WATER SYSTEMS, DISINFECTION BYPRODUCTS, AND THE USE OF MONOCHLORAMINE

9) How do the kinds and concentrations of disinfection byproducts formed by monochloramine compare to those formed by chlorine?

Water treated with chlorine and monochloramine contains different types and concentrations of disinfection byproducts.

- Compared to chlorine, water treated with monochloramine contains fewer regulated disinfection byproducts that have been linked to human health problems.
- The formation of disinfection byproducts is influenced by source water type and the type of disinfectant used.
- Formation can vary daily with the amount of natural organic matter in the water, temperature, rainfall, and distance from the treatment plant or other factors influencing water chemistry. [1]

Compared to chlorine, water treated with monochloramine contains lower concentrations of regulated disinfection byproducts. [2]

- Compared to water treated with chlorine, water treated with monochloramine contains lower concentrations of the two major types of *regulated* disinfection byproducts.[2]
- Compared to water treated with chlorine, water treated with monochloramine contains lower concentrations of *regulated* disinfection byproducts linked to bladder cancer.
- Regardless of the disinfectant used, the types and concentrations of disinfection byproducts vary from each utility and also from day to day.

Compared to water treated with chlorine, water treated with monochloramine may contain higher concentrations of unregulated disinfection byproducts. [3]

- EPA scientists are currently studying the *unregulated* disinfection byproducts[3] that form in water treated with monochloramine.
- Compared to water treated with chlorine, water treated with monochloramine may contain different *unregulated* disinfection byproducts than chlorinated water.
- EPA and other organizations continue to conduct research on *unregulated* disinfection byproducts.[3]

Additional Supporting Information:

1. Water chemistry describes the chemical properties of water such as pH, hardness, and alkalinity. Changes in water chemistry can cause subsequent changes to the physical (e.g., taste and odor) and biological (e.g., biofilm formation and nitrification) properties of water.
2. TTHM and HAA5 are the regulated disinfection byproduct groups that form at lower concentrations with monochloramine. See question 7 for more information about TTHM and HAA5.
3. Examples of these unregulated disinfection byproducts include nitrosamines (including nitrosodimethylamine, NDMA), iodo-trihalomethanes, and iodo-acids. See question 7 for additional detail on disinfection byproducts. Specific information on NDMA can be found at http://www.epa.gov/tio/download/contaminantfocus/epa542f07006.pdf. See question 19 for additional information on disinfection byproduct research.

Table 1: disinfection byproducts of various disinfectants

desinfectant	**organohalogenic desinfection byproducts**	**inorganic desinfection byproducts**	**non-halogenic desinfection byproducts**
chlorine (Cl_2)/ underchloric acid (HOCl)	trihalomethanes, halogenic acetic acids, haloacetonnitrils, chlorine hydrates, chloropicrin, chlorophenols, N-chloramines, halofuranones, bromohydrins	chlorate (particularly the application of hypochlorite)	aldehydes, alkanic acids, benzene, carboxylic acids
Chlorine dioxide (ClO_2)		chlorite, chlorate	unknown
chloramines (NH_3Cl etc.)	haloacetonnitrils, cyano chlorine, organic chloramines, chloramino acids, chlorohydrates, haloketons,	nitrite, nitrate, chlorate, hydrazine	aldehydes, ketons
ozone (O_3)	bromoform, monobromine acetic acid, dibromine acetic acid, dibromine aceton, cyano bromine	chlorate, iodate, bromate, hydrogen peroxide, underbromic acid, epoxy, ozonates	aldehydes, ketons, ketoacids, carboxylic acids

Read more: http://www.lenntech.com/processes/disinfection/byproducts/disinfection-byproducts.htm#ixzz1mS7ckseM

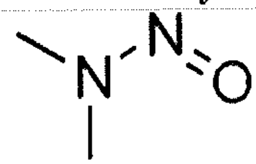
N-Nitrosodimethylamine

From Wikipedia, the free encyclopedia

N-Nitrosodimethylamine (NDMA), also known as **dimethylnitrosamine (DMN)**, is a semi-volatile organic chemical that is highly toxic and is a suspected human carcinogen. The US Environmental Protection Agency has determined that the maximum admissible concentration of NDMA in drinking water is 7 ng L^{-1}.[1] The EPA has not yet set a regulatory maximum contaminant level (MCL) for drinking water. At high doses, it is a "potent hepatotoxin that can cause fibrosis of the liver" in rats.[2] The induction of liver tumors in rats after chronic exposure to low doses is well documented.[3] Its toxic effects on humans are inferred from animal experiments but not well-established experimentally.

