



Chemical Sampling Information Diacetyl

General Description

Synonyms: Biacetyl; 2,3-Butanedione; 2,3-Butadione; 2,3-Diketobutane; Dimethyldiketone; Dimethylglyoxal; Glyoxal, dimethyl-

OSHA IMIS Code Number: D740

Chemical Abstracts Service (CAS) Registry Number: 431-03-8

NIOSH, Registry of Toxic Effects (RTECS) Identification Number: [EK2625000](#)

Chemical Description and Physical Properties: Green-yellow liquid

molecular formula: C₄H₆O₂

molecular weight: 86.09

boiling point: 88°C

vapor pressure: 178 mm

melting point: -3°C

Potentially hazardous incompatibilities: strong oxidizers, bases, reducing agents, metals

Health Factors

Potential symptoms: Eye, mucous membrane, respiratory system, skin irritation; persistent cough, phlegm production, wheezing, dyspnea (shortness of breath); unusual fatigue; episodes of mild fever or generalized aches; severe skin rashes.

Health Effects: Irritation-Eyes, Nose, Throat, Skin (HE15); Suspected cumulative lung damage---bronchiolitis obliterans (HE10)

Affected organs: : Eyes, respiratory system, skin

Notes:

1. No PEL or IDLH has been established. One of four rats died after a 6-hour exposure to vapors from heated (55°C) artificial butter flavoring containing 285 ppm diacetyl (~64% of total VOCs), but no deaths occurred among groups of six rats exposed to 203 ppm diacetyl (~68% of total VOCs) or 352 ppm diacetyl (~61% of total VOCs) (Hubbs et al., 2002).
2. A cause-effect relationship between diacetyl and bronchiolitis obliterans is difficult to assess because of mean diacetyl exposure levels ranging over four orders of magnitude for workplaces with affected individuals. In addition, food-processing and flavor-manufacturing employees with this lung disease were exposed to other volatile agents (CDC, 2007; Kanwal et al., 2006; Kreiss et al., 2002; Kullman et al., 2005; Lockey et al., 2002; NIOSH 2004, 2006).
3. Diacetyl is known to react with the amino acid arginine in proteins (Riordan, 1979) and inhibits enzymes that are important for protecting cells from oxidative damage, such as superoxide dismutase (Borders et al., 1985) and glutathione reductase (Boggaram and Mannervik, 1982) and glyoxalase I (Lupidi et al., 2001).
4. Diacetyl is metabolized to acetoin by diacetyl reductase, an ubiquitous enzyme that is uncompetitively inhibited by butyric acid (Nakagawa et al., 2002). Butyric acid is found along with diacetyl in some butter flavoring mixtures (Hubbs et al., 2002).

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Literature Basis:

- (occupational reports)
CDC: Fixed obstructive lung disease among workers in the flavor-manufacturing industry --- California, 2004--2007. *MMWR* **56**(16): 389-393, 2007.
- Kanwal, R., et al.: Evaluation of flavorings-related lung disease risk at six microwave popcorn plants. *J. Occup. Environ. Med.* **48**(2): 149-157, 2006.
- Kreiss, K., Gomaa, A., Kullman, G., Fedan, K., Simoes, E.J. and Enright, P.L.: Clinical bronchiolitis obliterans in workers at a microwave-popcorn plant. *New Eng. J. Med.* **347**(5): 330-338, 2002.
- Kullman, G., Boylstein, R., Jones, W., Piacitelli, C., Pendergrass, S. and Kreiss, K.: Characterization of respiratory exposures at a microwave popcorn plant with cases of bronchiolitis obliterans. *J. Occup. Environ. Hyg.* **2**(3): 169-178, 2005.
- Lockey, J., McKay, R., Barth, E., Dahlsten, J. and Baughman, R.: Bronchiolitis

Safety and Health Topics

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obliterans in the food flavoring industry [abstract]. *Am. J. Respir. Crit. Care Med.* **165**: A461, 2002.

- NIOSH Publication No. 2004-110: [Preventing Lung Disease in Workers Who Use or Make Flavorings](#). NIOSH 2004
- NIOSH Safety and Health Topic: [Flavorings-Related Lung Disease](#), NIOSH 2006
- Parmet, A.J. and Von Essen, S.: Rapidly progressive, fixed airway obstructive disease in popcorn workers: a new occupational pulmonary illness? [Letter] *J. Occup. Environ. Med.* **44**(3): 216-218, 2002.
- (inhalational toxicology in rats)
Hubbs, A.F., et al.: Necrosis of nasal and airway epithelium in rats inhaling vapors of artificial butter flavoring. *Toxicol. Appl. Pharmacol.* **185**: 128-135, 2002.
- (possible mechanisms of toxicity)
Boggaram, V. and Mannervik, B.: Essential arginine residues in the pyridine nucleotide binding sites of glutathione reductase. *Biochim. Biophys. Acta* **701**(1): 119-126, 1982.
- Borders, C.L. Jr., Saunders, J.E., Blech, D.M. and Frovich, I.: Essentiality of the active-site arginine residue for the normal catalytic activity of Cu,Zn superoxide dismutase. *Biochem. J.* **230**(3): 771-776, 1985.
- Lupidi, G., Bollettini, M., Venardi, G., Marmocchi, F. and Rotilio, G.: Functional residues on the enzyme active site of glyoxalase I from bovine brain. *Prep. Biochem. Biotechnol.* **31**(3): 317-329, 2001.
- Nakagawa, J., et al.: Molecular characterization of mammalian dicarbonyl/L-xylulose reductase and its localization in kidney. *J. Biol. Chem.* **27**(20): 17883-17891, 2002.
- Riordan, J.F.: Arginyl residues and anion binding sites in proteins. *Mol. Cell. Biochem.* **26**(2): 71-92, 1979.

Monitoring Methods used by OSHA

Laboratory Sampling/Analytical Method:

- **sampling media:** Two Silica Gel Tubes in series (150/75mg sect., 20/40 mesh)
analytical solvent: 95:5 ethanol:water
maximum volume: 3 Liters **maximum flow rate:** 0.05 L/min
current analytical method: Gas Chromatography; GC/FID
method reference: OSHA Manual of Analytical Methods ([OSHA PV2118](#))
method classification: Partially Validated
note: Separate the two tubes and cap both ends of each tube as soon as possible after sampling. Individually seal the two tubes.

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