DDAC and ADBAC Quaternary Ammonium Compounds: Draft Policy Analysis

TURA Administrative Council Meeting
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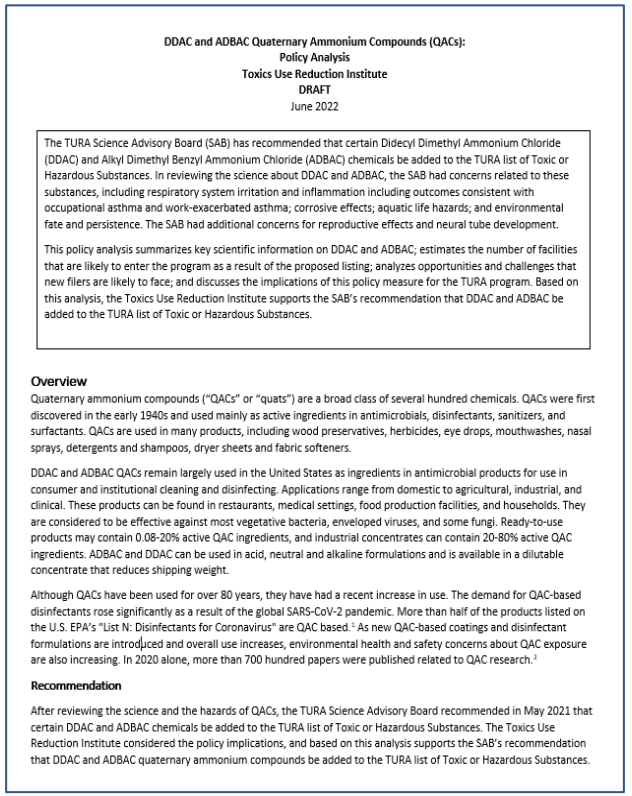
TURI
TOXICS USE REDUCTION INSTITUTE
UMASS LOWELL

Policy Analysis Overview

- Analyzes the implications of adding a substance category, DDAC and ADBAC Quaternary Ammonium Compounds
- With this addition, businesses in TURA covered sectors meeting relevant thresholds would be subject to TURA reporting, planning and fees
- Based on a thorough review of the Science Advisory Board's recommendation and policy implications, TURI recommends that a category of DDAC and ADBAC QACs, limited to 24 specific CAS registry numbers, be listed



DDAC and ADBAC Quaternary Ammonium Compounds (QACs):
Policy Analysis
Toxics Use Reduction Institute
DRAFT
June 2022

The TURA Science Advisory Board (SAB) has recommended that certain Didecyl Dimethyl Ammonium Chloride (DDAC) and Alkyl Dimethyl Benzyl Ammonium Chloride (ADBAC) chemicals be added to the TURA list of Toxic or Hazardous Substances. In reviewing the science about DDAC and ADBAC, the SAB had concerns related to these substances, including respiratory system irritation and inflammation including outcomes consistent with occupational asthma and work-exacerbated asthma; corrosive effects; aquatic life hazards; and environmental fate and persistence. The SAB had additional concerns for reproductive effects and neural tube development.

This policy analysis summarizes key scientific information on DDAC and ADBAC; estimates the number of facilities that are likely to enter the program as a result of the proposed listing; analyzes opportunities and challenges that new filers are likely to face; and discusses the implications of this policy measure for the TURA program. Based on this analysis, the Toxics Use Reduction Institute supports the SAB's recommendation that DDAC and ADBAC be added to the TURA list of Toxic or Hazardous Substances.

Overview

Quaternary ammonium compounds ("QACs" or "quats") are a broad class of several hundred chemicals. QACs were first discovered in the early 1940s and used mainly as active ingredients in antimicrobials, disinfectants, sanitizers, and surfactants. QACs are used in many products, including wood preservatives, herbicides, eye drops, mouthwashes, nasal sprays, detergents and shampoos, dryer sheets and fabric softeners.

