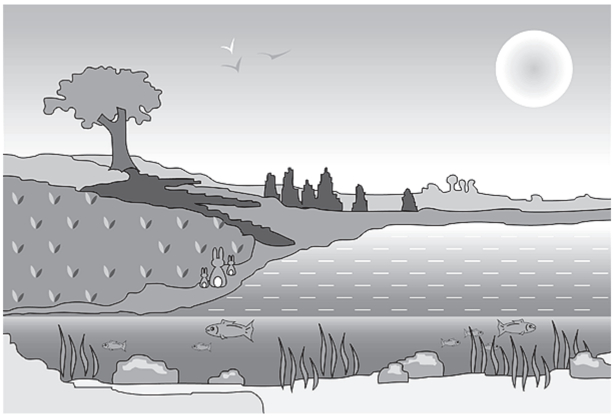
DOW CORNING



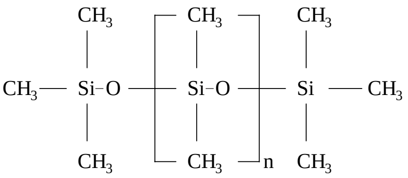
An Overview of Volatile Methylsiloxane (VMS)* Fluids in the Environment

Environmental Information - Update

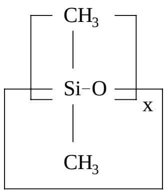
Health, Environment & Regulatory Affairs (HERA)

Summary of Use:

Volatile methylsiloxane (VMS) fluids are low molecular weight organosilicon materials with significant vapor pressure under ambient environmental conditions. They are volatile, low-viscosity silicone fluids consisting of-$(CH_3)_2SiO$- units in either linear or cyclic structures.



typically, n=0-4



typically, x=4-6

Although they are primarily used as intermediates in manufacturing high molecular weight silicone polymers, some VMS fluids are also found in cosmetics and other personal care formulations, often as carriers and emollients in antiperspirant, hair care, and skin care applications. The majority of the VMS materials in these personal care applications have a cyclic structure, and are designated as ‘cyclomethicones’ by the Cosmetic Toiletry and Fragrance Association (CTFA). Some linear VMS materials are finding applications in the USA as VOC-exempt solvents and CFC replacements in precision cleaning applications under the name *Dow Corning*© *OS* Fluids.

Environmental Entry:

VMS emissions from industrial sources are limited, because the compounds are manufactured and used as intermediates in enclosed systems. Although most of the VMS fluid volatilizes into the atmosphere from consumer applications, the amount released per use is extremely small, and environmental emissions are therefore very diffuse. Small amounts of VMS can also end up in wastewater. If these essentially insoluable compounds should end up in surface waters with treated effluent, they have been shown to partition to the atmosphere. VMS degrades readily in the air via ongoing natural processes, such as oxidation by OH radicals. [1, 2] With its short lifespan, the atmospheric content of VMS is expected to remain far below the No Observable Effect Level (NOEL).

Environmental Fate and Effects:

Atmospheric: The lifetime of volatile methylsiloxanes in the atmosphere is between 10 and 30 days. [1,2] The ultimate oxidative degradation products are naturally-occuring substances: carbon dioxide, silica and water. Because they contain no chlorine or bromine atoms and degrade quickly in the troposphere, [1,2] VMS materials have no potential to deplete (or even reach) stratospheric ozone. They do not contribute significantly to global warming in comparison to organic compounds, which have much higher carbon levels that are converted to CO_2.

* Refers to materials with a molecular weight under 600

Since all VMS compounds have the same building blocks (i.e., chains of silicon and oxygen atoms, and methyl groups attached to silicon), they degrade according to the same mechanisms to yield increasingly less volatile, silanol-rich structures with increased water solubility and decrease lipophilicity.

These oxidative degradation products are not expected to have any significant adverse environmental effects. As long as they remain in the atmosphere, such degradation products (i.e., partially oxidized VMS derivatives) are subject to the same oxidative conditions as their precursors, and will continue to degrade. Recent results have also shown the possibility of these partial degradation products being dry-deposited by attaching to dust particles.[3]

When the partial oxidates are deposited or scrubbed out of the atmosphere, they are not expected to present any threat to aquatic or terrestrial biota due to their decreased lipophilicity. These partial oxidates are expected to ultimately oxidize to natural silica, water and carbon dioxides.[4]

Recent studies demonstrate that VMS compounds have negligible potential to adversely impact urban air quality. Specifically, these studies show that VMS materials do not contribute to the formation of ozone in the urban atmosphere.[5] Similar conclusions were drawn when atmospheric reactivity data[1] were used to calculate the Photochemical Ozone Creation Potential (POCP) of VMS materials using the Harwell Photochemical Trajectory Model.[6]

VMS compounds are not persistent in the atmosphere. No significant contribution has been observed from VMS materials to ground level ozone generation[5] or aerosol formation.[7] Based on these findings, the U.S. EPA and almost all individual states in the U.S. have issued formal VOC exemptions for VMS fluids, acknowledging that they are not VOC ozone precursors.[8] These materials have also been approved as CFC replacements in precision-, metal-, and electronic cleaning applications.[9]

Aquatic: The cyclic tetramer $[(CH_3)_2SiO]_4$ (octamethylcyclotetrasiloxane, or OMCTS) has been extensively tested for ecotoxicological properties as part of an industry testing program carried out under the U.S. EPA Toxic Substances Control Act.[10] This regulatory-driven effort evaluated the possible transport of OMCTS from consumer products to aquatic ecosystems and the potential effects on aquatic organisms. The testing has served to define No Observable Effect Levels (NOEL) for this material, and the program (under a consent order negotiated with the EPA) included physico-chemical and environmental fate studies, as well as extensive aquatic toxicity testing.

Additional voluntary work sponsored by the industry through the Silicones Environmental, Health, and Safety Council (SEHSC) included broad-scale environmental fate modeling, wastewater treatment plant (WWTP) monitoring, and the development of a comprehensive aquatic risk assessment.

Although the studies indicated that toxic aquatic effects can be observed in laboratory tests,[11] a subsequent Exposure Assessment[12] and exposure monitoring at wastewater treatment plants[12] concluded that levels in the aquatic environment can be conservatively estimated at 64 to 444 times below the NOEL.[13] For benthic organisms, 157- to 1080-fold margins of safety have been estimated.[14] Rapid volatilization and additional dilution in most aquatic environments will increase this ratio even further.

Because of their physical properties (low water solubility, low density, rapid volatilization) and short lifetimes, OMCTS and other VMS compounds are not expected to reach ecologically significant levels in the aquatic environment. Concentrations are expected to be low and transient in water and sediments. No adverse effects are expected in the aquatic environment from the use of VMS in various applications.

The U.S. EPA has issued its “Final RM1 Aquatic Risk Characterization”(March 15, 1995), concluding that OMCTS represents a low risk to aquatic organisms.[15] The SEHSC risk assessment (including the supplemental studies) was the basis for the EPA conclusion that the agency’s concerns had been addressed, and no additional ecotoxicity data was required. This RM1 decision brings to closure the TSCA Section 4 Consent Order ecotoxicity testing program which was initiated in 1984 by the Interagency Testing Committee (ITC).

Dow Corning’s commitment to environmental responsibility includes continuous research to determine the fate and effects of our products. This summary is based on the most current information available on VMS materials. We will continue to share the results of our ongoing studies in a program of open communication with regulatory agencies, customers, employees, industry associations and the public. The company maintains an extensive facility in the U.S. dedicated to health and environmental sciences, and was a significant contributor to a handbook on the environmental aspects of organosilicon materials which is now in publication.[16]

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