

Quaternary Ammonium Compounds

The Basics



- Typically known as "Quats"
- Many individual chemicals
- Present in thousands of end-use formulations, many of which are blends of various Quats
- Common uses include disinfectants, surfactants, fabric softeners, antistatic agents, and wood preservation



Quat Types

- Each Quat has its own chemical and anti-microbiological characteristics
- USEPA has clustered Quats into four categories:
 - a. Group I: The alkyl or hydroxyl (straight chain) substituted Quats
 - Group II: The non-halogenated benzyl substituted Quats (including hydroxybenzyl, hydroxyethylbenzyl, naphylmethyl, dodecyhlbenzhyl, and alkyl benzyl)
 - Group III: The di- and tri-chlorobenzyl substituted
 Quats
 - d. Group IV: Quats with unusual substitutes (charged heterocyclic compounds)



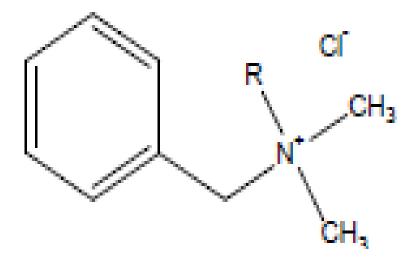
Alkyl dimethyl benzyl ammonium chloride (ADBAC)

- ADBAC is considered by USEPA to be the "model compound" for Quat Reregistration Eligibility Decision (RED) data development
- ADBAC is one of the most widely used Quats
- 24 compounds are considered ADBAC based on their general structures



Example ADBAC Structure

- Characterized by having a positively charged nitrogen (cation) covalently bonded to three alkyl group substituents and a benzyl substituent.
- $R = C_n H_{2n+1}$, where n = 8 to 18, with a mixture of carbon chain lengths, predominantly 12, 14 or 16





- Chemical structure determines chemical behavior
- Will be strongly cationic, so will attach to surfaces, both organic and inorganic
- Compound will be stable and hard to break, so has long lasting biocidal effect
- Anions, e.g. soaps or detergents, can attach to it, and hard water constituents, e.g. carbonate and sulfate



How Does ADBAC Work?

- ADBAC has a strong positive charge
- Bacteria have a negative charge
- ADBAC will attach to the bacteria and cause the cytoplasmic membrane to leak, damaging and eventually killing the bacteria



Biodegradation of Quat in Wastewater Systems

- Certain Quats will biodegrade
- Degradability is inversely proportional to alkyl chain length
- Degradation (better stated as removal via partitioning to sludge and biodegradation) will occur in a matter of days
- 90% removal cited in literature



Toxicity of Quat in Wastewater Systems

- Can be inhibitory or toxic at certain concentrations; toxicity increases with increasing chain length of alkyl group
- Is not believed to accumulate
- Will bind with anionic surfactants which creates a compound with different physiochemical properties; toxicity may be reduced due to the change in properties; new compound is hydrophobic and will partition to sludge
- Systems will acclimate to a degree, but slug loads can be a problem

Inhibitory Levels of Quat in Wastewater Systems

- Anaerobic process: 5 15 ppm
- Aerobic process
 - a. CBOD removal: 10 30 ppm
 - b. Nitrification: 2 5 ppm

Note: based on concentrations of the active ingredient(s)



How Can I Measure Quat Levels?

- Test strips: Hydrion, LaMotte, EM Quant; unit range is typically in increments of 50 or 100 ppm, hard to read
- Hach has a low range test kit for levels up to 5 ppm
- Potentiometric titration most accurate; ASTM Method D5806-95 for Quats used as disinfectants