DDAC and ADBAC QACs remain largely used in the United States as ingredients in antimicrobial products for use in consumer and institutional cleaning and disinfecting. Applications range from domestic to agricultural, industrial, and clinical. These products can be found in restaurants, medical settings, food production facilities, and households. They are considered to be effective against most vegetative bacteria, enveloped viruses, and some fungi. Ready-to-use products may contain 0.08-20% active QAC ingredients, and industrial concentrates can contain 20-80% active QAC ingredients. ADBAC and DDAC can be used in acid, neutral and alkaline formulations and is available in a dilutable concentrate that reduces shipping weight.

Although QACs have been used for over 80 years, they have had a recent increase in use. The demand for QAC-based disinfectants rose significantly as a result of the global SARS-CoV-2 pandemic. More than half of the products listed on the U.S. EPA's "List N: Disinfectants for Coronavirus" are QAC based.[1] As new QAC-based coatings and disinfectant formulations are introduced and overall use increases, environmental health and safety concerns about QAC exposure are also increasing. In 2020 alone, more than 700 hundred papers were published related to QAC research.[2]

Recommendation

After reviewing the science and the hazards of QACs, the TURA Science Advisory Board recommended in May 2021 that certain DDAC and ADBAC chemicals be added to the TURA list of Toxic or Hazardous Substances. The Toxics Use Reduction Institute considered the policy implications, and based on this analysis supports the SAB's recommendation that DDAC and ADBAC quaternary ammonium compounds be added to the TURA list of Toxic or Hazardous Substances.

QACs Policy Analysis

Summary of the Science

Use information

Opportunities for toxics use reduction

Regulatory context

Implications for the TURA program

Recommendation (pp. 1)

The TURA Science Advisory Board (SAB) has recommended adding:

5 DDAC and 19 ADBAC Quaternary Ammonium Compounds

Based on a thorough review of the information summarized in this policy analysis, the Toxics Use Reduction Institute recommends that this category be added to the TURA list.

Summary of Scientific Information (p. 2&3)

Respiratory Effects/Asthma: Surveillance studies, case reports, and animal studies indicate that DDAC and ADBAC are associated with respiratory system irritation and inflammation including outcomes consistent with occupational asthma and work-exacerbated asthma.

Summary of Scientific Information (p. 2&3)

Dermal Effects: ADBAC and DDAC are highly irritating to the skin, and long-term exposure may result in skin sensitization or allergic dermatitis.

Summary of Scientific Information (p. 2&3)

Irritant: Eyes, nose, throat, or lung irritation have all been reported among workers exposed to QACs.

Summary of Scientific Information (p. 2&3)

Reproductive/Developmental Effects: Some emerging evidence has suggested that exposure to QACs such as DDAC and ADBAC may affect reproduction and development in animals.

Summary of Scientific Information (p. 2&3)

Other Human Health Effects: A human biomonitoring study of 43 randomly selected volunteers detected measurable concentrations of QACs in the blood of 80% of participants and identified correlations between levels of QACs, cellular disruption and specific biomarkers related to human health.

Summary of Scientific Information (p. 2&3)

- **Environmental Fate**
  - Wastewater treatment plants remove some but not all QACs prior to discharge to the environment.
  - Concerns for **microorganisms** and **aquatic organisms** as well as the impact of QACs on **wastewater treatment plants**.
  - Found in **surface waters**, **soil**, **sediments**, and **wastewater sludge**.
  - DDAC and ADBAC are recognized as **toxic to aquatic life**.
  - They are considered **immobile in soil** by both EPA and ECHA. Due to their low volatility, they are expected to bind to sediments and soils.
  - There are also concerns that the overuse of DDAC, ADBAC, and other QACs could lead to development of **antibiotic-resistant bacteria**.

