

Sodium Hydroxide & Hydroquinone Based Film Developers: The Facts

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Regulations

Sodium hydroxide is classified by the FDA as Generally Recognized as Safe (GRAS) as a direct additive for human and animal foods if used in accordance with good manufacturing practices.⁴ Pesticides containing sodium hydroxide as an active ingredient must be registered with the EPA and are subject to safety review. However, sodium hydroxide is exempt from the Maximum Residue Limits (MRLs) imposed on other pesticides, meaning residue on food is unregulated.² OSHA has established a safe exposure limit of 2mg/m³ for sodium hydroxide.⁵

Sodium Hydroxide: NaOH

What is it?

Sodium hydroxide is a strong base with a pH of 13.0. In addition to its use in film development, sodium hydroxide is predominantly used to manufacture soap, paper, dyes, and petroleum products. It is also used in the processing of cotton and metals, as well as in laundering, bleaching, and cleaning products, principally commercial drain and oven cleaners.¹

Routes of Exposure

Sodium hydroxide can enter the body through inhalation, contact with skin or eyes, or accidental ingestion.² Data from NIOSH estimated that the number of workers exposed to sodium hydroxide was around 2.8 million.³

Health Effects

Sodium hydroxide is a caustic skin irritant, chemically burning skin and other organic tissue. Ingestion results in reduced esophageal motor function, vomiting, intestinal pain and intestinal lesions. Contact with eyes can result in damage to the corneas. Inhalation causes irritation of the upper respiratory system, and long-term exposure may result in discomfort and ulcers in the nasal passages. Negative effects have been known to occur at low doses; a young woman suffered irreversible lung damage after one day of working with 5% NaOH aerosols in a poorly ventilated room.²



¹Anon. n.d. "SODIUM HYDROXIDE." *National Center for Biotechnology Information. PubChem Compound Database*. Retrieved December 2,

2017 (https://pubchem.ncbi.nlm.nih.gov/compound/sodium_hydroxide#section=Top).

²Anon. n.d. "Hazardous Substances Data Bank (HSDB)." *U.S. National Library of Medicine*. Retrieved December 2, 2017 (<https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?abs%2Bhsdb%3A%40term%2B%40m%2B%40rel%2B1310-73-2>).

³Anon. n.d. *National Occupational Exposure Survey, Numbers of Employees Potentially Exposed to Specific Agents by 2-Digit SIC*. Retrieved December 2, 2017 (<https://web.archive.org/web/20111026171051/http://www.cdc.gov/noes/noes1/69070sic.html>).

Anon. n.d. eCFR — Code of Federal Regulations. Retrieved December 3, 2017 (https://www.ecfr.gov/cgi-bin/text-idx?SID=89ab5041fcda4db26043e17f0fde6d4a&pid=20151009&node=pt21.3.184&rgn=div5#se21.3.184_11763).

⁵Anon. 2012. "UNITED STATES DEPARTMENT OF LABOR." *Occupational Safety and Health Administration*. Retrieved December 3, 2017

Hydroquinone: C₆H₆O₂

What is it?

Also known as benzene-1,4-diol, hydroquinone is chemically classified as a phenol derivative with antioxidant properties. It is commonly used in photographic developers and in cosmetics as a skin-bleaching agent. It is also produced in the synthesis of dyes and

Routes of Exposure

All means of exposure (inhalation, ingestion, contact with skin and eyes) to hydroquinone are hazardous. However, inhalation is a much more pertinent issue for workplace exposure than for use of consumer products.⁷

Health Effects

Hydroquinone has been identified as a possible human carcinogen, mutagen and teratogen. Exposure may cause irritation of skin, eyes and mucus membranes. Other symptoms of exposure may include ringing in the ears, nausea, dizziness and vomiting. The estimated oral lethal dose for humans is 50-500mg/kg.⁶

⁶Anon. n.d. "Hydroquinone." National Center for Biotechnology Information. PubChem Compound Database. Retrieved December 3, 2017 (<https://pubchem.ncbi.nlm.nih.gov/compound/hydroquinone#section=Top>).

⁷Center for Disease Control. n.d. *Occupational Safety and Health Guideline for Hydroquinone*. Retrieved December 3, 2017 (<https://www.cdc.gov/niosh/docs/81-123/pdfs/0338.pdf>).

⁸Center for Drug Evaluation and Research. n.d. "About the Center for Drug Evaluation and Research - Hydroquinone Studies Under The National Toxicology Program (NTP)." *U.S. Food and Drug Administration Home Page*. Retrieved December 4, 2017 (<https://www.fda.gov/AboutFDA/CentersOffices/OfficeofMedicalProductsandTobacco/CDER/ucm203112.htm>).

⁹Anon. n.d. "Indirect Additives used in Food Contact Substances." *U.S. Food and Drug Administration*. Retrieved December 4, 2017 (<https://www.accessdata.fda.gov/scripts/fdcc/index.cfm?set=IndirectAdditives&id=HYDROQUINONE>).

¹⁰Anon. n.d. *Chemistry of Photographic Processing*. Retrieved December 4, 2017 (<http://sites.tech.uh.edu/digitalmedia/materials/3351/PHOTCHEM.pdf>).

¹¹Carothers-Liske, Chloe and Charly Bloomquist. 2017. "Investigation into Darkroom Chemicals and Practices at Whitman College."

Regulation

Hydroquinone was classified as Generally Recognized as Safe and Effective (GRASE) in 1982 by the FDA for use in cosmetics as a skin-bleaching agent. This status was revoked in 2006 following studies which suggested it was carcinogenic. However, the chemical is still approved for use while it undergoes further testing.⁸ It is also approved by the FDA for use as an indirect food additive, in other words it can be used in food packaging and food contact materials.⁹ OSHA has established a safe exposure level of 2mg/m³ on average for an 8 hour work shift.⁷

Bringing it all together.

Use in Photography

Hydroquinone and sodium hydroxide act as the developing agent and activator, respectively, in the developing solution. Hydroquinone reduces the silver halides in the film into silver metal, which creates the transparent and opaque sections on the film that make up the photograph. However this reduction can only take place in an alkaline solution. Therefore sodium hydroxide or a similar strong base is needed.¹⁰



Alternatives

There are many less toxic photographic developers which do not contain hydroquinone and sodium hydroxide. For example, EcoPro currently manufactures a LegacyPro developer which uses ascorbic acid as the developing agent. However, these new developers are often not preferred by artists because they do not offer as consistent or high quality results as hydroquinone and sodium hydroxide based developers. Furthermore, information on how to use these developers for more specific, advanced, or alternative techniques is often not as readily available.¹¹

Conflicts of Interest

In the sphere of photography, there has been enough research and enough demand by artists and consumers to prompt photographic supply companies to manufacture less toxic products, an example of the consumer overcoming corporate power.¹¹ In attempt to minimize industry bias, the majority of the data for this fact sheet was sourced from government data bases.