NDMA appears to have a very strong affinity as a poison for the liver and at least one case of poisoning in humans is reported. NDMA is water-soluble, colorless, and has at best a weak taste and odor. In the incident reported by New Yorker writer Berton Roueché, a jealous former boyfriend spiked lemonade with NDMA, which he had acquired while working at a cancer research center. At the time of writing, this substance was in common use in the laboratory to induce cancer in mice for study. The incident resulted in the death of an 11-month-old male child and a 30-year old man from, ultimately, massive liver damage. In the victims, NDMA produced very characteristic lesions in the liver, rapidly declining platelet count, and highly elevated SGOT levels. Other symptoms included headache, fever, vomiting, abdominal pain, scattered intradermal hemorrhage, lethargy, nausea, and diarrhea. [4]

NDMA is an industrial by-product or waste product of several industrial processes. It first came to attention as a groundwater contaminant in California in 1998 and 1999 at several sites that produced rocket fuel. Manufacturing of unsymmetrical dimethylhydrazine (UDMH), which is a component of rocket fuel that requires NDMA for its synthesis, proved to be the culprit in these cases. Of more general concern, water treatment via chlorination or chloramination of organic nitrogen-containing wastewater can lead to the production of NDMA at potentially harmful levels. Further, NDMA can form

N-Nitrosodimethylamine	
	
IUPAC name	
N,N-Dimethylnitrous amide	
Other names	
Dimethylnitrosamine *N,N*-Dimethylnitrosamine	
Identifiers	
CAS number	62-75-9 ✓
PubChem	6124
KEGG	C14704 ✗
ChEMBL	CHEMBL117311 ✗
Jmol-3D images	Image 1 (http://chemapps.stolaf.edu/jmol/jmol.php?model=CN%28C%29N%3DO)
SMILES	
Properties	
Molecular formula	$C_2H_6N_2O$
Molar mass	74.08 g mol^{-1}
Appearance	yellow liquid
Density	1.005 g/cm³
Boiling point	152 °C, 425 K, 306 °F
Solubility in water	29 g/100 mL (20 °C)
Hazards	
R-phrases	R26 R27 R28 R45 R61
Flash point	61 °C

or be leached during treatment of water by anion exchange resins.[5] Finally, NDMA is found at low levels in numerous items of human consumption including cured meat, fish, beer, and tobacco smoke [5] It is, however, unlikely to bioaccumulate.

✗ (verify) (what is: ✓/✗?)
Except where noted otherwise, data are given for materials in their standard state (at 25 °C, 100 kPa)
Infobox references

NDMA's contamination of drinking water is of particular concern due to the minute concentrations at which it is harmful, the difficulty in detecting it at these concentrations, and to the difficulty in removing it from drinking water. It does not readily biodegrade, adsorb, or volatilize. As such, it cannot be removed by activated carbon and travels easily through soils. Relatively high levels of UV radiation in the 200 to 260 nm breaks the N-N bond and can thus be used to degrade NDMA. Additionally, reverse osmosis is able to remove approximately 50% of NDMA.[6]

References

1. ^ Andrzejewski et al.; Kasprzykhordern, B; Nawrocki, J (10 June 2005). "The hazard of N-nitrosodimethylamine (NDMA) formation during water disinfection with strong oxidants". *Desalination* **176** (1–3): 37–45. doi:10.1016/j.desal.2004.11.009 (http://dx.doi.org/10.1016%2Fj.desal.2004.11.009) .
2. ^ George et al.; Rao, KR; Stern, R; Chandrakasan, G (2001). "Dimethylnitrosamine-induced liver injury in rats: the early deposition of collagen". *Toxicology* **156** (2–3): 129–38. doi:10.1016/S0300-483X(00)00352-8 (http://dx.doi.org/10.1016%2FS0300-483X%2800%2900352-8) . PMID 11164615 (http://www.ncbi.nlm.nih.gov/pubmed/11164615) .
3. ^ Peto, R. et al. (December 1, 1991). "Dose and Time Relationships for Tumor Induction in the Liver and Esophagus of 4080 Inbred Rats by Chronic Ingestion of N-Nitrosodiethylamine or W-Nitrosodimethylamine". *Cancer Research* (51): 6452–6469.
4. ^ "Annals of Medicine - The Prognosis for this Patient is Horrible". *The New Yorker*: 57–71. January 25, 1982.
5. ^ *a b* Najm, Issam; Trussell, R. Rhodes (February 2001). "NDMA Formation in Water and Wastewater". *Journal AWWA* **93** (2): 92–99.
6. ^ William A. Mitch; Jonathan O. Sharp; R. Rhodes Trussell; Richard L. Valentine; Lisa Alvarez- Cohen; David L. Sedlak (2003). "N-Nitrosodimethylamine (NDMA) as a Drinking Water Contaminant: A Review". *Environmental Engineering Science* **20** (5): 389–404. doi:10.1089/109287503768335896 (http://dx.doi.org/10.1089%2F109287503768335896) .

External links

- Nitrosodimethylamine (NDMA) Information (http://www.sfwater.org/detail.cfm/MC_ID/10/MSC_ID/51/MTO_ID/NULL/C_ID/1865)
- Method Development for the Determination of N-Nitrosodimethylamine (NDMA) in Drinking Water (http://www.epa.gov/nerl/research/2004/g2-6.html)
- SFPUC NDMA White Paper (http://www.valleywater.org/media/pdf/SFPUC_NDMA_White_Paper.pdf)
- Public Health Statement for n-Nitrosodimethylamine (http://www.atsdr.cdc.gov/toxprofiles/phs141.html)
- Toxicological Profile for n-Nitrosodimethylamine CAS# 62-75-9 (http://www.atsdr.cdc.gov/toxprofiles/tp141.html)
- NDMA Safety Data (http://www.physchem.ox.ac.uk/MSDS/NI/N-nitrosodimethylamine.html)

Categories: Nitroso compounds | IARC Group 2A carcinogens