Papers after the SAB

- Review paper by Quat Residue Group: **Quaternary ammonium compounds: perspectives on benefits, hazards, and risk** Osimitz 2021

  Conclusions: QAC are safe and have been used for a long time. Risk assessments should be done, using only reliable studies

- Review paper by multidisciplinary, multi-institutional team of 26 authors from academia, governmental, and nonprofit organizations: **Quaternary Ammonium Compounds: A Chemical Class of Emerging Concern** Arnold 2023

  Conclusions: identified known and suspected health and env effects.

  Identifying and removing unnecessary uses of QACs, pointing to existing safer alternatives for essential uses, and incentivizing innovation of safer alternatives can prevent harm

Chemicals included in the SAB recommendation

Delimited Category based on EPA 2017 pesticide Registration Review Final Work Plans

5 DDAC QACs

19 ADBAC QACs

DDAC

CAS Number	Ingredient Name
7173-51-5	Didecyl dimethyl ammonium chloride
32426-11-2	1-Decanaminium, N,N-dimethyl-N-octyl-, chloride
5538-94-3	1-Octanaminium, N,N-dimethyl-N-octyl-, chloride
68607-28-3	Oxydiethylenebis(alkyl*dimethyl ammonium chloride) *(as in fatty acids of coconut oil)
61789-18-2	Alkyl* trimethyl ammonium chloride*(as in fatty acids of coconut oil)

ADBAC

CAS Number	Ingredient Name
53516-76-0	Alkyl (60%C14, 30%C16, 5%C18, 5%C12) dimethyl benzyl ammonium chloride
68424-85-1	Alkyl (50%C14, 40%C12, 10%C16) dimethyl benzyl ammonium chloride
8001-54-5	Alkyl (50%C12, 30%C14, 17%C16, 3%C18) dimethyl benzyl ammonium chloride
139-08-2	Alkyl (100% C14) dimethyl benzyl ammonium chloride
8045-21-4	Alkyl (50%C12, 30%C14, 17%C16, 3%C18) dimethyl ethylbenzyl ammonium chloride
73049-75-9	Dialkyl (60% C14, 30% C16, 5% C18, 5% C12) methyl benzyl ammonium chloride
121-54-0	Benzenemethanaminium, N,N-dimethyl-N-(2-(2-(4 (1,1,3,3tetramethylbutyl)phenoxy)ethoxy)ethyl)-, chloride
1330-85-4	Dodecylbenzyl trimethyl ammonium chloride
68424-85-1	Alkyl (60%C14, 25%C12, 15%C16) dimethyl benzyl ammonium chloride
61789-71-7	Alkyl (61% C12, 23% C14, 11% C16, 2.5% C18, 2.5% C10, traceC8) dimethyl benzyl ammonium chloride
68424-85-1	Alkyl (58%C14, 28%C16, 14%C12) dimethyl benzyl ammonium chloride
85409-23-0	Alkyl (68%C12, 32%C14) dimethyl ethylbenzyl ammonium chloride
68956-79-6	Alkyl (60%C14, 30%C16, 5%C12, 5%C18) dimethyl ethylbenzyl ammonium chloride
68989-01-5	Alkyl (50% C14, 40% C12, 10% C16) dimethyl benzyl ammonium saccharinate
68391-01-5	Alkyl (67%C12, 25%C14, 7%C16, 1%C18) dimethyl benzyl ammonium chloride
68424-85-1	Alkyl (95%C14, 3%C12, 2%C16) dimethyl benzyl ammonium chloride
68391-01-5	Alkyl (41%C14, 28%C12, 19%C18, 12%C16) dimethyl benzyl ammonium chloride
63449-41-2	Alkyl (67%C12, 25%C14, 7%C16, 1%C8, C10, and C18) dimethyl benzyl ammonium chloride
61789-18-2	Alkyl (as in fatty acids of coconut oil) trimethyl ammonium chloride

Estimating use information (p. 4)

Review Tier II : 5 potential filers

Program staff estimate a total of 5-10 users of QACs in TURA covered sectors.

