

# General information on Quaternary Ammonium Compounds - Quats

## Description

Quaternary ammonium compounds (Quats/QAC), such as FeF® Benzalkonium Chloride (BKC), FeF® Cetrimide and FeF® CTAB (Cetrimonium Bromide), constitute a group of cationic substances expressing a high affinity to membrane proteins. Due to their antibacterial activities, Quats are widely used as disinfectants, preservatives/ antiseptics and detergents in medical treatments such as ophthalmic and nasal preparations and skin disinfection, to eliminate bacterial infections and contaminations.

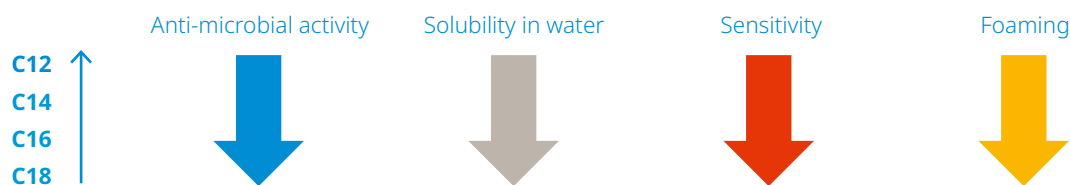
Quats are characterized by a fast, long-lasting effect against common bacteria, both gram+ and gram-, fungi, algae and enveloped vira such as HIV, herpes and corona. Their antimicrobial activity derives from their ability to attach to the membrane of the micro-organism and disrupt it.

## Properties

The different alkyl (fatty) chain lengths give the Quats different properties. For example, antimicrobial activity is greater for shorter chain lengths, however skin sensitivity decreases as the chain length increases. Shorter chain lengths are more soluble, and they also foam more.

Our production and process know-how allows us to offer Quats with a completely well-defined alkyl chain length distribution, whether it is with our standard chain length or with customized chain length distributions.

### Alkyl chain length



## Mode of action

The Quats' alkyl (fatty) chains have a good affinity for bacterial membranes, and the mechanism of action is the disruption of intermolecular interactions. Quats can cause dissociation of cellular membrane lipid layers, compromising cellular permeability controls and inducing leakage of cellular contents.

The Quats' hydrophilic cationic region destabilizes the pathogen's surface by forming electrostatic interactions with negatively charged components. These interactions effectively out-compete the divalent cations, which normally stabilizes surface structures by linking adjacent negatively-charged components. Once close contact is accomplished by the hydrophilic region, the Quat's hydrophobic region proceeds to penetrate the hydrophobic bilayer to cause cell leakage and cytolysis.

## Product characteristics

**Solubility:** FeF® Quats are miscible with water or lower alcohols, such as methanol, ethanol and propanol in all ratios. They are not miscible with benzene or ether.



**Compatibility:** Mixing Quats with ordinary soaps and/or with anionic detergents may decrease the activity. As Quats are cationic compounds, they should not be mixed with anionic compounds which would have a neutralizing effect. Quats can be inhibited by Tween® and by lecithin. Avoid mixing Benzalkonium Chloride (BKC) with citrates, iodides, nitrates, permanganates, salicylates, silver salts and tartrates. Incompatibilities have also been reported with other substances including aluminium, fluorescein sodium, hydrogen peroxide, kaolin and some sulfonamides.

**Stability:** 5 years shelf life.

**Other:** Odourless, Colourless, Easy to formulate, Surface active / adhesive, Non-volatile and very stable.

## Antimicrobial effect

FeF® Quats are effective at all pH levels. However their effectivity increases when the pH increases. The higher the pH, the lower the concentration needed to obtain an antimicrobial effect. As opposed to bacteriostatic/fungistatic compounds which only prevent micro-organisms from dividing (growing), Quats are bactericidal/fungicidal, meaning they will kill micro-organisms whether they are in a growth phase or not. FeF® Quats have been tested against several relevant microbial strains, and shown to be effective against a wide range of micro-organisms at low concentrations. FeF® Quats are compared here with ethanol and with a positive control containing Meropenem (a broad-spectrum antibiotic). See Table 1.

**Table 1:** Minimal Inhibitory Concentrations. Mean results in % or µg/ml.

Species	ATCC no.	BKC %	CTAB %	Cetrimide %	Ethanol %	Meropenem µg/ml	Control strain/ Meropenem µg/ml	Range of control µg/ml
Candida albicans	2091	< 0.001	< 0.001	0.002	>1	>16	-	-
Corynebacteria amycolatum	CCUG 33685	0.002	0.004	0.004	>1	0.006	0.006	0.06-0.25
Streptococcus dysgalactiae	12394	< 0.001	< 0.001	0.002	>1	< 0.015	0.06	0.06-0.25
Enterococcus faecalis	29212	< 0.001	< 0.001	< 0.001	>1	0.125-8	0.125-8	2-8
Staphylococcus aureus MRSA	33591	< 0.001	< 0.001	< 0.001	>1	16	-	-
Staphylococcus aureus	29213	< 0.001	< 0.001	< 0.001	>1	0.06	0.06	0.03-0.12
Pseudomonas aeruginosa	27853	0.008	0.063	0.016	>1	0.5	0.5	0.25-1
Mycobacterium abscessus NFM32	-	< 0.001	< 0.001	< 0.001	>1	< 0.001	-	-
Acinetobacter baumannii	19606	0.002	0.002	0.008	>1	1	-	-
Staphylococcus lugdunensis	70328	< 0.001	< 0.001	< 0.001	>1	0.25	-	-

Statens Serum Institute, Denmark (2016)

Typical Quats concentrations in finished products can vary from 0.001% up to 0.1% w/w as an excipient and up to 2% w/w as an active ingredient, depending on the application (ophthalmic, topical, nasal, gynaecology, etc.).