This is a very rough estimate because of the lack of reliable information on use of QACs.

Uses outside of TURA covered SICs are likely.

Opportunities for TUR (p. 5)

- **Caprylic acid or octanoic acid**
  - Produced by the distillation of coconut or palm kernel oils. Corrosive in concentrated form.
- **Citric Acid**
  - Extracted from pineapple waste and citrus fruits. Corrosive in concentrated form.
- **Hydrogen Peroxide**
  - Readily available in retail stores as a dilute 3% formulation. Note that there is evidence that hydrogen peroxide and peroxyacetic acid together are respiratory sensitizers and may cause asthma, therefore the combination is **not** considered a safer alternative.
- **L-Lactic Acid**
  - Naturally occurring organic acid. Concentrated L-Lactic Acid is corrosive and a severe skin and eye irritant.

Opportunities for TUR (p. 5)

- **ALCOHOLS**
  - E.g. isopropanol (IPA) and ethanol (ethyl alcohol)
  - Evaporate quickly and are best used for spot cleaning.
  - Concentrated alcohols are flammable, are VOC's and exposure may cause nausea, dizziness, headache, and irritating effects to the skin, eyes, and throat.
- **AQUEOUS OZONE**
  - Typically produced at the point of use in an ozone generator, either portable equipment or handheld spray bottle devices.
  - Aqueous ozone has a short shelf life as the ozone readily reverts back to oxygen. Ozone gas is on the TURA list of Toxic or Hazardous Substances, and chemical and inhalation exposure at high concentrations can cause respiratory irritation and exacerbate asthma.

Opportunities for TUR (p. 5)

- **HYPOCHLOROUS ACID**
  - Chlorine solution generated by dissolving concentrated sodium dichloroisocyanurate (NaDCC) tablets in water, or by using electrolyzed water systems
  - Chlorine solutions have inherent hazards, but TURI lab testing indicates that airborne chlorine is lower for tablet-generated hypochlorous acid solutions than for bleach (sodium hypochlorite) solutions.
  - For more information on hypochlorous acid, see TURI's fact sheet.

Opportunities for TUR: Non-Chemical Alternatives

- **STEAM**
  - Free of chemicals; effective and suitable for many surfaces.
  - Caution needed to avoid burns.
- **UV LIGHT**
  - Suitable for specific applications, e.g., unoccupied medical rooms, high-tech electronic devices, inside air ducts.
  - UV hazards for eyes and skin.

Regulatory Context (p. 6)

- US EPA FIFRA
- European Biocidal Products Regulation
- Health Canada
- California Department of Pesticide Regulation
- California Biomonitoring

Implications for the TURA Program (p. 6)

- Implications of category designation
- TURA program services
- Fees and planning-related costs

Implications of Category Designation

- TURA's approach to categories has generally been based on the approach used under EPCRA.
  - A delimited category includes a finite number of chemicals specifically designated to be included as part of that category.
- Example: diisocyanates
- Defining a chemical category is appropriate in a number of circumstances & can provide several advantages compared with listing chemicals individually.

Implications of Category Designation

Similar functionality avoids Adverse Substitutions

Similar Hazards Across a Group

Often used in mixtures

TURA Program Services

- Information
- Laboratory testing
- Continuing Education
- OTA services
- Industry Grants
- Research

Fees

Total additional cost in fees to filers (and revenue to the program) could be $5,500 to $11,100 in per-chemical fees (5-10 filers for ADBAC and DDAC).

No new base fees are estimated at this time.

The Massachusetts Toxics Use Reduction Institute

www.turi.org

126 John Street, Suite 14
Boott Mills West
Lowell, MA 01852

Heather Tenney
Toxics Use Reduction Institute
Heather@turi.org

Resources

- TURI QAC Fact Sheet
- TURI SAB Minutes and Materials